Guidance Note 50

QUANTIFYING AND JUSTIFYING USEFUL HEAT OUTPUTS

INTRODUCTION

GN 50.1

This Guidance Note relates to the provision by Responsible Persons (RPs) of supporting evidence for the quantification and justification of Qualifying Heat. Such evidence must accompany Design Submissions. Additional supporting evidence may also be required from an RP following a Scheme audit, in which case a specific request will be made by the CHPQA Administrator.

GN 50.2

It should be noted that under changes to the Non-Domestic RHI Regulations (May 2018) that for applications made on or after 22 May 2018, heat used for the drying of wood-fuel and the drying, cleaning or processing of waste ceased to be eligible heat uses. Any heat used for these purposes is not eligible for RHI support. For more information on RHI eligibility criteria, please see Ofgem's website (https://www.ofgem.gov.uk/environmental- programmes/non-domestic-rhi).

GN 50.3

The CHP Qualifying Heat Output (CHP_{QHO}) is the amount of 'useful heat' supplied annually from a CHP Scheme. According to the CHPQA Standard, 'useful heat' is heat from a CHP Scheme delivered to satisfy an economically justifiable demand for heat or cooling. It must be heat that can be demonstrably utilised to displace heat that would otherwise be supplied from other sources. It 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.

GN 50.4

Ensuring that the CHP_{QHO} claimed constitutes **useful heat** and that it has been appropriately quantified are key considerations in the CHPQA Certification process. The CHPQA programme needs to be assured that the heat (or cooling) loads served by the CHP:

1. are by their nature economically-justifiable; and

2. do not exceed that which would otherwise be satisfied by heat (or cooling) processes other than CHP.

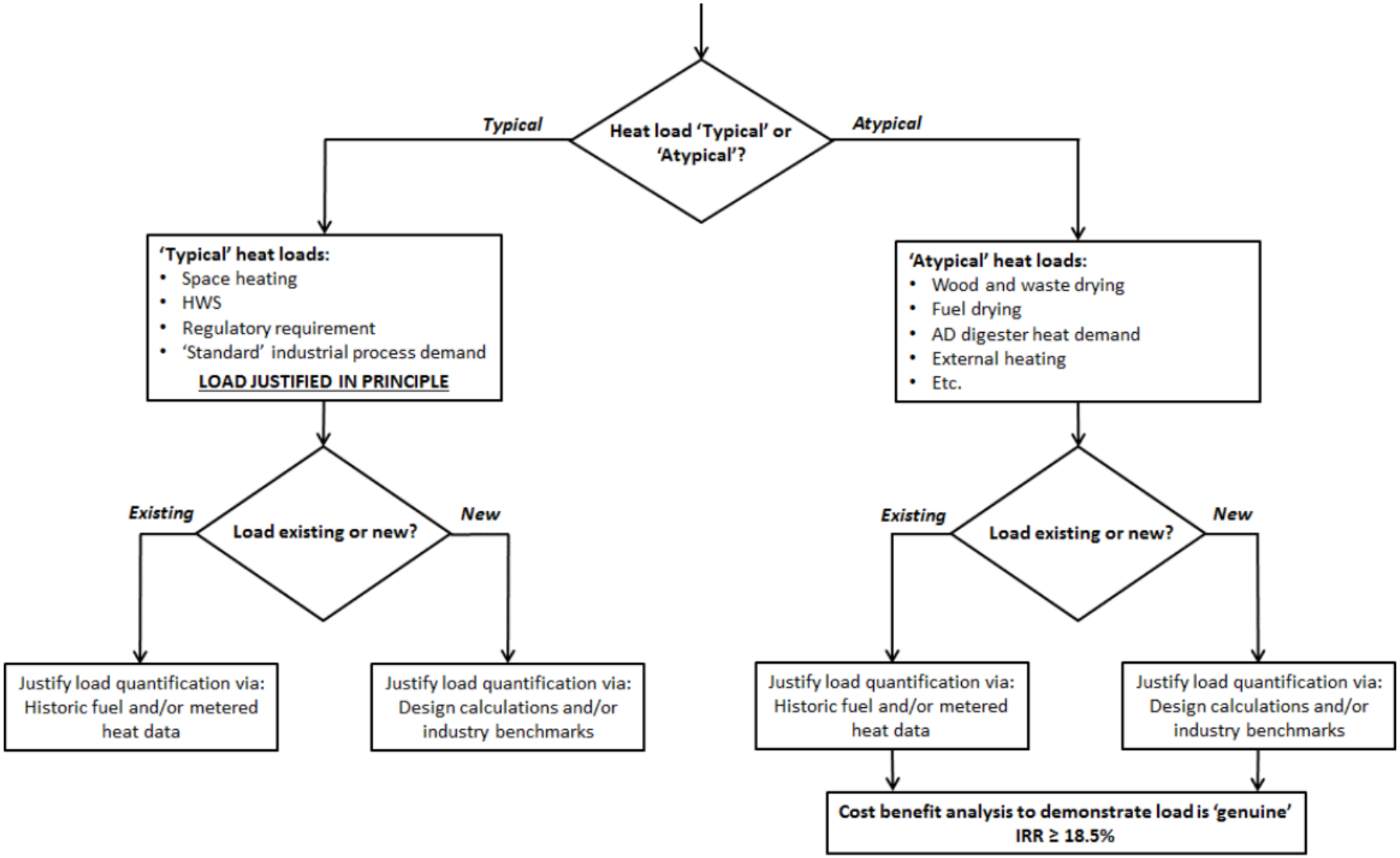
GN 50.5

For the purposes of this Guidance Note, heat loads are categorised as 'typical' and 'atypical':

- **'Typical'** heat loads are those that CHPQA will usually consider to be economically-justifiable by default due to their nature, subject to quantification to satisfy GN50.3 above (see also GN 50.5 to GN 50.8).

- **'Atypical'** heat loads are unusual or unconventional heat loads, where the 'usefulness' of the heat might be in doubt. For such loads, a cost-benefit analysis must be provided to CHPQA to demonstrate that they are economically-justified at the quantities claimed. See GN 50.9 to GN 50.12.

The diagram on the next page illustrates the requirements.



‘TYPICAL’ HEAT LOADS

GN 50.6

The need for space heating and/or hot water services for residential and commercial buildings is normally considered ‘essential’ and so in principle is economically-justifiable, subject to quantification.

GN 50.7

Heat is also considered useful by default if the need is driven by a legislative requirement. For example, this would include heating for the pasteurisation of kitchen waste, where legislation demands that the waste is pasteurised for 1 hour at 70°C. The heat used in the pasteurisation process is considered useful heat but needs to be quantified, taking into account the amount of waste that needs to be pasteurised and the design of the system.

As part of the CHPQA Design Submission, the Responsible Person must provide evidence of the legislative requirements including the text of the published regulation and a copy of any relevant permits stating the conditions under which the permit was granted. Additional information on the legislative requirements may also be requested by CHPQA depending on the specific circumstances of the Scheme.

GN 50.8

Heat for industrial processes will normally be considered as economically- justifiable if the demands are shown as necessary for production. A description of the processes and the relevant heat requirements must be provided by the RP. The quantification of the heat loads to be served by the CHP must also be supported with appropriate evidence.

GN 50.9

The onus is on the Responsible Person to justify that the heat claimed as qualifying is in fact useful heat. In making a Design Submission, the Scheme’s RP is required to provide details of heat demands, including quantification, and evidence that the claimed CHP_{QHO} can be considered useful heat. The evidence required will largely depend on whether the heat load is existing or new.

Existing Heat Loads - Typical

GN 50.10

In cases where the heat from a new CHP Scheme **displaces heat from existing heat source(s)** serving existing heat demand(s), then the CHP heat loads can be considered useful heat as long as:

- The heat load(s) are not atypical,

- The RP provides a description of each of the CHP heat loads being claimed as useful heat in the Design Submission,

- The RP provides evidence that the heat demands intended to be met by the CHP Scheme do not exceed that of the existing heat generation process. This should normally comprise actual data on the historic fuel consumption or metered heat that is used to derive the total heat load profiles to be provided, along with the CHP output profiles, as attachments to the Design Submission.

If actual data is not available or is insufficient to quantify an existing heat load, then it should be treated as a 'new' heat load and the quantification evidence described below provided.

New Heat Loads - Typical

GN 50.11

'New' heat loads are those where there is insufficient or unrepresentative historical fuel consumption or metered heat data to justify the size of the CHP heat load being claimed as useful. This includes:

- Where the site, or part of the site, which the CHP Scheme is to be serving is new,

- Where there is an expansion of site operations causing existing heat loads to be increased or additional heat loads to be added. For example, the introduction of a new process or building,

- Where the heat loads are existing and already served by existing plant (e.g. boilers), but there is poor availability of actual heat or fuel consumption data to adequately quantify the heat loads.

GN 50.12

For 'new' heat loads, the quantification of the qualifying heat from the CHP Scheme needs to be evidenced by the RP providing design calculations. Examples might include:

- For industrial processes, the annual production rate of products (e.g. tonnes of product) and the anticipated consumption of heat/steam in the various stages of the manufacturing process. This would need to be supported by design calculations for each stage and/or appropriate industry benchmarks based on best available technology practices.

- For space and hot water heating, building heat loss calculations or calculations

based on recognised benchmarks.

‘ATYPICAL’ HEAT LOADS

GN 50.13

The CHPQA programme considers certain heat loads to be ‘atypical’. These are unusual or unconventional heat loads, where the usefulness of the heat may be in doubt, and include the following:

- drying processes including, for example, woodchip and waste drying, drying of fuel for own use, drying of animal bedding;
- digester heat demand in AD plants (heat other than that required by pasteurisers where this is a legislative requirement);
- external heating such as: outdoor swimming pools; heating of top soil; heating landfill lagoons; seawater heating for brine extraction; defrosting of sports fields; etc.

This is not an exhaustive list and Responsible Persons who believe that they may have an atypical heat load are advised to contact CHPQA prior to submission to discuss the scheme’s particular circumstances.

GN 50.14

In order for CHPQA to certify schemes with atypical heat loads, the applicant must be able to demonstrate that the heat demand meets the definition of ‘useful heat’. It therefore needs to be demonstrated that the heat demand would exist in the absence of a CHP plant and that it would otherwise be satisfied at market conditions by other heat generation processes. This is likely to require the RP to provide a cost-benefit analysis, **irrespective of whether the heat load already exists and is being served by other means**.

GN 50.15

The detailed cost-benefit analysis for the heat load should involve evaluating all of the expected revenues from satisfying the proposed atypical heat demand and comparing that with the costs that will be incurred. These should cover capital (including equipment costs, engineering design, procurement, installation and commissioning) and operating costs (costs of fuel and maintenance, and other costs as relevant). The cost-benefit analysis should assume that CHP does not exist and that the heat is only provided through an alternative to CHP (e.g. boiler plant). Any fiscal benefits or revenue that would accrue from CHP cannot be included as part of this analysis.

GN 50.16

In support of the economic analysis, the Responsible Person needs to provide a detailed market analysis of the alternative systems, and evidence for the assumptions

and calculations made. Where the heat load is not yet in place, the analysis should include evidence that the heat load will materialise in the future when the scheme starts operating. In the case of the drying of a fuel or other product, this could for example be in the form of **existing contracts or memoranda of understanding** with potential clients.

GN 50.17

The cost-benefit analysis should be undertaken as a cash flow over 15 years resulting in a calculated Internal Rate of Return (IRR)[1]. The use of simple payback period is not acceptable. To be considered economically-justifiable, serving the atypical heat load must achieve an IRR at least 18.5%[2].

CHP heat used for processing of CHP fuel

GN 50.18

Where a proportion of the CHP heat claimed as qualifying is used in the processing of fuel (e.g. drying of the incoming biomass or waste fuel), which is then consumed (or intended to be consumed) in the CHP scheme, then this heat may be classified as a useful CHP heat output as long as it is displacing heat from other sources. In such cases, it must still be demonstrated that this use of the heat is an economically-justifiable precursor to the combustion of the fuel within the CHP plant.

SUMMARY OF EVIDENCE REQUIREMENTS

GN 50.19

The table below provides a summary of the types of supporting evidence that will be required to justify the quantification of existing or new heat loads. This is not exhaustive and CHPQA may require additional evidence depending on individual Scheme circumstances.

Application	Typical Evidence Requirements	
	Existing Heat Loads	New Heat Loads
Space heating, and hot water services for buildings	Fuel bills for 12 consecutive months, showing the fuel consumption for the boiler that has been historically used to provide the necessary heat, and the boiler's heat generation efficiency.	Description of where and how the useful heat is used. Total floor heated area of the building(s) being heated (or cooled). Reference to benchmark data on

[1] The Internal Rate of Return of an investment is the Discount Rate that gives a Net Present Value (NPV) equal to zero.

[2] An IRR of 18.5% is equivalent to achieving a simple payback period of just under 5 years for a project with constant annual savings over a 15-year assessment period.

Application	Typical Evidence Requirements	
	Existing Heat Loads	**New Heat Loads**
	For cooling to be served by an absorption chiller, the cooling load and details of the absorption chiller (rated capacity, output, Coefficient of Performance (CoP), and range of operating temperatures).	typical heat and/or or cooling loads for buildings (e.g. CIBSE TM54, or other sources of credible benchmarks for heat/cooling demand). For cooling to be served by an absorption chiller, the cooling load and details of the absorption chiller (rated capacity, output, Coefficient of Performance (CoP), and range of operating temperatures).
Industrial process heat	• Fuel bills for 12 consecutive months. • Actual heat consumption figures in the various stages of the production process. • Temperatures at which heat is required. • Heat demand profiles (half hourly).	• The annual production rate of the product. • Reference to industry standards detailing benchmark heat demand. • Temperatures at which heat is required. • Fully set-out calculations from first principles.
Atypical heat loads	As per industrial process heat, plus; • Description of the business case, and full cost-benefit analysis for the claimed heat demand. As appropriate, this should include a description of the market for the product (e.g. dried woodchip) or outcome of the heating. • Memoranda of understanding and contracts with potential customers for the product or the heat itself, if being sold. • Pre-treatment conditions and explanation/justification for them. For example, for wood or wood-fuel drying, input moisture level supported by evidence on the source of the wood. • Relevant specifications for the product/outcome. For example, desired moisture levels supported by evidence such as agreements and specifications by clients • Detailed description of the process and equipment supported by evidence such as technical specifications including parameters such as efficiency, temperatures, flow rates, etc.	

Application	Typical Evidence Requirements	
	Existing Heat Loads	New Heat Loads
	• Description of good practices employed to maximise the process efficiency. • Capital costs of the technology supported by evidence such as quote from supplier.	

EXAMPLE HEAT LOAD QUANTIFICATION AND ECONOMIC JUSTIFICATION FOR WOODCHIP DRYING

In order to quantify the amount of heat required for woodchip drying, the amount of feedstock (tonnes/year) and the input and output moisture levels (percentage moisture content) are required. Evidence of the system throughput in terms of the woodchip dried should be provided using, for example, agreements and memoranda of understanding with customers. Regarding the input moisture levels, it should be noted that best practice is to allow woodchip to naturally dry to levels between 35 – 40% and to cover the woodchip to prevent it from absorbing moisture. For the purpose of CHPQA calculations of the drying heat load, a maximum input moisture level of 40% should be used.

Evidence regarding the required output moisture level (e.g. based on client or customer specifications and requirements) should also be provided. Experience, based on boiler specifications, shows that most boilers are capable of combusting woodchip with moisture levels between 20% and 25%. Depending on the type of gasifier used, woodchip may need to be dried to 10% moisture content. Some gasifiers (updraft fixed bed gasifiers) will have a built-in drying zone and so higher moisture levels are possible. A Design Submission to CHPQA should be accompanied by evidence demonstrating customer requirements in terms of the required output moisture levels and the woodchip's intended use (i.e. whether for use in boilers or gasifiers and the associated boiler/gasifier datasheets).

Assuming 50,000 tonnes of wet woodchip per year and a drying requirement from 40% to 20% moisture content (mc) at 40°C at 50% drying efficiency:

The total mass of dried wood with 20% moisture is:

$$50{,}000 \times [(1 - 40\%) / (1 - 20\%)] = 37{,}500 \text{ tonnes/year}$$

The amount of moisture to be removed is:

$$50{,}000 - 37{,}500 = 12{,}500 \text{ tonnes/year}$$

The theoretical minimum heat demand is:

(12,500 tonne water × 2,405 MJ/tonne water) / 3,600 = 8,350 MWh/year

(Where 2,405 MJ/tonne water is the latent heat of water evaporation at 40°C)

Assuming a dryer efficiency of 50%, the actual heat demand is therefore:

16,700 MWh/year

Different types of dryers will have different efficiencies and so details and manufacturer specifications of the drier used should be provided to support the assumptions made.

For CHPQA assessment and auditing purposes, in addition to measurements of heat input to the drier, records of the woodchip dried as well as woodchip supplied to customers should be kept. For example, for submissions associated with a drying business that receives wet woodchip, dries it and returns the dried woodchip to customers, records of deliveries (including amounts of wet woodchip and moisture content) and agreements with the customers (agreed moisture level for delivered woodchip) should be maintained and provided to CHPQA upon request.

Following the determination of the heat load, cost-benefit analysis needs to be undertaken to show that the additional heat load is economically-justifiable. Example calculations for the above case are shown below.

Item	Description / calculations
Capital costs of alternative to CHP (oil boiler) and woodchip drier	For the drying heat load above, a 2.5 MW_{th} oil boiler and drying floor is the conventional system that would be used rather than CHP. A capital cost (capex) of **£300k** is assumed. Evidence needs to be provided in the form of supplier quotes.
Operating costs	Assume 50,000 tonnes/yr of wet woodchip (40% mc) is bought at £70/tonne giving a cost of £3,500k /yr, Heat to the dryer is supplied by an oil burner with an efficiency of 85%, thus the oil consumption is 16,700/0.85 = 19,650 MWh/yr. Heating oil price is 47.2 p/litre (3.8 p/kWh), thus total heating oil cost = £747k /yr Assume basic annual operation and maintenance cost = 4% of capex = £12k /yr Major 5 yearly overhaul costs = 5% of capex (£15 k) which spread evenly amounts to an average of £3k /yr Thus, the total annual operating costs are **£4,262k /yr**
Revenue	37,500 tonnes/yr of dry woodchip (20% mc) is sold at £115/tonne giving a revenue of **£4,313k /yr**

Financial analysis	The annual saving is £4.313M - £4.262M = **£51k /yr** The simple payback period is thus 300/51 = 5.9 years The IRR of a capital cost of £0.3M followed by a constant net income stream of £51k /yr for 15 years is 14.9%. This means the heat load is not economically- justifiable and cannot be claimed as useful heat.

IRR for the example above assuming fixed annual income:

Project year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Cash flow, £k	-300	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51

IRR **14.9%**

In reality, fluctuations in parameters such as maintenance costs and forecasted energy prices will cause the net annual income to vary.

Ideally, the economic case should account for such fluctuations. In the example below, major overhaul costs, which occur every 5 years, are properly accounted for rather than spreading them evenly across all years. IRR for the example above assuming varying annual income.

Project year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Cash flow, £k	-300	56	56	56	56	31	56	56	56	56	31	56	56	56	56	31

IRR **15.4%**

