UKETS13 FAR – Monitoring and reporting in relation to the free allocation rules

February 2025

This document is intended to provide guidance for operators of installations. If there is any inconsistency between the guidance and legislation, the legislation prevails.

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Contents

1. Overview

This document has been designed to help operators of installations to understand the requirements for monitoring and reporting all data required for free allocation of UK allowances and for the update of benchmark values.

Important note

The UK ETS Authority has announced that the start of the second allocation period has been moved from 2026 to 2027 for free allocation (FA) purposes. This follows recognition of stakeholder views and concerns over the potential misalignment of industrial decarbonisation and carbon leakage policy. This change also enables us to align the implementation of the Free Allocation Review with the introduction of the UK CBAM, ensuring a holistic policy approach to carbon leakage, and providing additional time for policy development in what is a complex and challenging area. These are important decisions which will impact the future of business and industry, and we want to get them right.

Following this announcement, any changes to FA policy following the Free Allocation Review will take effect from 2027. The Free Allocation Review consultation sought views on some changes to FA rules, such as changes to the carbon leakage list and application of the carbon leakage exposure factor, which, if implemented, could change eligibility for FA. Depending on the outcome of the Free Allocation Review, some installations' eligibility to FA could change after the baseline data collection exercise from April - June 2025 has concluded. In addition, the indicative FA values produced by the baseline data report (BDR) template may be subject to revision following the publication of any changes to the FA rules resulting from the review.

The relevant legislation in this area is:

- **The Greenhouse Gas Emissions Trading Scheme Order 2020 (the Order)** (https://www.legislation.gov.uk/uksi/2020/1265/contents) as amended from time to time
- **The Free Allocation Regulation (FAR)** (https://www.legislation.gov.uk/eur/2019/331/contents) as it has effect in domestic law and as amended from time to time

- **The Monitoring and Reporting Regulation (MRR 2018)** (Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018) on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council (disregarding any amendments adopted after 11th November 2020) as given effect for the purpose of the UK ETS by Article 24 of the Order and subject to the modifications made by Schedules 4, 7 and 8 to the Order
- **The Verification Regulation (VR 2018)** (Commission Implementing Regulation (EU) 2018/2067 of 19 December 2018 on the verification of data and on the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council (disregarding any amendments adopted after 11th November 2020) as given effect for the purpose of the UK ETS by Article 25 of the Order and subject to the modifications in Schedules 5 and 8 to the Order

Note that "Monitoring plan" (MP) in this document always means the one approved under the MRR. "Monitoring methodology plan" (MMP) always means the plan relevant under the FAR.

2. Concepts and approaches

2.1 Benchmarks and sub-installations in the UK ETS

Benchmarks are reference values that enable the performance of peers (i.e. sub-installations producing the same 'product') to be compared. Benchmarks are not emission limit values, however, and are combined with other values to determine the number of allowances freely allocated to UK ETS participants. In the context of the UK ETS, benchmarks are related to the greenhouse gas (GHG) efficiency of production processes, expressed as GHG emission intensity, or more specifically as 'direct emissions [t CO_2(e)] per tonne of product'. The UK ETS utilises the benchmarks from phase IV of the EU ETS for the first free allocation period (2021 – 2026), with each benchmark set as the average GHG efficiency of the 10% best performing installations in the sector across the EU.[1] Such an approach requires sound methodology to ensure equal treatment across the wide range of circumstances found at installations. This approach is outlined in Chapter 5.

It is relatively simple to determine GHG efficiency in cases when only one product is produced at an installation. The operator must monitor the emissions as well as the quantity of (saleable) product.[2] However, the typical installation in the UK ETS produces more than one product. In such a case it is necessary to split the emissions by making meaningful measurements or assumptions, before the GHG efficiency (emissions/production) can be calculated. The way to split emissions in the UK ETS is through 'sub-installations'. The shortest possible description of a sub-installation is:

> The system boundaries of a mass and energy balance, encompassing inputs, outputs, and emissions to determine benchmarks for a product or group of products, independent of other products (including heat or electricity) produced in the same installation.

The above definition indicates that the system boundaries do not necessarily conform to physical parts of the installation such as boilers, kilns, distillation columns or combined heat and power (CHP) units (also referred to as cogeneration). One sub-installation can

[1] As set by Article 10a(2) of the EU ETS Directive. Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Union and amending Council Directive 96/61/EC (Text with EEA relevance).

[2] Annex I of the FAR contains product definitions. They do not always refer to saleable quantities. More details are discussed in section 4.8.

encompass several units,[3] but also one physical unit can serve several sub-installations.[4] Additionally, there could be a time factor, when one physical unit is used consecutively for different sub-installations, for example a furnace is used to produce different types of glass covered under separate product benchmarks. A detailed example of the split of an installation into sub-installations is presented in section 2.5. Further examples (including further steps to calculate the allocation) can be found in guidance document 'UKETS11 FAR - Determining allocation at the installation level'.

The same concept is also applicable to the so-called 'fall-back approaches', i.e. rules for allocation to parts of installations that are not covered by product benchmarks. These are:

- The heat benchmark (for measurable heat) sub-installations
- The fuel benchmark sub-installations
- Process emissions sub-installations

For a more detailed explanation of the concept, in particular, the context of determining 'attributable emissions', which is an essential requirement of monitoring and reporting for FA purposes, please refer to section 5.3.

Note: Schedule 2, paragraph 3(1)(b), to the UK ETS Order requires that 'where such an [schedule 2] activity is carried out on a site, the combustion of fuels in any combustion unit [applies]'. This requirement can lead to situations where an installation has only one product benchmark (e.g. lime) along with a smaller heat or fuel benchmark sub-installation for non-related combustion activities e.g. for heating of offices or workshops at the installation.

2.2 Inputs, outputs, and emissions of a sub-installation

When looking into the definitions of sub-installations in sub-paragraphs (2), (3), (5) and (6) of Article 2 of the FAR, the common element is that 'inputs, outputs, and emissions' together form the sub-installation, i.e. they define the boundaries of each sub-installation, where 'boundary' is understood to relate to a mass and energy balance that ultimately allows:

[3] For example, the mineral oil refinery benchmark may encompass a dozen or more units situated on a site for some km^2

[4] For example, where a boiler produces steam that is used for heating several production processes belonging to different other sub-installations

- The calculation of the GHG efficiency of each sub-installation, with the aim of creating a 'benchmark curve' to calculate the benchmark value for a product, and

- To calculate the allocation of FA for each sub-installation by applying the benchmark determined above.

To achieve consistency between both intended uses of the sub-installations, system boundaries must be identical for both purposes. Consequently, the same data reported by operators can be used for both purposes, which allows for reasonable efficiency in the monitoring, reporting and verification (MRV) of the relevant baseline data.[5] This is why the FAR cover both purposes, requesting the 'monitoring methodology plan' (MMP, see chapter 3) as well as the BDR to cover both data sets in order to ensure that all relevant data is monitored and reported.

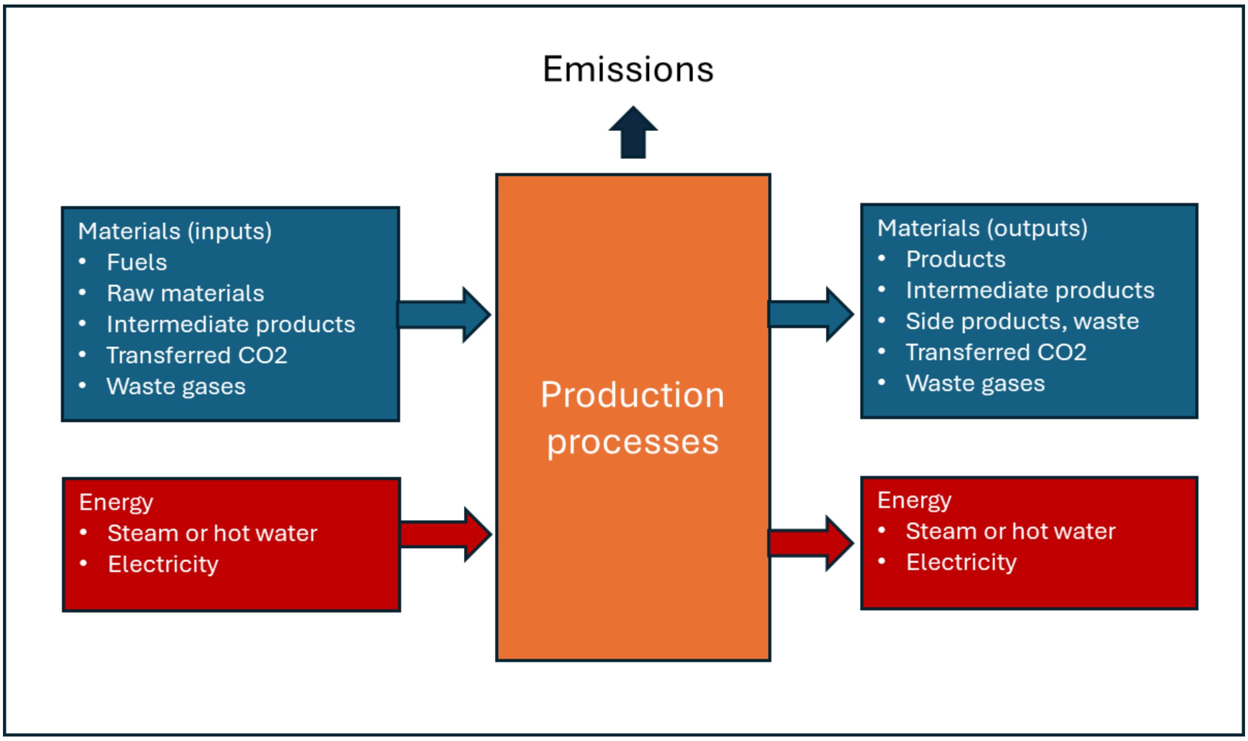


Figure 1: Generic approach to defining a sub-installation by considering the mass and energy balance of a production process that should be subject to benchmarking

[5] In 2019, operators of installations with an EU ETS permit on or before 30 June 2019 (incumbent installations) applied for a free allocation of allowances for the 2021 to 2025 UK ETS allocation period by submitting a verified BDR to their regulator (this period has subsequently been extended to 2026). The next baseline data collection for the 2027 – 2030 free allocation period will take place between April and June 2025.

Figure 1 represents a fictitious, very general production process which may be covered by the UK ETS, to help understand the terms 'inputs', 'outputs, and 'emissions'. This process has the broadest possible list of inputs and outputs, as follows:

- Input materials under the mass balance aspect:
  - Fuel - materials which are combusted for generating heat for use in the process under consideration or elsewhere. Both the fuel quantity (and its carbon content/emission factor) as well as its energy content are relevant for attributing it to the sub-installation. The energy content is not directly used for allocation or benchmark calculation, but for corroboration of the correct attribution across the whole installation.
  - Raw materials - materials which participate in other chemical reactions or physically modified in the process for generating the product, a by-product or a waste. Note that only materials that generate emissions are considered for monitoring, i.e. those materials which are considered 'source streams' under the MRR. Process materials that fulfil these criteria and have a relevant energy content must be considered (i.e. reported), even when the primary purpose of the material's use is not energy generation.
  - Intermediate products - materials which fall under the product definition of a product benchmark given in Annex I to the FAR, but where for example, the process under consideration adds a finishing step. In principle the same applies as for 'raw materials'. However, according to Article 16(7) of the FAR, operators must ensure that the same quantity of the product or intermediate product is not double counted for allocation purposes.
  - Transferred CO2, i.e. (pure) CO2 that is used within the production process - this is to be monitored like any other source stream under the MRR.
  - Waste gases[6] (e.g. blast furnace gas, converter gas etc.) – these are considered normal source streams under the MRR and need to be monitored like other fuels. However, separate monitoring is required for FAR purposes:[7] Where the waste gas is not fully consumed in the same sub-installation where it

[6] According to FAR Article 2(11): "*'waste gas' means a gas containing incompletely oxidised carbon in a gaseous state under standard conditions which is a result of any of the processes listed in point (10) [i.e. in the definition of the process emissions sub-installation], where 'standard conditions' means temperature of 273,15 K and pressure conditions of 101 325 Pa defining normal cubic metres (Nm3) according to Article 3(52) of the Monitoring and Reporting Regulation 2018*".

[7] As such gases often exhibit a low usable energy content (NCV) but a high emission factor, the FAR apply special rules to the attribution of waste gas-related emissions to sub-installations to level the playing field as much as possible between users of waste gases and users of other fuels. For more information refer to 'UKETS17 FAR - Waste gases and process emissions sub-installations'.

is produced, a part of the waste gas is attributed to the sub-installation producing the waste gas, and the remaining part to the sub-installation consuming it. Note that those two sub-installations may be part of separate installations. Thus, only the ‘consumer part’ of the waste gas stream must be included when a waste gas (in accordance with the definition of the FAR) is input to a sub-installation.

- Energy inputs:
  - The energy contained in fuels and raw materials, as mentioned in the bullet points above.
  - Energy contained in a heat transfer medium such as hot water, steam, etc - such energy is referred to as ‘measurable heat’ by the FAR. ‘Net measurable heat’ is the quantity to be monitored, i.e. the difference between the enthalpy of the heat medium entering the process and the one returning (in case of steam, the return is usually called ‘condensate’). Furthermore, information on the origin of the heat is required, i.e. whether it was produced within the boundaries of the UK ETS or outside. Sections 4.9 to 4.12 of this document as well as ‘UKETS15 FAR – Cross-boundary heat flows’, provide further information on monitoring the required parameters.
  - Electricity input - in the context of the UK ETS, where the benchmark relates to direct emissions, electricity input is not usually required for the full energy balance of a production process. However, for several product benchmarks the FAR states that ‘exchangeability between electricity and fuels’ is relevant. Those product benchmarks’ system boundaries define which uses of electricity are to be considered and so need to be monitored and reported for use in the allocation formula. More information is found in ‘UKETS11 FAR - Determining the allocation at installation level’.
- Output materials under the mass balance aspect:
  - Product - these are the (physical) products of the sub-installation, such as ‘tonnes of facing bricks’. For product benchmarks the operator must ensure not only correct quantification (in most cases the saleable production), but also whether the product complies with the specific product definition (in this case: ‘Facing bricks with a density > 1000 kg/m3 used for masonry based on EN 771-1, excluding pavers, clinker bricks and blue braised facing bricks.’). In many cases this will mean comparing the product’s quality with a definition given for

one or more specific PRODCOM[8] codes. Several special rules apply, e.g. CWT approach for refineries, special metering points instead of saleable products (e.g. for glass bottles and jars), or normalising the quantity sold to a reference state based on chemical analyses (e.g. for lime and dolime).

Note that where a mass balance is applied for MRR purposes (i.e. where significant amounts of carbon remain in the product) the carbon content and, where relevant, its energy content must be recorded to determine the emissions and the energy balance. However, the main purpose of monitoring the quantity of products is to calculate the free allocation, as well as to determine the updated benchmark values.

In the case of 'fall-back' sub-installations, one reason for monitoring products is to ensure their correct treatment regarding significant risk of carbon leakage, where applicable. Additionally, these data are required to calculate energy consumption per product to determine whether there have been energy efficiency changes (Article 6 of the ALCR).

Point (b) in section 2.6 of Annex IV to the FAR requires that the operator reports quantities of products (aggregated by PRODCOM code) for all types of sub-installations (i.e. also for fall-back sub-installations).

- Intermediate products - see above under 'inputs'. Operators should determine whether an intermediate product should be considered a 'product' of the sub-installation in which it is produced, or of the sub-installation in which the 'product' is finished, to avoid double counting of the allocation. Otherwise only potential carbon or energy content need to be monitored.
- Side products (by-products) and waste - like other materials, these only need to be monitored if relevant in terms of carbon content for the determination of the sub-installation's emissions, and energy content for corroboration purposes.
- CO2 transferred out of the (sub-)installation relevant for determination of the sub-installation's emissions (relevant rules are set out in Article 49 of and Annex IV to the MRR).
- Waste gases - see above under 'inputs'. If a waste gas is exported from the sub-installation, a part of its emissions is accounted for under the sub-installation which is producing the waste gas, and only a CO_2 equivalent to

[8] PRODCOM codes are set out under Commission Regulation (EU) 2019/1933 and can be found at https://www.legislation.gov.uk/eur/2019/1933/annexes

natural gas of the same energy content (multiplied by a correction factor for differences in reference efficiencies) is counted as exported.

- Energy outputs:
  - Measurable heat exported from a product benchmark sub-installation is to be treated like a second product, i.e. the emissions associated with this heat must be subtracted[9] from the emissions of that sub-installation (which means the sub-installation is more efficient than another installation with similar emissions, but no heat export).

    However, the situation is different for heat benchmark sub-installations and the district heating sub-installation. As their 'product' is the measurable heat, it counts towards their own activity level even if exported to other installations, except where the installation receiving the heat is eligible for allocation itself. In other words, only export of heat to non-UK ETS installations or entities is eligible for allocation under the heat benchmark. However, the amount of eligible heat for these sub-installations is the outcome of a more complex installation-wide calculation that is discussed in section 4.12.

  - Electricity produced: in principle electricity production is not eligible for any free allocation, and therefore it is formally never part of a sub-installation. Nevertheless, electricity can be produced in processes which are otherwise (e.g. due to their physical integration in units used for the purpose of the sub-installation) considered inside the (product) benchmark sub-installation, e.g. expansion turbines, CHP plants in some cases,[10] etc. As explained for measurable heat, electricity is also a 'second product', for which a deduction from the attributed emissions is needed to reflect the additional efficiency of the process.

- Emissions:
  - Direct emissions in line with the MRR: in line with the installation's approved monitoring plan (MP),[11] the installation's emissions are determined using either a calculation-based methodology (based on source streams), a measurement-based methodology (using continuous emission measurement systems, CEMS), a non-tier approach ('fall-back methodology'), or combinations thereof. All GHGs (CO2, N2O, PFCs) will be monitored (the latter two only occur in the

[9] Note that the emissions to be deducted here are only to be reported by the operator if the respective fuel mix (emission factor and boiler efficiency, if applicable) are known. In other cases, only the quantity of heat is to be reported.
[10] For example, recovery boilers integrated with CHP systems in chemical pulp sub-installations.
[11] "Monitoring plan" (MP) in this document always means the one approved under the MRR. "Monitoring methodology plan" (MMP) always means the plan relevant under the FAR.

process emission sub-installation, or in a few product benchmark sub-installations). Often it will be simple to split these emissions into sub-installations, where source streams are used only by a single sub-installation, or where an emission source monitored by CEMS is fully attributable to a single sub-installation. However, it is likely that more complicated splits must be made. This will usually take into account the following considerations (combinations of these approaches may be necessary, depending on an installation's situation):

- Source streams are split using the same approach as applied above for the respective fuels and materials, ensuring that the correct NCVs and emission factors are used.
- In the case of CEMS, proxy values used for 'corroborative calculations' (mandatory for all CO2 CEMS under the MRR) can be used to assign the source streams instead of the measured emissions to determine a proportionality factor by which the measured emissions can be split to sub-installations.
- At sub-installation level, a few source streams may have to be monitored which are not included in the MP under the MRR. For example, where an integrated steel plant (including a coke oven and a power plant for waste gas use) is monitored under one mass balance ('bubble' approach), neither the coke nor the waste gases produced need to be monitored, but only the coal entering the coke oven. If this happens, the sub-installation level monitoring requires the amounts of coke and waste gases, as well as their NCV and carbon content, to be monitored. Within this document and the related reporting templates these source streams are referred to as 'internal source streams'. However, to limit the administrative burden, the FAR do not require the operator to apply specific tiers for such monitoring. Operators can follow the hierarchy of approaches set out in the FAR (see section 4.6), including avoiding unreasonable costs.
- Where physical units serve several sub-installations (particularly units producing measurable heat) the preferred method (which is reflected in reporting templates) is to first determine the specific emissions per TJ of measurable heat using the relevant fuel mix (and including process emissions from flue gas cleaning). Thereafter, operators should attribute the emissions of that physical unit to each sub-installation using the quantities of heat consumed in each sub-installation. Note the special rules for splitting emissions from CHP units into emissions attributed to electricity and to heat (see section 4.10).

  - To avoid double counting or data gaps, operators can determine the emissions of (*n–1*) sub-installations by the approaches above, if the installation has *n* sub-installations. The operator can calculate emissions of the last sub-installation as the difference between the whole installation's emissions and the emissions of the other (*n–1*) sub-installations.[12] Note, however, that there are cases of emissions and other data which do to belong to any type of sub-installation (see section 2.2.1). In those cases, this 'non-eligible' fraction can be considered a 'virtual sub-installation' for testing if 100% of the data are attributed.

- **'Attributed emissions'** are a wider concept than the direct emissions. They are required for establishing the benchmarking curves to update the benchmark values. They allow for comparability between different installation configurations, as discussed in section 2.1. Therefore, certain 'indirect emissions' must be included when updating the benchmark values, in line with the methodology used in the UK for the third phase of the EU ETS (2013-2020). As is shown in section 2.3, the following additions to the direct emissions under the MRR must be made:

  - Addition of emissions for imports of measurable heat: if available, the operator must report the actual emission factor of the imported heat. Where the actual emission factor cannot be determined, the attributed emissions will be determined at a later stage using the amount of measurable heat reported for the relevant sub-installation (as the value of the [updated] heat benchmark is not known at the time of data collection)

  - Deductions made for heat exports

  - Where a waste gas is imported and consumed, only the 'consumption'-related fraction of the direct emissions is accounted for (i.e. a deduction is applied to the direct emissions, see section 5.3)

  - If waste gases are exported from the sub-installation, the 'production'-related fraction remains at the sub-installation (is added to the direct emissions)

  - Addition of an emission equivalent for 'exchangeable' electricity, if applicable

[12] This approach can be used for all other data sets to be attributed to sub-installations. See section 2.2.1 for which data sets cannot be attributed to sub-installations.

- Subtraction of an emission equivalent for electricity production, if applicable.

2.2.1 Non-attributed elements

The split of data from installation level to sub-installations, as described in the bullet points above, is relevant for the complete MRV system under the FAR, i.e. all the data mentioned (if applicable at the individual installation) must be reported in the BDR. The MMP must therefore contain information on how each data set is determined for each sub-installation.

After attributing all inputs, outputs and emissions to sub-installations following the FAR, some inputs, outputs, and emissions will remain not attributed to any sub-installation (these elements are not eligible for free allocation). Examples include:

- Fuels and/or measurable heat used for electricity production, and the related emissions
- Measurable heat produced in nitric acid sub-installations, from electric boilers or imported from non-UK ETS entities
- Emissions related to heat exported to UK ETS installations
- Waste gases or fuels flared for purposes other than safety flaring outside product benchmark sub-installations, and related emissions.

To limit the administrative burden, the sub-installation split may be simplified by applying the ‘95%’ rule when attributing ‘de-minimis’ parts of the installation to sub-installations (Article 10(3) of the FAR). More information is given in section 4.

2.3 Attributed emissions

To update the benchmark values (i.e. for generating new benchmark curves), other aspects need to be considered rather than just the direct emissions of a sub-installation. The aim is that the specific GHG emissions per tonne of product from each installation must be made comparable to each other, i.e. system boundaries must be strictly consistent, and related rules must be obeyed by operators.

The method for attributing emissions to sub-installations is given in section 10 of Annex VII to the FAR. For calculating the “attributed emissions” of each sub-installation the following formula is used (note that not all terms are relevant for all types of sub-installations; for further information and examples see section 5.3.

Equation 1

$$AttrEM = DirEm^{*} + Em_{H,import} - Em_{H,export} + WG_{corr,import} - WG_{corr,export} + Em_{el,exch} - Em_{el,produced}$$

The variables of this equation are explained in section 5.3. Detailed examples provide guidance to operators for developing their MMP. Operators must ensure data are complete and there is no double-counting in their BDR and activity level report (ALR).

2.4 Further rules on splitting data into sub-installations

The FAR contain some specific rules on practical approaches to splitting data according to sub-installations. These are:

- **Distinction between carbon leakage (CL) / non-CL:** Article 10(3) of the FAR requires that the heat benchmark sub-installation, fuel benchmark sub-installation and process emission sub-installation are each split into two (or three, in the case of heat separate sub-installations), depending on the sector's risk of carbon leakage. The split is carried out on the basis of the PRODCOM[13] or NACE[14] codes to which the production processes and/or final (physical) products correspond, i.e. if measurable heat is used to produce a product deemed not at risk of carbon leakage, this amount of heat is attributed to the "non-CL heat benchmark" sub-installation, while other measurable heat within the same installation may belong to the "CL heat benchmark" sub-installation.

- **The "95% rule":** As a simplification of the above rule, a de-minimis rule was introduced. It allows an operator to not make this split, if more than 95% of the related activity level (in the example of the first bullet point: the total measurable heat not falling under a product benchmark sub-installation) belongs to either CL or non-CL sub-installation.

- Similarly, the district heating sub-installation has been included in this simplification rule: if either of the three[15] heat benchmark sub-installations consume more than 95% of the total heat, the remaining less than 5% may be attributed to the same sub-installation.

[13] The applicable PRODCOM codes are those set down in Commission Regulation (EU) 2019/1933 https://www.legislation.gov.uk/eur/2019/1933/annexes

[14] NACE codes mean "NACE Rev 2.0" as laid down in Regulation (EC) No 1893/2006 of the European Parliament and of the Council, as amended (codes can found in the annex) https://www.legislation.gov.uk/eur/2006/1893/pdfs/eur_20061893_2019-07-26_en.pdf

[15] CL, non-CL heat benchmark sub-installation, and district heating sub-installation.

- **Completeness checks (Article 10(5) of the FAR):** When designing the MMP, and throughout monitoring and reporting, the operator shall regularly carry out checks on data completeness, as laid down in Article 10(5) of the FAR. These checks include the completeness of source streams and emission sources, measurable heat flows, waste gas flows, physical products and their PRODCOM codes, etc., in line with the considerations given in sections 2.2 and 5.3.
- **Specific rules for avoiding double counting:**
  - Products of a production process returned into the same production process are deducted from annual activity levels (Article 10(5)(j) of the FAR). Where the activity level according to Annex I to the FAR refers to the amount of saleable product, this rule is not relevant.
  - Where measurable heat is produced by recovery from another sub-installation (particularly from flue gas streams coming from a fuel benchmark sub-installation, but also all other types of waste heat), such heat can be eligible for inclusion in the heat benchmark sub-installations. To avoid double counting, the amount of heat divided by a reference efficiency of 90% is to be deducted from the sub-installation where the heat is recovered (Article 10(5)(k) of the FAR). Where the deduction must be expressed in terms of tCO_2, a suitable conversion factor (heat or fuel benchmark, as applicable) is to be used.

2.5 Example for splitting an installation into sub-installations

In the example installation (shown in Figure 2 below) the following physical units are operated:

- A kiln for cement clinker production
  - Waste heat from the exhaust gas is supplied to a district heating network
- A cement grinding plant,[16] where a directly fired dryer is used for some raw materials

[16] Cement grinding plants, when operated as stand-alone installations, are usually not UK ETS installations, since their combustion units (if any) are usually below 20MW rated thermal input. However, in this example (which is purely illustrative), the assumption is that the grinding is within the boundaries of the UK ETS installation. This is because it contains a combustion unit (the dryer), and paragraph 5 of Schedule 2 of the Order requires that the "*rated thermal input of all combustion units on the site must be added together, except for (a) combustion units with a rated thermal input below 3 megawatts; (b) combustion units that use only biomass as a fuel.*"

- A kiln for lime production, in which during some months of the year magnesite is burnt instead of lime.

The operator of such installation would perform the following steps to develop an MMP or a BDR.

Step 1: List all physical units, inputs, outputs and emissions
As a first step the operator should list all physical units, their inputs, outputs, and emissions as shown in Table 1 below. Thereafter the operator can proceed to identify which types of sub-installation are relevant (using the sequence given in Article 10(2) of the FAR), before attributing inputs, outputs, and emissions to these sub-installations. This may require an iterative approach, as it may not always be obvious in the first instance which sub-installations are relevant. The example here illustrates the relationship between physical units and sub-installations, as this is often useful for further development of the monitoring approaches.

> Note: The FAR defines sub-installations only via “inputs, outputs and emissions” (see section 2.2 of this document). Hence there is no formal requirement to attribute physical units to sub-installations, particularly because – as also shown in this example – physical units can serve several sub-installations. Therefore, the exercise of “attributing” physical units should be understood as a useful step in the practical approach of designing an MMP.

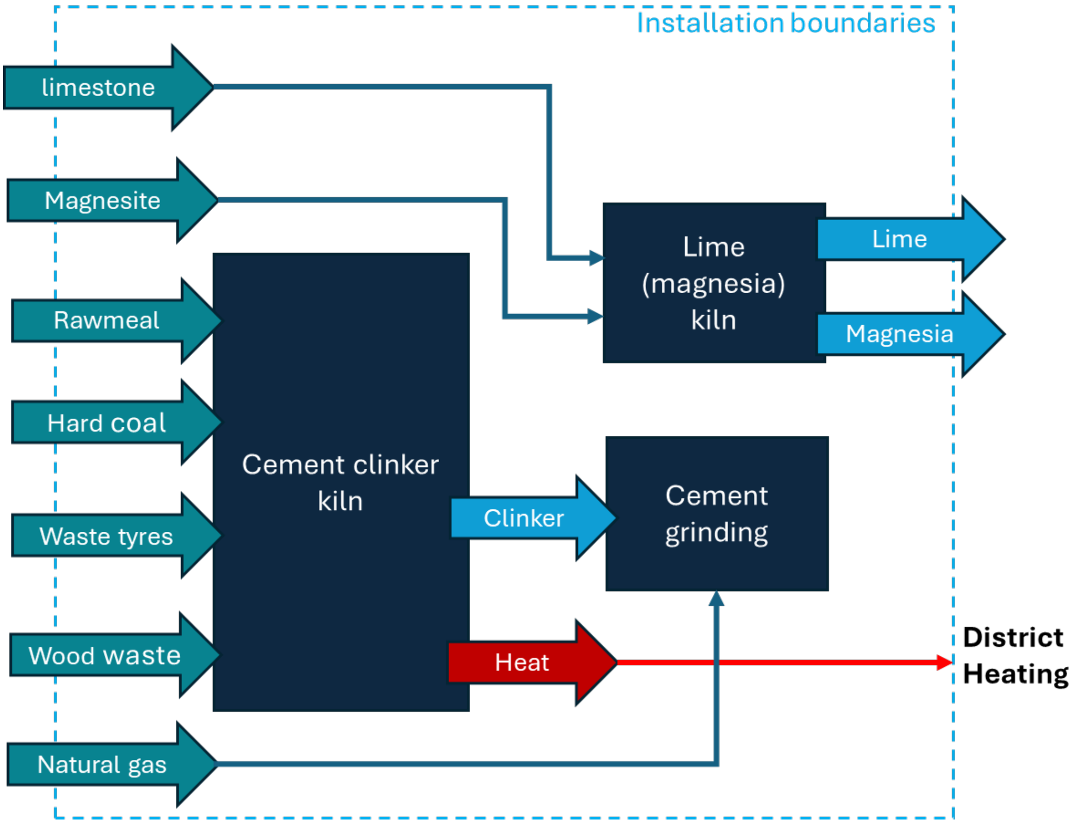


Figure 2 Fictitious example installation for illustrating the sub-installation concept

Table 1 below lists the physical units, inputs, outputs, and emissions of the example installation required for splitting the installation into sub-installations in line with the FAR. This table illustrates the situation before carrying out the steps described in the main text.

Inputs	Physical units	Outputs	Emissions
• Hard coal (to cement clinker kiln) • Waste tyres (to cement clinker kiln) • Wood wastes (to cement clinker kiln) • Natural gas (to dryer and lime kiln) • Raw meal • Limestone	• Cement clinker kiln • Grinding plant (including dryer) • Lime/magnesium oxide (magnesia) kiln • (Heat exchanger for district heating)	• Clinker • Cement(s) • Lime • Magnesium oxide (magnesia) • District heating	• From coal • From tyres • Biomass (zero-rated) • From natural gas • Process emissions from raw meal • Lime process emissions

• Magnesite			• MgO process emissions

Step 2: Identify relevant sub-installations

- Identify **product benchmark sub-installations** using the product definitions of Annex I to the FAR:
  - The operator identifies that the cement clinker produced falls within the definition of the "grey cement clinker" benchmark
  - The operator identifies that the lime produced falls within the definition of the "lime" product benchmark
  - The operator assesses the composition of the magnesium oxide (magnesia) which results from the burning of magnesite. As it does not contain significant amounts of calcium oxide, it does not fall within the definition of the dolime or sintered dolime benchmark. Consequently, fall-back sub-installations will be relevant for this process.
- Identify potential **heat benchmark sub-installations:**
  - The only case of measurable heat found in this example is the heat generated from the waste heat of the clinker benchmark sub-installation. To decide which sub-installation is relevant, the operator must assess if they have evidence for the use of the measurable heat. In the example it is assumed that the operator is co-owner of the heat network. The other owner is a local electricity and heat providing company. The latter acts as a service company that is responsible for the contracts and invoicing of the heat end-users. From information provided by the service company, the operator of the example installation can categorize the heat users as private households, except for one consumer which is a small factory producing essential oils and perfumes. The NACE codes for these products are 2053 and 2042, neither of which are found on the EU Carbon Leakage List (CLL)[17] which the UK ETS continues to use. However, as the operator has evidence for all baseline years that the heat delivered to this factory was usually around 4% of the total heat produced, the operator can apply Article 10(3) of the FAR and consider the whole measurable heat to fall within the district heating sub-installation.[18]

[17] https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/carbon-leakage_en#carbon-leakage-list
[18] Without this evidence, both district heating and non-carbon leakage heat benchmark sub-installation would be relevant.

- Identify **fuel benchmark sub-installations:**
  - Remaining fuel used in this example installation – after accounting for fuel used in the sub-installations above – is 1) in the dryer of the cement grinding plant, and 2) in the magnesite burning.
  - The operator must assess if these two processes are considered to belong to sectors exposed to carbon leakage. The operator concludes that both processes belong to sectors found on the CLL.[19] Consequently, only the "CL fuel benchmark sub-installation" is relevant in the example.
- Identify **process emissions sub-installations:**
  - The only process emissions not covered elsewhere are related to the decomposition of magnesium carbonate ($MgCO_3$) to magnesium oxide / magnesia (MgO) in the lime / magnesia kiln. As discussed above under the fuel benchmark sub-installation, this process belongs to a sector exposed to carbon leakage. Therefore the "CL process emissions sub-installation" is relevant.

Step 3: Assign inputs, outputs, emissions (and physical units) to sub-installations
The operator of the example installation uses Table 1 as a checklist for assigning the relevant materials and fuels to sub-installations. This is relatively simple in most cases:

- Grey clinker sub-installation:
  - Physical units: cement kiln, including preheaters, pre-calciner, clinker cooler, auxiliary equipment, etc. In this example, the sub-installation is self-contained and there is no doubt about physical boundaries to other sub-installations. The heat exchanger for the district heating, including boiler water preparation, relevant metering equipment etc. can be clearly identified at the installation and on the plans and flow charts attached to the MMP.
  - Inputs:
    - Fuels: hard coal, waste tyres, wood wastes. In the example there is no flue gas cleaning which gives raise to further emissions (no De-NOx).
    - Process materials: raw meal as already monitored for MRR purposes (Method A – input based).

[19] Production of cement: NACE 23.51. Magnesium oxide is not explicitly found on the PRODCOM list. However, depending on its further use it might be considered a refractory material (NACE 23.20) or inorganic basic chemical (NACE 20.13) – both NACE codes are found on the CLL.

  - Outputs (products): only cement clinker is the relevant product for the activity level. If not already monitored for MRR purposes, additional monitoring of clinker must be introduced for allocation purposes. The measurable heat is considered an export of this sub-installation to another sub-installation.
  - Emissions: monitoring is fully covered by the MP under the MRR, as none of the relevant fuels or materials are used in other sub-installations. Note that the waste tyres and wood wastes include both biomass and fossil emissions. Under the FAR the same monitoring rules apply for biomass emissions as under the MRR.
  - Attributed emissions: when determining the “attributed emissions” of this sub-installation, an appropriate number of emissions need to be deducted related to heat export to the district heating sub-installation. See “district heating sub-installation” below.
- Lime sub-installation:
  - Physical units: lime kiln and auxiliary equipment. Note that the lime kiln is shared with the magnesium oxide / magnesia production (fuel benchmark and process emissions sub-installations). To identify when the lime (magnesia) kiln falls under the lime sub-installation, the operator needs to monitor the periods when it is used for each production process i.e. there must be an effective system for distinguishing and documenting each production process (including unambiguous assignment of times of transition between processes).
  - Outputs (products): the operator uses Method B (output based) under the MRR. Therefore, lime production (output) is already monitored which includes appropriate composition data (content of free calcium oxide (CaO) and free MgO in the product), required to calculate the HAL corrections in line with Annex III to the FAR.
  - Inputs:
    - Limestone: no monitoring required, as it is not required for allocation purposes, and quantification is possible indirectly using the stoichiometric relationship to the product.
    - Natural gas: since natural gas is also used for other purposes, monitoring in accordance with the MP under the MRR is not sufficient. More details are given below under step 4.
  - Emissions: the lime process emissions can be determined from MRR data. The emissions from natural gas can be determined using the same emission factor as for the total natural gas, in line with the MP under the MRR. However, the amount

of natural gas attributable to the lime sub-installations needs to be determined as explained under step 4 below.

  - Attributed emissions: identical to “emissions” above.

- District heating sub-installation:
  - Physical units: heat exchanger and all the auxiliary equipment for running the heat distribution network (including water treatment, metering, pumps, etc.) are clearly identifiable.
  - Inputs: none relevant (fuels are considered part of the grey cement clinker sub-installation).
  - Outputs (products): measurable heat exported from the installation.
  - Emissions: none.
  - Attributed emissions: in accordance with the FAR, operators should not attribute emissions in respect of measurable heat imported or exported from a sub-installation, if the emission factor of the fuel mix is unknown. In this case, operators should report only the quantity of heat.
- CL fuel benchmark sub-installation:
  - Physical units: lime kiln (when magnesium oxide / magnesia is produced but not lime); cement grinding plant dryer.
  - Inputs: natural gas - for monitoring requirements see step 4 below.
  - Outputs (products): several grades of cement; magnesium oxide.
  - Emissions: emissions proportionate to the natural gas attributable to this sub-installation, using the emission factor in accordance with the MP under the MRR.
  - Attributed emissions: identical to “emissions”.
- CL process emissions sub-installation:
  - Physical units: lime kiln at times it is not operated under the “lime” product benchmark sub-installation.
  - Outputs (products): magnesium oxide / magnesia. As for lime, it is assumed that method B (output based) is used for monitoring under the MRR, and appropriate data are available.

  - Inputs: raw magnesite. Not relevant for monitoring in this example.
  - Emissions: as determined under the MRR, proportionate to the quantity of magnesium oxide produced.
  - Attributed emissions: identical to "emissions".

- Completeness check:
  - The operator finds no input, output, or emissions within the installation's boundaries which have not been assigned to a sub-installation. If there are unattributed items, the operator would check whether they correspond with the list set out in section 2.2.1.
  - In this case there is no need for the operator to monitor electricity, since electricity is not produced on site, and exchangeability of fuels and electricity is not relevant for the grey clinker or lime product benchmarks, as per Annex I to the FAR.
  - Waste gases, flaring, and transfer of CO2 to or from other sub-installations or installations are not relevant. Therefore, the related sections in the MMP template and the BDR can be omitted.

The relevant sub-installations are defined in Figure 3.

Step 4: Identify monitoring needs

In this example installation further data need to be monitored in addition to data already monitored under the MRR:

- Activity level of each sub-installation: this is the most important parameter for allocation purposes. It must be reported on an annual basis for the purpose of assessing whether allocation changes are required. In the example installation, activity levels include the following:
  - Grey cement clinker: clinker production is a new monitoring requirement. In this example, emissions from clinker production are monitored on an input basis as per the MP.
  - Lime: lime production is already monitored using Method B (output based) for emissions monitoring under the MRR. However, for FAR purposes production data must be corrected to 'standard pure lime' using composition data (content of free calcium oxide (CaO) and free MgO in the product), as per Annex III to the FAR. In this case, CaO and MgO composition data are already monitored under Method B of the MRR.

  - District heating sub-installation: the operator must determine measurable heat exported on an annual basis.
  - CL fuel benchmark sub-installation: the operator must determine the total energy input to this sub-installation (expressed as terajoules, i.e. fuel quantity multiplied by its NCV). See "split of natural gas" below.
  - CL process emissions sub-installation: as stated above, the operator reports these process emissions already as part of their AEM report. Emissions from burning magnesite are fully attributable to this sub-installation.
- Split of natural gas: natural gas in this example is used in two physical units (lime kiln and dryer) which are shared between two different sub-installations (fuel benchmark sub-installation and lime benchmark). To assign the correct amount of natural gas to each sub-installation, the operator should use the following:
  - At least one sub-meter is required to split gas use between the cement grinding plant dryer and the lime kiln. As per the point below, the operator should install the gas sub-meter on the lime kiln. If a sub-meter is not installed (due to technical infeasibility or unreasonable costs), then the operator will need to determine the split based on an indirect method (correlation or estimation).
  - Readings of the gas meter at the lime kiln are required every time the operator switches production between lime and magnesium oxide / magnesia. If a gas sub-meter is not installed, then another method would be required to split gas use between the two sub-installations, as detailed in section 4.5.
- Production figures: For the fall-back sub-installations, the operator will need to monitor all associated products. These data are required by the regulator to confirm carbon leakage status via PRODCOM code checks as well as assessing energy consumption by product to determine energy efficiency changes, as per Article 6 of the ALCR. In this example installation, the operator will have to monitor:
  - Quantities of cement: at least the two PRODCOM categories "Portland cement" and "other hydraulic cements", but other categories may apply.
  - Magnesium oxide / magnesia: The quantity will be derived from MRR data.
  - District heating: as the network supplies both domestic as well as industrial consumers, the operator will need to check whether consumption by the industrial customer er remains under the 5% threshold for remaining in the district heating sub-installation. Additionally, the operator will need to regularly check whether other industrial consumers (including potentially CL exposed ones) are added to the network.

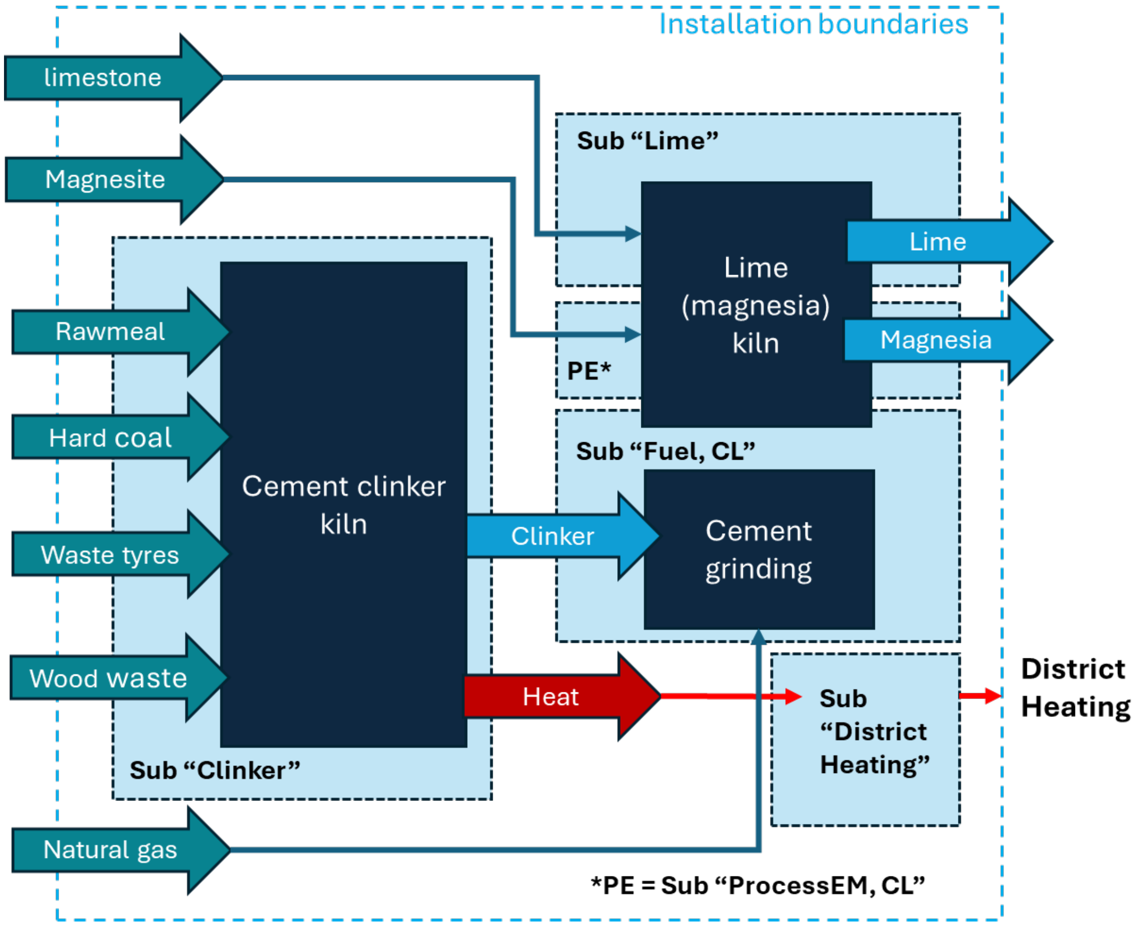


Figure 3 Final result of the sub-installation definition example

2.6 Terms used in the MRR and VR (emissions monitoring)

When monitoring data under the FAR, regulators utilise concepts that are familiar across the MRR and the VR. However, although there are similarities, there are also differences which are explained below.

- **Underlying principles** (Articles 5 to 9 of the MRR): completeness; consistency, comparability and transparency; accuracy; integrity of methodology, and continuous improvement. Although not explicitly mentioned in the FAR, these principles should be applied to avoid more time-consuming and difficult verification.
- **Calculation-based approaches** (standard method and mass balance method). Relevant terms include:
  - "Source streams" meaning carbon-containing fuels or materials which operators are obligated to monitor; note that the FAR requirement to monitor emissions at sub-installation level leads to the term "internal source stream" used in the BDR

template and MMP template. This relates to source streams which are produced by one sub-installation and consumed by another one within the same installation, so that at installation level they give net zero emissions.

- "Activity data" meaning the amount of material or fuel, not to be confused with the term "activity level" used for sub-installations in the FAR.
- "Calculation factors" including net calorific value (NCV), emission factor, oxidation factor, conversion factor, carbon content and biomass/fossil fraction.

- **Measurement-based approaches** using CEMS (Continuous Emission Measurement Systems) applied to **"emission sources"**.
- **No-tier approaches** used in cases when an operator cannot reach tier 1 for at least one source stream or emission source. These are referred to as "fall-back methodologies". However, for the MRR this term relates only to installation-level emissions and must not be confused with the term "fall-back approach" or "fall-back sub-installation" used in the context of free allocation rules. The latter term means one of the heat benchmarks, fuel benchmarks or process emissions sub-installations (see also section 5.2 of this document).
- **"Combustion emissions"** and **"process emissions":** From the MRR perspective these two terms are distinguished mainly for the purpose of defining which calculation factors are relevant. For combustion emissions, an operator must monitor an NCV value and oxidation factor, while for process emissions an operator must apply a conversion factor (the distinction is less clear within a mass balance approach). Important differences must be noted when applying the FAR:
    - Process emissions attributable to one of the process emissions sub-installations are clearly defined by Article 2(10) of the FAR. The definition applies only to process emissions not attributed to any other sub-installation type, and contains a correction for waste gases, whereby less than the total direct emissions are attributed (for details see sections 2.3 and 5.3).
    - Process emissions from flue gas cleaning (desulphurisation, deNOx) are considered part of the fuel mix for determining the emission factor of measurable, as well as non-measurable, heat.
- **Biomass emissions:** these are accounted for as zero under the MRR, if sustainability criteria defined by the Directive 2009/28/EC[20] are satisfied, where applicable. Guidance document 'UK ETS03 MRR - Reporting biomass in installations'

[20] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources

provides further details on how to treat biomass. The FAR follows that approach in full.

- **Minimum requirements** for monitoring (based on a building block system using **"tiers"**): while this is a central tool of the MRR to balance accuracy needs for larger emitters against the administrative burden for smaller emitters, the concept is not relevant under the FAR which uses an "accuracy hierarchy" concept.
- **"Unreasonable costs"** and **"technical feasibility"** are used as criterion for deviating from minimum tier requirements. The concepts are also applicable under the FAR in relation to the "accuracy hierarchy", although for "unreasonable costs" some of the assumptions differ. See section 4.6.2 for further details.
- **"Uncertainty"** as a systematic means of determining whether one monitoring method is "better" than another one is relevant under the FAR (see section 4.6.3). However, the need to perform a (simplified) uncertainty assessment will be an exception rather than the rule under the FAR, while for the purposes of the MRR an uncertainty assessment is usually mandatory. Guidance document 'UKETS02 MRR/FAR - Uncertainty assessments for installations' is dedicated to the topic of uncertainty assessment and includes a chapter on uncertainty for FAR purposes.
- **"Procedures"** are used in an MRR context to avoid overloading the monitoring plan with too much detail, and to keep the number of monitoring plan updates to a reasonable level. The MRR requires that for several monitoring tasks (such as ensuring completeness of the list of source streams, for sampling and analysis, for purposes of the control system, etc.) the operator "establishes, documents, implements and maintains procedures for activities under the monitoring plan, as appropriate". These procedures are not considered formally part of the MP. The same approach is used in Article 8(3) of the FAR for the MMP, although the number of explicitly mentioned procedures is small. Section 4.5 of guidance document 'UKETS01 MRR - General guidance for installations' is a good starting point to learn more about such procedures.
- **"Default values"** are the diverse types of fixed values or literature values that are used for calculation factors to avoid the need to perform sampling and analyses. The concept is extended to further types of material properties in the FAR, for establishing the quality of products where required.
- **Sampling and analyses**, as required to determine calculation factors in the MRR, or material properties in general under the FAR: the requirements set out in the MRR include the need to have a sampling plan and to use a laboratory accredited for the specific analysis method. If this is not possible, the laboratory must demonstrate

equivalent competence. Details are elaborated in 'UKETS07 MRR - Sampling and analysis'.

- "**Data flow procedures**" and "**control system**", including the "**risk assessment**": details in the context of the MRR are given in guidance document 'UKETS04 - MRR Data flow activities and control systems'. Some information in the FAR context is given in section 3.5 of this document.
- **Verification:** For annual emissions, a broad suite of guidance is available on GOV.UK.[21] For FAR-related verification, all important aspects are covered by 'UKETS14 FAR/VR - Verification of FAR baseline data reports, annual activity level data and validation of MMPs', including detailed guidance on topics such as the process of verification, competence requirements for verifiers, accreditation rules, etc.

2.7 Terms introduced by the FAR important for monitoring

The FAR introduces some specific terms required for monitoring and reporting of FA data. These are briefly explained here:

- **Determination methodology:**[22] this is the overarching term which covers both forward-looking monitoring as well as backward-looking data collection. The MMP must define determination methodologies for all relevant data sets. This implies that both forward and backward-looking aspects must be covered.[23] Therefore, it may sometimes be necessary to mention two different approaches for the same data set within the MMP - one for the first BDR, which requires collection of already existing data, and a second one for future monitoring. This assumes that an operator may sometimes have only data of lower quality available for historic data, but will usually be able to use "most accurate available data sources" in line with section 4 of Annex VII to the FAR for future monitoring, since the operator will be able to install required meters etc. An example of when an operator would need to consider both forward and backward-looking monitoring would be a Hospital and Small Emitter (HSE) or Ultra Small Emitter (USE) that was completing a BDR, without an approved MMP, to apply for FA for the first time.

[21] https://www.gov.uk/government/collections/uk-emissions-trading-scheme-uk-ets-technical-guidance-and-tools

[22] Section 2 of Annex VII of the FAR defines: 'Determination methodology' means either of the following: (a) a methodology of identifying, collecting, and processing data already available at the installation for data sets of historical data, or (b) a monitoring methodology for a specific data set based on an approved monitoring methodology plan.

[23] In 2019, the UK approach was to allow the operator to choose whether to use one template or two.

> Note that for simplicity this guidance document usually just refers to "historical data" where it means data already available (i.e. stemming from the period "pre-MMP approval"). Where it needs to be clarified that only data is meant which is monitored in the future (after MMP approval), this document uses the term "monitoring data". Where such specification is not given, both data types are implied.

- **Data set:** this term means "one type of data, either at installation level or sub-installation level". In comparison to MRR terminology, a data set can be activity data (amount of fuel or material) or a single calculation factor (e.g. the NCV or emission factor). Due to the wider nature of data relevant for determining benchmarks or for FA, a data set can also be an amount of electricity, measurable heat, waste gas, or a parameter relevant to determine such amounts e.g. the flow of steam, the temperature and pressure of the steam, etc. Furthermore, data sets are not restricted to the installation level. There can also be transfers of heat or materials between sub-installations which require monitoring, and which consequently must be considered as data sets. A data set can also mean qualitative information to be monitored, such as whether a product or a heat consumer falls within a CL sector, whether an amount of pulp is put on the market, or whether measurable heat stems from an UK ETS source. Finally, individual parameters also required to determine the activity level of some special product benchmarks are considered data sets, such as the activity level of each individual CWT function (Annex II to the FAR), and correction factors required to calculate activity levels in accordance with Annex III to the FAR.
- **Direct and indirect determination methodologies:** For an explanation see section 4.4.
- **Data sources:** this is another overarching term, encompassing monitoring methodologies such as the chosen measuring instrument(s) and (laboratory) analyses, but also default values and estimation methods, as well as sources for historical data, such as databases or written documentation of monitoring methods and data obtained in the past.
- **Most accurate available data sources:** Article 7 of the FAR requires the operator to "use data sources representing highest achievable accuracy pursuant to section 4 of Annex VII". Use of other data sources is allowed in cases where the use of most accurate data sources is technically not feasible, would incur unreasonable costs, or where the operator can provide evidence that another chosen method exhibits lower uncertainty. Section 4 of Annex VII to the FAR gives a hierarchy of preferred data sources according to accuracy. More details are discussed in section 4.5 of this document.

- **Primary data sources, Corroborating data sources:** the FAR requires the operator to select the data source of highest accuracy for each data set. This is referred to as the “primary data source”. It is the source to be used for the BDR. However, as a means of quality control, the FAR also requires the operator – to the extent feasible without incurring unreasonable costs – to also select, if available, a second data source for each data set. The second data source can be lower down the hierarchy of preferred data sources according to section 4 of Annex VII to the FAR and is called a “corroborating data source”. Corroboration data sources serve two purposes - firstly, for the corroboration of the primary data source i.e. for carrying out cross checks, and secondly for filling data gaps where data are missing from the primary data sources. If, for example, the measuring instrument used as a primary source fails, the operator would use the correlation method detailed as a corroborating source. This avoids arbitrary use of non-approved methods for filling data gaps, and at the same time “forces” operators to ensure an effective control system (see section 3.5).
- **Historical Activity Level (HAL):** the HAL is the parameter to be multiplied with the relevant benchmark for determining the preliminary annual number of emission allowances allocated free of charge for each sub-installation. According to Article 15 of the FAR, this is usually the arithmetic mean of all annual activity levels in the baseline period, taking into account all years during which the installation has been operating for at least one day. In cases where the sub-installation has been operating for less than two calendar years during the relevant baseline period, the HAL is the annual activity level of the first calendar year of operation after the start of normal operation. If that start is later than the end of the baseline period, the HAL is determined based on the first full year of operation (Article 15(7) of the FAR).
- **(Annual) Activity Level (AAL or AL):** Article 15(3) to (6) of the FAR indirectly defines the different activity levels:
    - For product benchmarks, the annual activity level is the amount of product as defined in Annex I to the FAR for this benchmark, produced during the calendar year. In some cases (defined by Annex III to the FAR) further correcting parameters are required to determine the AL of each year as well as the HAL. Section 4.8 of this document provides more information (including step-by-step guidance)
    - For heat benchmark and the district heating sub-installations, the AAL is the amount of eligible measurable heat. Section 4.12 of this document gives step-by-step guidance for determining the eligible amounts
    - For fuel benchmark sub-installations, the annual energy content of the eligible fuel quantities gives the AAL. Step-by-step guidance is given in section 4.13

- For process emissions sub-installations, the annual eligible emissions are identical to the AAL. Step-by-step guidance is given in section 4.14.

- **Heat, measurable heat, net measurable heat:** in the FAR, heat is generally considered as a benchmarkable "product". However, only heat that is "measurable" is of concern from a monitoring point of view, since other types of heat are handled based on the energy content of the corresponding fuels. "Measurable heat" is defined in the FAR (Article 2(7)) as

  "*a net heat flow transported through identifiable pipelines or ducts using a heat transfer medium, such as, in particular, steam, hot air, water, oil, liquid metals and salts, for which a heat meter is or could be installed*".

  As heat flow must be determined as a "net" amount, monitoring must account for the enthalpy of the heat medium delivered from the heat production unit (boiler house, CHP unit, heat exchanger for heat recovery, etc.) to the heat consumer[24] minus the enthalpy contained in the heat medium returned to the heat producer. If the medium is not completely returned to the producer, appropriate assumptions must be made to make the heat consumption process comparable. More information on monitoring requirements for measurable heat is given in section 4.9. Guidance on allocation rules relating to cross-boundary heat flows is provided in 'UKETS15 FAR – Guidance on cross-boundary heat flows'.

  Note: This series of guidance documents uses the terms "heat", "measurable heat" and "net measurable heat" as synonyms i.e. the different phrases are only used for better readability. It is not the intention to differentiate between "net" and "other" measurable heat.

- **District heating:** Article 2(4) of the FAR defines district heating to mean "*the distribution of measurable heat for the purpose of heating or cooling of space or of production of domestic hot water, through a network, to buildings or sites not covered by EU ETS or UK ETS with the exception of measurable heat used for the production of products and related activities or the production of electricity*". This definition is required to distinguish this heat use from other non-carbon leakage heat uses, because Article 16(3) of the FAR provides a derogation from the diminishing multipliers for FA to non-carbon leakage heat uses starting in 2026.

- **Cooling:** Heat in general can be used to drive absorption cooling processes, and cooling can be distributed via networks just like heat, including in public district cooling networks. As net measurable heat is the difference in enthalpy between

[24] Depending on the situation, the "consumer" can be a process within the installation, in the same or another sub-installation, or outside the installation.

delivered and returned medium, cooling would have to be considered as negative heat delivery. However, there are many difficulties associated with such an approach. Therefore, the FAR includes a clear rule in section 7.1 of Annex VII: "*Where heat is used to provide cooling via an absorption cooling process, that cooling process shall be considered as the heat consuming process*." This means that there is no need for further consideration of heat or cooling delivered to consumers downstream of the cooling process. Consequently, this guidance document does not provide further detail on cooling. However, operators should keep in mind that production of cooling should be considered a self-standing process for heat consumption, and such heat consumption may require monitoring.

- **"Import"** and **"export"** of materials and fuels, heat, electricity or waste gases are terms widely used in the FAR as well as this document and can relate to both the installation and sub-installation level. As there is no further explanation given in the FAR, it is best to understand these terms as straightforwardly as possible: It has been discussed in section 2.1 that sub-installations are system boundaries of a mass and energy balance. Therefore, an import is everything that enters those system boundaries, and an export is everything that leaves the system boundaries. Sections 2.2 and 5.3 give further information on the relevance of various imports and exports for the purpose of attribution of emissions to sub-installations. In most cases, for the purpose of attributing emissions, every import and export from a sub-installation will require monitoring. Note that in case of heat imports and exports there is an additional need to distinguish the UK ETS status of connected installations, and in the case of exports, to also distinguish district heating, CL and non-CL use.

- **Waste gases**[25]: Certain gases to which specific FA rules apply. Those are gases which contain combustible carbon and are therefore a borderline case exhibiting certain properties of fuels, but also of process emissions, and are often transferred between (sub-)installations. It is a term used exclusively by the FAR for distinguishing those gases from all other kinds of flue gases or off-gases. Sections 2.2 and 5.3 provide some insight to the treatment of waste gases. More information is provided in guidance document 'UKETS17 – FAR Guidance on waste gases and process emissions sub-installations'.

- **Flaring, safety flaring:** Flaring means a process in which (gaseous or liquid) fuels or process gases are disposed of by burning without use of the contained energy. There

[25] Article 2(11) of the FAR: "*'waste gas' means a gas containing incompletely oxidised carbon in a gaseous state under standard conditions which is a result of any of the processes listed in point (10), where 'standard conditions' means temperature of 273,15 K and pressure conditions of 101 325 Pa defining normal cubic metres (Nm3) according to Article 3(52) of the Monitoring and Reporting Regulation 2018.*" Article 2(10) contains a definition of the process emissions sub-installation, and lists processes such as the reduction of metal compounds or ores, carbonate decomposition, chemical syntheses other than for a primary purpose of generating heat, etc.

are two purposes of flaring: either there is no other use for the fuel or the energy, or there would be a safety problem (e.g. danger of explosions) if the fuel or gas is not burned as quickly as possible. The latter purpose is "safety flaring".[26] Since different FA rules apply to safety flaring than for other types of flaring, operators will have to determine which type of flaring takes place at their installations, if any, and will have to monitor the related waste gas emissions separately.

[26] Article 2(13) of the FAR defines safety flaring to mean "*the combustion of pilot fuels and highly fluctuating amounts of process or residual gases in a unit open to atmospheric disturbances which is explicitly required for safety reasons by relevant permits for the installation.*"

3 The monitoring methodology plan

3.1 Content of the monitoring methodology plan

The approved MMP is the most important document for every installation participating in the UK ETS and applying for FA under UK ETS. Like the MP under the MRR, it should establish the "user manual" for the operator's tasks of monitoring and data collection. Therefore, it should be clear, comprehensive and understandable, so that all, particularly new, staff can follow the instructions. It must also allow the regulator to clearly and quickly understand the operator's monitoring activities. Finally, the MMP is a guide for the verifier to help them assess the operator's BDR and ALR.

Article 8(1) of the FAR requires that the MMP contains "*a description of the production processes and a detailed description of monitoring methodologies and data sources. The monitoring methodology plan shall comprise a detailed, complete and transparent documentation of all relevant data collection steps, and shall contain at least the elements laid down in Annex VI* ". Additionally, the MMP must include a flow diagram as per Annex VI, point (1)(d), which requests "*a flow diagram and plan of the installation which allow an understanding of the main material and energy flows…*". Such flow diagrams should include unique designators (names, abbreviations) for every relevant physical unit and measuring instrument or sampling point, such that the rest of the MMP can clearly refer to them.[27]

Operators must ensure that for every data item required in the BDR or ALR, they explain how the data are obtained in their MMP. As outlined in chapter 2.7, two groups of data need to be covered: Firstly, "everything that is needed to determine the annual activity levels of each sub-installation", and secondly, "everything that is needed to determine the attributed emissions of each sub-installation". Similarly, overall installation-level data must be provided. The requirements should cover "everything that is needed to monitor each individual data set listed in Annex IV of the FAR".

[27] Point (1)(d) of Annex VI to the FAR requires a flow diagram which contains *"at least the following information:*

- *The technical elements of the installation, identifying emissions sources as well as heat producing and consuming units;*
- *All energy and material flows, in particular the source streams, measurable and non-measurable heat, electricity where relevant, and waste gases;*
- *The points of measurement and metering devices;*
- *Boundaries of the sub-installations, including the split between sub-installation serving sectors deemed to be exposed to a significant risk of carbon leakage and sub-installations serving other sectors, based on NACE rev. 2 or PRODCOM*".

Typical elements of an MMP include instructions for the following activities of the operator (applicability depends on the specific installation's circumstances):

- Data collection (metering data, invoices, production protocols, etc.)
- Sampling of materials and fuels
- Laboratory analyses of fuels and materials
- Maintenance and calibration of meters
- Description of calculations and formulae to be used, including for correlations and other estimation methods, where applicable
- Internal control activities for quality control and quality assurance
- Data archiving (including protection against manipulation and retention for specified time periods)
- Regular identification of improvement opportunities.

However, MMPs should be drafted carefully to reduce administrative burdens where possible. Since MMPs must be approved by the regulator, certain changes to the MMP are only allowed with the consent of the regulator. The FAR reduces administrative efforts by following the approach already established in the MRR:

- Only changes which are "significant" need approval by the regulator (Article 9(4) of the FAR, see section 3.4).
- Data collection activities for which it is not crucial to explain every detail, and which by their nature tend to be frequently amended, may be put into "written procedures". Such procedures must be referenced and described[28] briefly in the MMP (see Article 8(3) of the FAR) but are not considered part of the approved MMP. The relationship between MMP and written procedures is the same as for MRR purposes.
  UK ETS operators use templates for monitoring methodology plans and annual activity level reports. These can be obtained from GOV.UK.[29]

[28] To limit the administrative burden, Article 8(3) of the FAR require that the operator includes a "reference" to the procedure in the MMP, while the MRR requires a "description" of the procedure in the MP. However, the MMP template contains the option to include a description for the procedures, too. This should help to avoid the situation that the regulator must ask for the full documentation of the procedure in too many cases. Operators are therefore advised to make use of these description fields in the MMP.
[29] https://www.gov.uk/government/collections/uk-emissions-trading-scheme-uk-ets-technical-guidance-and-tools

3.2 Developing the MMP

When developing an MMP, operators should follow some guiding principles:

- Knowing in detail the situation of their own installation, the operator should make the monitoring methodology as simple as possible. This is achieved by attempting to use the most reliable available data sources, robust metering instruments, short data flows, and effective control procedures.[30]
- Operators should consider their BDR and ALR from a verifier's perspective. What would a verifier need to know about how data have been compiled? What will ensure data flow is transparent? What controls are needed to prevent errors, misrepresentations, and omissions?
- As installations can undergo technical changes over time, the MMP must be considered a living document. To minimise administrative burden, operators should be mindful of which elements need to be set out in the MMP, and which elements can be described in written procedures supplementing the MMP.[31]

Operators will find that developing an MMP will usually be more demanding than developing a MP under the MRR, as the amount of data to be monitored is generally higher. As operators need to split an installation into sub-installations, there are numerous different possible scenarios, and it is impossible to provide a one-size-fits-all approach for developing the MMP. However, some general advice can be given. Firstly, the systematic (high level) approach is:

- Determine which sub-installations are relevant:
  - Check the installation's products against Annex I to the FAR to find out which product benchmarks apply
  - Follow the systematic approach outlined in sections 4.12 to 4.14 of this document to identify further sub-installations.
- Determine which data need monitoring and reporting (for an example see section 2.5). Initially, operators should determine answers to the following questions:
  - Are measurable heat flows relevant?

[30] Article 8(2) of the FAR: "… *Based on the risk assessment in accordance with Article 11(1) and control procedures referred to in Article 11(2), when selecting monitoring methods, the operator shall give preference to monitoring methods that give most reliable results, minimise the risk of data gaps, and are least prone to inherent risks, including control risks*. …".

[31] It should be noted that the verifier will review both the MMP and any subsidiary procedures during verification.

  - Are waste gases or transfer of CO_2 (whether pure or as inherent CO_2 within the meaning of the MRR) relevant?
  - Is flaring relevant and, if so, is flaring conducted for safety reasons or not?
  - Is monitoring of electricity relevant? (e.g. does the installation produce electricity? Does the installation have a product BM sub-installation where exchangeability of fuels and electricity, in line with Annex I of the FAR, is relevant?)

  In cases where any of the above are relevant, then the corresponding MMP will be more complex.

- Determine the source for each relevant data set (rules are explained in chapter 6):
  - The data source for historical data
  - The primary data source for monitoring data, and
  - The corroborating data source.
- Establish the internal control system (risk assessment, control measures and procedures) and further procedures required, including the responsibilities for M&R, for quality assurance/quality control measures, for filing, IT systems, etc.

As it may not always be straightforward to decide which data sets are relevant, the operator may start completing the BDR or ALR template, noting available data sources for each data entry field.

Alternatively, the operator may use the MMP template as a checklist when considering which data sources to include. However, for more complex installations it is advisable to first follow the step-by-step instructions for identifying the relevant sub-installations and data requirements, as outlined in sections 4.12 to 4.14 of this document.

Subsequently, the next step is to select the sources representing the highest accuracy as described in section 4.6. After having selected appropriate data sources, the operator should describe the sources and how they will use them (i.e. the formulas they will use).

Having now described all data sources the operator must detail the data flow from primary data to final (annually aggregated) data in the BDR or ALR for each data set. A description of the data flow is usually set out in the associated procedures and should include a description of the internal control system (see section 3.5). Further information on procedures is set out in section 4.5 of guidance document 'UKETS01 MRR – General guidance for installations', and section 4.6 explains the role of the data flow and control procedures. Further information and examples are set out in guidance document 'UKETS04 MRR – Data flow activities and control system'.

Finally, the operator should perform a quality check of the MMP, noting the last paragraph of Annex VI to the FAR: "*The descriptions of the methods used to quantify parameters to be monitored and reported shall include, where relevant, calculation steps, data sources, calculation formulae, relevant calculation factors including unit of measurement, horizontal and vertical checks for corroborating data, procedures underpinning sampling plans, measurement equipment used with reference to the relevant diagram and a description how they are installed and maintained and list of laboratories engaged in carrying out relevant analytical procedures. Where relevant, the description shall include the result of the simplified uncertainty assessment referred to in Article 7(2)(c). For each relevant calculation formula, the plan shall contain one example using real data.*"

It is useful to keep the above requirement in mind when completing the MMP template. To keep its size manageable, the description fields in the template are kept generic and short. However, all the information above must be added, either in the free text fields, or in separate attached files.

3.3 Approval of the MMP

The MMP is crucial for ensuring the consistency and quality of FAR-related data and it must be approved by the regulator. The regulator will check it against criteria such as:

- Is the MMP complete? Are the required descriptions and diagrams attached? Are all data sets required for the BDR covered (including, where relevant, description of the different data sources for historical and monitoring data)?
- Transparency: is the description of the installation, its processes and sub-installations and the attached diagrams sufficiently clear for understanding?
- Is the MMP compliant with the requirements set out by the FAR? In particular, are data sources of the highest available accuracy used and, if not, are the deviations sufficiently explained and relevant evidence attached (evidence for unreasonable costs, technical feasibility, or simplified uncertainty assessments, as relevant)?

3.3.1 Timing

Incumbent operators (i.e. operators who held a permit under EU ETS before 30 June 2019 for the first allocation period) had to submit their MMP, along with their verified BDR before 30 June 2019. The MMP was approved and attached to the UK ETS permit in time for the start of the UK ETS on 1 January 2021. For the second allocation period, the majority of MMPs will already be approved ahead of the 2025 baseline data collection.

The rules for new entrants are different. If you are an eligible new entrant and wish to apply for a FA from the New Entrant Reserve (NER) you must submit both:

- A new entrant data report that has been verified in accordance with the VR
- An MMP

You may apply any time after the end of the year you started normal operations.

If you apply after your installation has been operating for a full calendar year, your new entrant data report must contain data for the year you started operations (year 0), and the first full calendar year of operation (year 1). See Article 5 of the FAR for more information on how to apply for FA as a new entrant.

See UK Emissions Trading Scheme for installations: how to comply on timings for the submission of MMPs, new entrants and renouncement of FA.

3.4 The improvement principle – approval of MMP updates

The MMP must always correspond to the current nature and functioning of the installation. When changes occur at the installation, e.g. because products (the sub-installations), technologies, processes, fuels, materials, measuring equipment, IT systems, or organisational structures (i.e. staff assignments) are changed (where relevant for FAR monitoring), the MMP must be updated (Article 9 of the FAR).[32] The MMP may also need to be updated because of the requirement to regularly consider whether improvements can be made to the monitoring methodology, and when taking into account the verifier's recommendations for improvement.

Depending on the nature of the changes, one of the following situations can occur:

- If an element of the MMP itself needs updating, one of the following can apply:

[32] Article 9(2) of the FAR provides a list of situations in which an MMP update is mandatory:
"*(a) new emissions or activity levels occur due to new activities carried out or due to the use of new fuels or materials not yet contained in the monitoring methodology plan;*
(b) the use of new measuring instrument types, new sampling or analysis methods or new data sources, or other factors, lead to higher accuracy in the determination of reported data;
(c) data resulting from the previously applied monitoring methodology has been found incorrect;
(d) the monitoring methodology plan is not, or no longer, in conformity with the requirements of this Regulation;
(e) it is necessary to implement recommendations for improvement of the monitoring methodology plan contained in a verification report."

  - The change to the MMP is a significant one (see Article 9(5) of the FAR). The operator must apply to the regulator for a variation of its permit at least 14 days before making the modification to the MMP or, where this is not possible, as soon as reasonably practicable, as per the conditions of their permit. In cases of doubt, operators are advised to proceed on the basis that their change is significant and their regulator will let them know if this is not the case (see the second sentence of Article 9(4) of the FAR).
  - The change to the MMP is not significant. The operator must notify the regulator on or before 31 December in the year in which the change occurred.
- An element of a written procedure is to be updated. If this affects neither the (optional)[33] description of the procedure in the MMP, nor the quality of the monitoring methodology or control procedures, the operator can update the written procedure without notifying the regulator (so long as any changes to the MMP are not 'significant').

It is considered best practice for the operator to make use of a "change log", in which all nonsignificant changes to the MMP and to procedures are recorded, as well as all versions of submitted and approved MMPs. The operator must implement a written procedure for regular assessment of whether the monitoring plan is up to date (Article 9(1) and point 1(g) of Annex VI to the FAR).

For the period between update of the MMP and approval by the regulator, operators are advised to follow the same principles under the MRR (see also section 4.7 and 4.8 of 'UKETS01 MRR – General guidance for installations'):

- Operators should use the updated MMP, if it complies with the FAR and it will be possible for the regulator to approve it.
- However, if there are alternative data sources available (e.g. in line with a previously approved MMP as well as those contained in the new one), the operator should continue using (i.e. keeping records of) both data sources until the regulator approves the updated MMP.
- After approval of the updated MMP the operator may discard any data not in line with the latest approved MMP, if different data sources were used in parallel because of the MMP update.

[33] To limit the administrative burden, Article 8(3) of the FAR requires only that the operator includes a "reference" to the procedure in the MMP, while the MRR requires a "description" of the procedure in the MP. However, the MMP template contains the option to include a description for the procedures, too. This should help avoid situations where the regulator needs to ask for the full documentation of the procedure. Operators are therefore advised to make use of these description fields in the MMP.

- The operator shall keep complete documentation of all versions of the MMP submitted and approved, including a record of the dates that each version applied (Article 9(6) FAR). This is needed to allow a fully transparent audit trail for the verifier.

3.5 The control system

As UKETS01 MRR – General guidance for installations states: "*Monitoring […] is more than just reading instruments or carrying out chemical analyses. It is of utmost importance to ensure that data are produced, collected, processed and stored in a controlled way. Therefore, the operator must define instructions for 'who takes data from where and does what with the data'. These 'data flow activities' […] form part of the monitoring plan (or are laid down in written procedures, where appropriate […]). A data flow diagram is often a useful tool for analysing and/or setting up data flow procedures. Examples for data flow activities include reading from instruments, sending samples to the laboratory and receiving the results, aggregating data, calculating the emissions from various parameters, and storing all relevant information for later use. As human beings (and often different information technology systems) are involved, mistakes in these activities can be expected.*"

Similarly, the information above applies to the MMP. The requirements for an effective internal control system for FA data, as set out in Article 11 of the FAR, align with Articles 58 to 65 of the MRR and therefore the guidance will not be duplicated in this document. Further information on risk assessments and control measures for mitigating risks can be found in the following sources:[34]

- UKETS01 MRR - General guidance for installations (section 4.6)
- UKETS04 MRR - Data flow activities and control system
- A European Commission tool for the risk assessment.[35]

Since the requirements of the FAR are very similar to those of the MRR, operators are advised to use the same procedures and control measures as developed for the MP and extend them to all relevant data sets of the MMP, where possible. Such an approach will reduce the possibilities of errors and will keep the control system relatively simple,

[34] This is particularly true for historical data. However, for future monitoring it may be necessary that the operator provides a justification for its use or may have to obtain an instrument higher up in the hierarchy provided in FAR Annex VII section 4.4, if the current instrument does not fall under the highest accuracy categories. More information is given in section 4.6.
[35] https://climate.ec.europa.eu/document/download/58ad2c9c-a916-4e00-8fa3-df651a4e859d_en?filename=tool_risk_assessment_en.xls

minimising the need for additional training, and ultimately simplifying the verification of FAR data by the synergies between MP and MMP.

3.6 Avoiding and closing data gaps

3.6.1 Temporary deviations from the approved MMP

Article 12(1) of the FAR sets out the process for situations when, for technical reasons, an operator cannot apply the approved monitoring methodology set out in an MMP. This applies, for example, if a measuring instrument fails and needs to be replaced or repaired. In such circumstances, the following applies:

- In many cases the MMP will contain a "corroborative data source" for each data set (which is of lower accuracy than the primary data source but already approved by the regulator). The operator should therefore use the corresponding corroborative data source, instead of the primary data source, for the period of missing primary data.

- If no corroborative data source has been approved as part of the MMP, the operator must select another available data source in line with the hierarchy provided in section 4 of Annex VII to the FAR.

- The operator shall take all necessary measures to restore the approved monitoring methodology promptly. If the operator cannot restore the approved monitoring methodology, for technical infeasibility or unreasonable costs reasons, the operator must select a new data source in line with the hierarchy provided in section 4 of Annex VII to the FAR and submit a revised MMP to the regulator for approval as soon as reasonably practicable.

Article 12(3) of the FAR requires the operator to, as soon as reasonably practicable, develop a written procedure to avoid any such data gap in the future and modify the MMP (i.e. to include the new corroborating data source) (which may require the regulator's approval if it is a 'significant' modification). Furthermore, the operator shall assess whether and how the control activities must be updated, and to include a procedure for avoiding such deviation in the future.

3.6.2 Missing data

Where a data gap in the BDR or ALR is due to missing primary data, the operator should use the corroborating data source for the period of missing data. However, if corroborative data are missing, or where no corroborating data source has been defined in the approved MMP, Article 12(2) requires the operator to use an appropriate estimation method for determining *conservative* surrogate data for the respective period and missing parameter. Appropriate methods can be "based on best industry practice, recent scientific and technical knowledge”. The term “conservative” is further explained in section 3.6.3.

Data gaps must be listed in an Annex to the BDR,[36] and due justification must be provided for each data gap.

Similarly for temporary deviations from the MMP, Article 12(3) of the FAR requires the operator to, as soon as reasonably practicable, develop a written procedure to avoid this type of data gap in the future (for example, by selecting a more reliable primary data source or by improving the data flow activities) and to modify their MMP (which may require the regulator’s approval if it is a ‘significant’ the modification). Furthermore, the operator must assess whether (and how) the internal control activities need to be updated.

3.6.3 Conservative approaches

The FAR does not contain a definition of “conservative”. The MRR defines: “*‘conservative’ means that a set of assumptions is defined in order to ensure that no under-estimation of annual emissions or over-estimation of tonne-kilometres occurs*”. Note that tonne-kilometres are the activity levels for aviation activities to which a benchmark is applied for allocation. Therefore, in the same spirit, a definition for FAR purposes might read as follows:

‘Conservative’ means that a set of assumptions is defined to ensure that no underestimation of a sub-installation’s attributed emissions or over-estimation of its activity level occurs.

There is no simple one-size-fits-all approach for making conservative estimates. “Excessively conservative” data should be avoided, as the principle of accuracy means that systematic over or under-reporting is to be avoided. Chapter 4 of guidance document ‘UKETS05 MRR - Making conservative estimates and data gaps’ contains a “toolbox” for filling data gaps (examples are given only for emissions), which can be applied to data collected under the FAR. The toolbox proposes to add a “safety margin” to ensure that data are conservative. This can be done, for example, by adding/subtracting 2σ to averages of correlated values or using the maximum/minimum value of historical measurements, etc. as appropriate in line with the above suggested definition. Note that it is important to establish whether the safety margin should be added or subtracted. This will be determined by whether the operator wishes to reduce the risk of under or over

[36] For historical data, it should be considered sufficient to list in the MMP all data sources used. As historical data in general must make use of “available data”, gaps may occur, and estimations will often be required. However, as in such case the estimation method itself is considered a “data source”, “unfillable” data gaps will hardly occur. Therefore, the justifications required for data gaps can be given by a more general description of data availability, instead of giving separate justifications for individual time periods or data sets. Also, any safety margins added for ensuring conservativeness of data can be kept moderate.

reporting the relevant parameter. For example, in the case of annual emissions reporting, the operator will need to reduce the risk of under-reporting emissions, so the safety margin should be added to the average estimated value. Alternatively, for annual activity level reporting, the operator will need to reduce the risk of over-reporting activity levels, so the safety margin should be deducted from the average estimated value.

4 Monitoring rules

4.1 Overview of FAR monitoring rules

The monitoring and reporting system of the FAR is more demanding than for annual emissions under the MRR, because there are multiple different types of data - not only source streams or emission sources, but also products (quality and quantity), heat (temperature, pressure, saturation, quantity of flow and return flow) and electricity - are to be monitored.[37] Furthermore, monitoring at sub-installation level requires more effort than at installation level. Hence operators, verifiers and regulators need to acquire additional knowledge.

For balancing these additional requirements and keeping monitoring efforts reasonable, the FAR monitoring rules are kept simpler than for annual emissions monitoring. These simplifications are set out below:

- In the FAR, no tiers are defined (unlike in the MRR). However, to ensure the monitoring system is robust, the operator must select the "most accurate data sources". For this purpose, the FAR provide a set of hierarchical approaches (see section 4.6), thereby creating a system of "tiers light".
- There is no categorisation of installations (categories A, B, C, and installations with low emissions) or other data sets (such as major/minor/de-minimis source streams). Therefore, there are fewer rules to be followed.
- For assessing the quality of the monitoring approach, there is no mandatory uncertainty assessment. An exception applies when an operator must provide evidence that deviation from the hierarchy of approaches can be justified, based on the lower uncertainty of the proposed approach (see section 4.6.3).

Overall, the same cost efficiency principle as for the MRR applies, i.e. operators can use the monitoring approaches including measuring instruments and sampling and analysis methods already installed under the MP as much as possible. Furthermore, the same principle as in the MRR applies to avoid approaches which are technically infeasible or would incur unreasonable costs (see section 4.6.2). However, the improvement principle is also applicable (see section 3.4), although it is less stringent, due to the absence of defined minimum tiers.

[37] This complexity is the reason why the term "data set" is often used in the FAR and this guidance, to cover all types of different data.

To develop the MMP and for monitoring and reporting data under the FAR, operators must follow Articles 6 to 12 of the FAR, together with Annex VII ("Data monitoring methods"), Annex VI ("Minimum content of the monitoring methodology plan"), and Annex IV ("Parameters for baseline data collection", i.e. the content of a BDR). In addition, the MRR provides appropriate provisions, particularly for installation level emissions data but also on general approaches such as risk assessment, control system, use of instruments not under the operator's control, QA/QC measures, etc. The operator should apply similar principles to the MRR to FAR data, where the FAR do not provide direction. Furthermore, the VR for verification purposes and the CLL must be considered.

Article 6 of the FAR (General obligation to monitor) has already been discussed in section 3.3.1. Article 7 (Monitoring principles) establishes the basis for the "hierarchy of approaches" which is discussed in section 4.6. Article 8 (Content and submission of the MMP) is discussed extensively in sections 3.1 to 3.3, and Article 9 (Changes to the MMP) is the basis for section 3.4.

Article 10 (Division into sub-installation) is key to the benchmarking system of the UK ETS. In this guidance document it is discussed in chapter 2 and in chapter 5. Guidance on Article 11 of the FAR (Control system) is provided in section 3.5, and Article 12 (Data gaps) is dealt with in section 3.6.

The remainder of chapter 4 will focus on Annex VII to the FAR which sets out the data monitoring and reporting provisions.

4.2 Overarching principles

Article 7(1) of the FAR sets out the principles of monitoring: "*Operators shall determine complete and consistent data and ensure that there are no overlaps between sub-installations and no double counting. Operators shall apply the determination methods laid down in Annex VII, exercise due diligence and use data sources representing highest achievable accuracy pursuant to section 4 of Annex VII*." Thus, two aspects can be considered as cornerstones for FAR monitoring:

- Data must be complete (without double counting) and consistent (detailed rules are presented in section 5.3).
- Accuracy is key. Operators must exercise due diligence to achieve this goal.

The FAR requires the operator to use the monitoring methods set out in Annex VII. To keep the FAR manageably concise and brief, many requirements apply generally (see section 2.7). However, each of the ca. 10 000 installations in the EU ETS (and the ca. 680 under the UK ETS) is different, and it is virtually impossible to provide detailed monitoring rules covering all these situations.[38] Thus section 3.1 of Annex VII to the FAR provides overarching principles (in line with what is known from the MRR):

- Where Annex VII does not explicitly provide an applicable monitoring method, the operator must apply "a suitable method" approved by the regulator (i.e. the operator must develop a method and request the regulator's approval).
- Such a tailored method is considered "suitable" (i.e. can be approved by the regulator), if any metering, analyses, sampling, calibrations and validations for the determination of the specific data set are carried out by applying methods based on corresponding EN standards.
- Where such standards are not available, the methods shall be based on suitable ISO standards or national standards.
- Where no applicable published standards exist, suitable draft standards, industry best practice guidelines or other scientifically proven methodologies shall be used, limiting sampling and measurement bias.

To summarise, operators should follow EN standards or other "proven best practices" and methods must be scientifically justifiable. To avoid arbitrary development of monitoring approaches, such self-developed methods are ranked lowest in the hierarchy of approaches (see section 4.6).

4.3 Installation level data and split to sub-installations

One of the most fundamental aspects of monitoring and reporting under the FAR is the assigning of data to sub-installations, which requires monitoring at sub-installation level. Monitoring at sub-installation level is more exacting compared to monitoring at installation level under the MRR. Under the MRR, there is often only one measurement point per source stream required. Under the FAR, the number of necessary measurement points increases with the number of sub-installations, i.e. at least *n* measurement points are required per parameter, with *n* being the number of sub-installations where the parameter under consideration is relevant.

Section 3.2 of Annex VII to the FAR contains the fundamental rules for splitting data into sub-installations. Section 3.2.1 sets out rules for situations where direct measurement is infeasible and is further explained in section 4.3.2. Section 3.2.2 sets out rules for

[38] This is why the MP and MMP must be developed by the operator for their installation-specific situation, because "general applicable rules" in legislation alone have proven insufficient, for ensuring consistency of time series and for being a basis for verification.

situations where several measurement instruments of different quality are used to split installation-level data.

4.3.1 Use of sub-meters

One of the most common situations at UK ETS installations is that a fuel is used in several physical units of the installation. The following (relatively simple) example is used to illustrate the basic principles of splitting data into sub-installations. However, similar approaches apply to all kinds of materials and energy flows, e.g. the attribution of heat or electricity consumption to sub-installations.

In the example, natural gas consumption is determined using continual metering. In UK ETS installations there is often a central measurement (a main gas meter) taken when the gas first enters the installation boundary, and further sub-meters at individual process units. The quality of the meters may differ. The main meter is the most important for financial purposes, and both the operator and the gas supplier are interested in accurate measurements. In the UK, meters must comply with the Non-Automatic Weighing Instruments Regulations 2016 or the Measuring Instruments Regulations 2016. When this is not the case, the owner of the instrument (often the gas supplier or grid operator) will ensure regular maintenance and calibration (including the instruments for temperature and pressure compensation). However, for cost reasons, sub-meters are often of lower accuracy (higher uncertainty). Furthermore, it is likely that not all units have separate metering, or the locations of the meters may not coincide with the boundaries of the sub-installations. Section 3.2.2 of Annex VII to the FAR sets out rules required for such cases, as explained using the example below.

The example (see Figure 4) considers a fictitious installation where natural gas is used in three physical units serving two sub-installations. Units 1 and 2 belong to sub-installation 1, and unit 3 belongs to sub-installation 2. The figure illustrates different cases typical of many installations:

- Case 1: In this simple, cost-effective example, the total amount of gas is metered by the measuring instrument MI_{total} This instrument is also used in the approved MP under the MRR (as discussed in section 4.5, methods in accordance with the monitoring plan are considered as having the highest accuracy under the FAR, and must be used). The second measuring instrument (MI-1) measures all fuel input to sub-installation 1 and should be used for FAR purposes.[39] Gas input to sub-

[39] This is particularly true for historical data. However, for future monitoring it may be necessary that the operator provides a justification for its use or may have to obtain an instrument higher up in the hierarchy provided in FAR Annex VII section 4.4, if the current instrument does not fall under the highest accuracy categories. More information is given in section 4.6.

installation 2 is simply calculated as the difference between the readings of MI_{total} and MI-1.[40]

- Case 2: This is another simple example, with two meters (M1-1 and M1-2) measuring fuel input to each sub-installation. As the total gas entering the installation is not measured, the approved MP under the MRR requires the operator to determine gas consumption (to calculate installation-level emissions) by adding the readings from M1-1 and M1-2. Consequently, both meters are used in the approved MP and thus comply with point (a) of section 4.4 of Annex VII to the FAR and can be used directly for FAR purposes.

- Case 3: In this example the two meters (M1-1 and $M1_{total}$) are located in a way that prevents the operator from determining fuel input to both sub-installations. The operator will need to install a sub-meter at a position as per MI-1 or MI-2 in case 2 and then continue to monitor as per case 1. The operator must apply another method for determining the sub-installation gas consumption for the purpose of historical data. The operator should consider correlations or other estimation methods as discussed in section 4.4. For (forward-looking) monitoring data, the operator can avoid installing another meter only if they can demonstrate to the regulator that installing another meter would incur unreasonable costs or would be technically infeasible.

- Case 4: In this example, fuel input to each sub-installation is "over-determined", i.e. there are more measuring instruments than required. In such cases, the sum of the sub-meters' readings (MI-1a, MI-1b and MI-2) is likely to differ from the reading of the main meter $M1_{total.}$ As explained above, the main fiscal meter ($M1_{total}$) is usually the most accurate, i.e. in MRR terms it complies with the highest tier (it exhibits the lowest uncertainty). Similarly, under the FAR, the fiscal meter represents the most accurate available data, as it falls under point (a) of section 4.4 of Annex VII (it is the instrument used under the approved MP under the MRR). Therefore, the sub-installations' data must be adjusted such that their sum is identical to the installation-level data. This is achieved by applying point (2)(a) of section 3.2 in Annex VII to the FAR: A "reconciliation factor" is calculated (in this case: Reading of MI_{total} divided by the sum of the readings of the three sub-meters). The readings of

[40] Point (2)(b) of section 3.2 of Annex VII to the FAR: "*If only one sub-installation's data are unknown or of lower quality than the data of other sub-installations, known sub-installation data may be subtracted from the total installation data. This method is preferred only for sub-installations which contribute smaller quantities to the installation's allocation.*" The last sentence indicates that the FAR in general prefers direct metering over indirect methods such as this subtraction. Where more than just a "smaller quantity" is to be metered, therefore the preferred approach would involve the installation of an additional meter for sub-installation 2 and to use the reconciliation factor approach described under case 4.

the sub-meters are thereafter corrected by multiplying them with that reconciliation factor.

Note: Case 4 assumes that $M1_{total}$ is the most accurate measuring instrument, and the sub-meters are of lower quality (accuracy). This is not always the case. In some cases, one sub-meter e.g. MI-2 may be of considerably higher quality (accuracy) than the other two sub-meters. In this case the operator could use the method described in case 1 instead. The sub-meters MI-1a and MI-1b could be used as corroborating data sources. Section 3.2.2 of Annex VII to the FAR doesn't indicate a preference for either approach, i.e. where the operator has enough data sources available, the choice is to be made based on Section 4.4 of Annex VII.

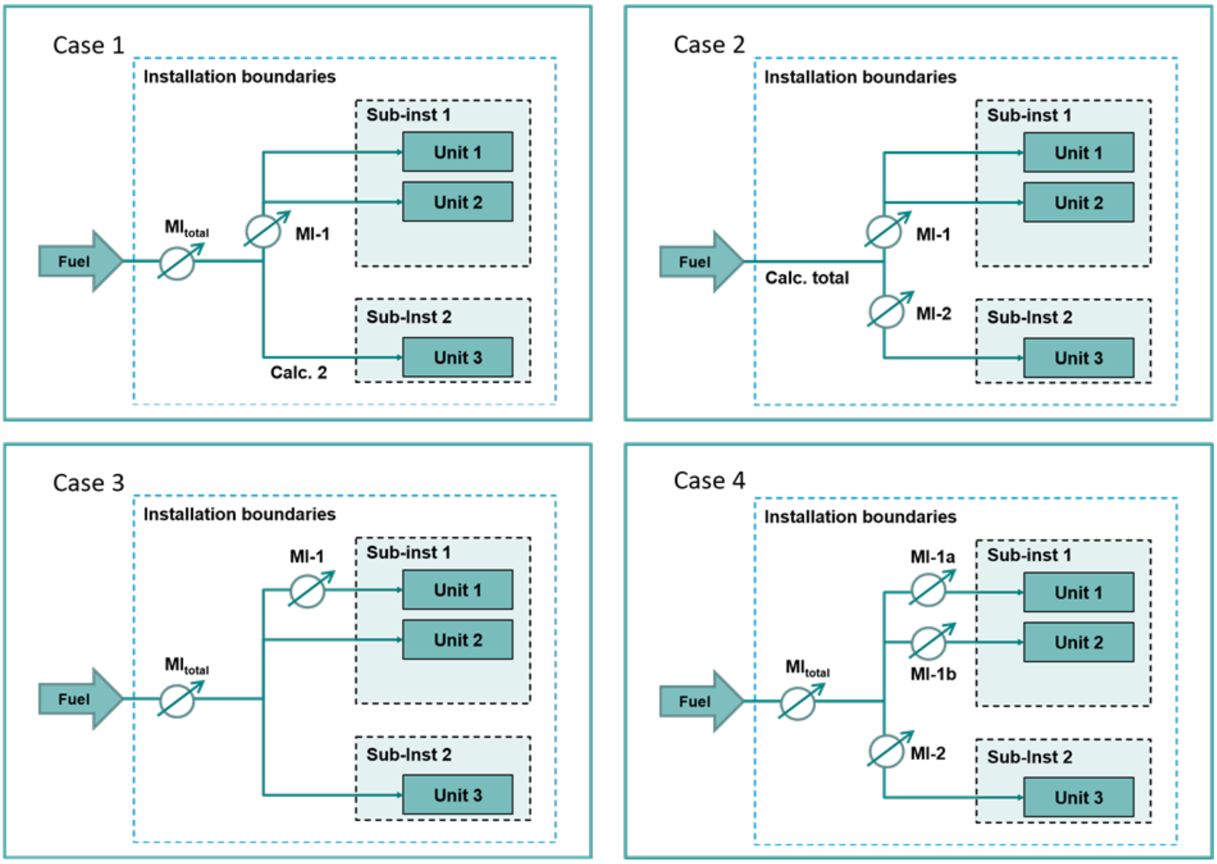


Figure 4: Different examples of metering to split fuel between sub-installations. For explanation of the different cases see main text

4.3.2 Split into sub-installation without direct metering

As in the previous example (case 3), sometimes there are no measuring instruments available for splitting data according to sub-installation boundaries. Moreover, there will be examples where separate measurement is impossible because processes take place simultaneously, or within the same physical unit. As mentioned in section 4.2, Annex VII to the FAR does not contain detailed rules for every possible case. However, section 3.2.1 of Annex VII to the FAR provides the following two rules for handling sub-installation splits in the absence of direct measurements:

- Point (a) covers the situation of sequential production within the same "production line" (or physical unit). Operators can split inputs, outputs and corresponding emissions based on the usage time of the physical units.

  This rule applies e.g. to the lime kiln described in section 2.5, where the same gas meter serves two different sub-installations, and data are split using time periods (i.e. readings from the gas meter are required every time a switch between sub-installations is performed).[41] Other common examples occur in the chemicals and food industries, where different products are produced in batches, one after the other, using the same equipment. In some cases, operators will need to assign (measurable) heat to the production of each product separately, if some products attract CL status and others don't (i.e. to split measurable heat between heat CL and heat non-CL sub-installations).

- Point (b) covers cases where time periods are not appropriate, i.e. situations where different products are produced simultaneously. This can include examples where it is impossible to split the data, such as when heat is consumed in chemical reactions where several products are produced from the same process.[42] A more common situation is when measurable heat must be attributed to a plethora of production processes and physical units in a complex installation, where it would incur unreasonable costs to install an appropriate number of heat meters.

The rule allows the operator to split the data according to sub-installation boundaries (e.g. the amount of measurable heat and the associated emissions) "based on the mass or volume of individual products produced or estimates based on the ratio of free reaction enthalpies of the chemical reactions involved or based on another suitable distribution key that is corroborated by a sound scientific methodology."

Section 4.5 provides examples of the application of these rules.

[41] It could be argued that a clock is a measuring instrument, too. However, in this case the clock is only half the story. The operator must also set up a methodology for determining the exact time of the switch between sub-installations, i.e. a transition period may have to be attributed to the two sub-installations using reasonably justified assumptions.
[42] However, this example is of little practical relevance, since some of the product benchmarks for chemicals are defined in a way that they cover the complete relevant product mix (e.g. HVC, aromatics, etc.).

Note: In some cases, when using different methods to split data, the operator may find that the installation wide figures calculated using MRR data differs from the sum of the sub-installations' data calculated under the FA. The rules of section 3.2 of Annex VII (use of difference or reconciliation factor, see section 4.3.1) must be used to ensure the FA data totals equal the installation-wide figures calculated under the MRR. Additionally, some data may not be attributed to any sub-installation (see section 2.2.1).

4.4 Direct vs. indirect data determination

The FAR acknowledges that due to the potentially high number of data sets to be determined it will often not be possible (according to technical feasibility and/or unreasonable costs) to install measuring instruments at every appropriate location. The same issue applies to appropriate sampling and analyses. Therefore, the FAR differentiates the following in Annex VII:

- **Direct determination:** This means that fuels, materials, measurable heat, waste gases, electricity are measured using an appropriate measuring instrument which provides the quantity, such as m^3 or tonnes of fuel, TJ of heat or MWh of electricity consumed, etc.

  Direct determination can also apply when the operator uses documents containing values stemming from direct measurements, e.g. invoices for fuels based on measuring instruments not under the operator's control, or historical data contained in the operator's written documentation or databases.

  In the case of sampling and analyses, direct determination means that the parameter of interest is analysed directly (e.g. the carbon content of a material), while indirect determination would apply when other constituents are analysed, and the carbon content determined by deducting the other constituents from the total.

- **Indirect determination**: This means that data are calculated based on other values which can be directly measured. An example would be the situation described in case 1 in section 4.3.1, where the fuel consumption of sub-installation 2 is calculated (i.e. indirectly determined) as the difference between other values determined by direct measurement (fuel consumption at installation level and for sub-installation 1). Another example is the analysis of quicklime in which free calcium oxide (CaO) and free magnesium oxide (MgO) as well as impurities are measured, and unreacted CO2 is calculated using 100% - (CaO + MgO + impurities).

As a general rule under the FAR, operators should select direct determination over indirect methods when possible, as set out in the hierarchy of approaches discussed in section 4.6 of this document.

Section 3.4 of Annex VII to the FAR provides a broad range of indirect methodologies, particularly for the attribution of measurable heat to sub-installations when heat metering is not installed or not sufficient for FA purposes, as heat consuming processes are very diverse (such as driving (endothermic) chemical reactions, heating, drying, distilling of materials, space heating, disinfection, etc):

> *"Where no direct metering or analysis approach is available for a required data set, in particular for cases where net measurable heat is going into different production processes, the operator shall propose the use of an indirect determination method, such as:*
>
> (a) *calculation based on a known chemical or physical process, using appropriate accepted literature values for the chemical and physical properties of substances involved, appropriate stoichiometric factors and thermodynamic properties such as reaction enthalpies, as appropriate;*
>
> (b) *calculation based on the installation's design data such as the energy efficiencies of technical units or calculated energy consumption per unit of product;*
>
> (c) *correlations based on empirical tests for determining estimation values for the required data set from non-calibrated equipment or data documented in production protocols. For this purpose, the operator shall ensure that the correlation satisfies the requirements of good engineering practice and that it is applied only to determine values which fall into the range for which it was established. The operator shall evaluate the validity of such correlations at least once a year."*

Once an operator has established an appropriate method for attributing a relevant parameter to each sub-installation, further parameters (if correlated) can be attributed accordingly.[43] Such an example would occur when an operator must split the total measurable heat consumed between CL and non-CL production processes. Once the

[43] FAR Annex VII section 10.1.1 states: "Where emissions from source streams or emission sources cannot be attributed in accordance with other approaches, they shall be attributed using correlated parameters, which have already been attributed to sub-installations in accordance with section 1.2. For that purpose, the operator shall attribute source stream amounts and their respective emissions proportionally to the ratio in which those parameters are attributed to sub-installations. Appropriate parameters include the mass of products produced, mass or volume of fuel or material consumed, amount of non-measurable heat produced, operating hours, or known equipment efficiencies."

operator has established an appropriate methodology for splitting heat between sub-installations (for example using the ratio of CL/ non-CL production if production is simultaneous), they can apply the same ratio to split fuel input, energy input and emissions according to sub-installation boundaries.

Measurable heat metering is often a special case. Examples when the operator uses integrated heat meters (where all separate measurements of flow, temperature, pressure and state of the heat medium are included), would be considered direct determination under the FAR. Similarly, examples when the operator uses separate metering, for example measuring flow, temperature and state of the heat medium together at the boiler outlet in combination with measuring flow/temperature together as the heat medium returns to the boiler, could be considered direct determination. On the other hand, an example when the operator uses separate metering of temperatures and flow (and saturation state) at different locations could be considered indirect measurement, particularly if not all necessary parameters are measured at all relevant locations. In case of doubt the operator should seek the agreement of the regulator when selecting data sources.

4.5 Examples of indirect determination methods and correlations

Example 1 – heat BM sub-installations (chemicals)

In this example measurable heat is produced in one CHP unit. The heat is consumed in two production processes, one producing a CL exposed product, and the other a non-CL product. Therefore, the operator must attribute the heat, and the associated fuel consumption and emissions, to the respective heat benchmark sub-installations (heat CL and heat non-CL sub-installations). For the example it is assumed that few direct measurements are available.

Step 1 - Determine measurable heat produced: operators would at least measure fuel input to the CHP unit, and they would know, or be able to find out from documentation, the design efficiencies for production of electricity and heat in the unit. The fuel input to the CHP is already required under the MRR. The operator can calculate the amount of measurable heat produced using the design efficiency and the fuel input, as per section 8 of Annex VII to the FAR (see section 4.10). Once heat output is calculated, emissions related to heat production can be calculated also. The cogeneration tool in the BDR and ALR will calculate emissions attributable to heat production from the CHP and will split fuel input between heat and electricity production using the relevant equations from section 8 of Annex VII to the FAR. The operator should reference this tool in their MMP and provide full details of all relevant data inputs into the tool. The remaining emissions are associated with electricity production and are therefore not attributed to any sub-installation.

Step 2 - Determine the split between the CL and non-CL heat benchmark sub-installation: The operator may choose to split the total measurable heat by assigning the total heat amount proportionate to the mass of the two products, each multiplied by a weighting factor. In this case the mass of the two products is directly measured, and the weighting factors are taken from the design documentation of the installation (assuming that this documentation contains information such as "x TJ heat consumed per tonne of product", or "y tonnes of saturated 110°C steam" – the minimum requirement here would be that relevant information is available for both products and using comparable units. In this case, TJ heat and tonnes of steam can be compared by using appropriate steam tables). The MMP must detail the method for determining the weighting factors with appropriate justification where necessary.

In this example the following equation would apply:

Equation 2

$$H_{total} = H_{CL} + H_{nonCL} = h_{CL} \times M_{CL} + h_{nonCL} \times M_{nonCL}$$

Where H_{total} is the total amount of measurable heat consumed in the installation, H_{CL} and H_{nonCL} are the variables to be determined, and *h* is the specific heat consumption per tonne of product, and *M* the mass of the product in tonnes. Since there are only two products, only one of the two specific heat consumptions must be known, if the total heat is known. If all three variables are known, a reconciliation factor may be necessary (see example 4 in section 4.3.1).

The fuel input and emissions of each sub-installation can be determined from the heat-related data determined in step 1, using the ratio H_{CL}/H_{nonCL} determined in step 2.

Example 2 - Lime kiln with 2nd product

This relates to the example installation described in section 2.5 and assumes that the operator does not measure gas input to the kiln. The operator requires the following information to attribute natural gas between the lime sub-installation and the fuel BM sub-installation:

- The times when (saleable) lime is produced, and/or when magnesium oxide (MgO) / magnesia is produced. The operator should include details of how they will make the split (it is assumed that there will be a period during the production switch when neither saleable lime nor saleable magnesium oxide is produced, yet gas consumption must be attributed to one or the other). Operators may choose to assume production commences when the feed of the new raw material is started.[44] This information must be clearly detailed in the MMP.

- As burning of magnesium oxide / magnesia and of lime happens at different process temperatures, it is unlikely that the same amount of gas is consumed per hour in both cases. For determining the hourly gas consumption, the operator could adopt one of the following methodologies:
  - Carry out tests at a time when no other gas consuming units are operating at the installation, for example during maintenance outages.
  - Use literature values for the specific energy demand of burning lime and magnesium oxide (and using some adjustment factors for heat losses, for which reasonable assumptions must be made).
  - Other appropriate methodologies as determined by the operator, so long as such methods have been approved by the regulator.

Examples of correlations

There are examples when correlations may be useful: according to section 9 of Annex IV to the MRR, the amount of clinker produced can be backcalculated using the amount of cement produced and the clinker/cement ratio of different cement grades produced. The opposite calculation can be used to determine the cement amounts needed in the example presented in section 2.5.

The MRR also explicitly allows the use of "empirical correlations", for example, operators can determine emission factors based on density measurements of specific oils or gases, including those common to the refinery or steel industry (i.e. waste gases in the FAR sense), or emission factors based on the net calorific value for specific coal types. Such correlations must be determined by applying the common rules laid down for laboratory analyses.

4.6 Selecting the most accurate data source

Article 7 of the FAR requires the operator to use "*data sources representing highest achievable accuracy pursuant to section 4 of Annex VII*". The process of selecting appropriate data sources is explained in this section.

In many cases the operator will have several options for determining a certain data set. Options could include adding the measurements of several sub-meters to give the total,

[44] If sufficiently justified, more complicated procedures could also be used. For example, if the output of the intermediate production period is fed to the cement clinker production at that example site, the related gas consumption as well as related process emissions could be considered part of the clinker sub-installation.

or to use the main fiscal meter as a primary data source and use the sub-meters to split data between sub-installations. Operators may have a choice between using meters under the operator's own control and other meters (e.g. under the fuel supplier's control). Alternatively, the operator may have no appropriate metering or means of analyses and then must choose between one or more indirect determination methods (including estimations or correlations, where necessary).

The operator must choose determination methods for both historical data and for subsequent monitoring data. Due to the improvement principle (e.g. requirements to install additional monitoring under the FAR), data sources for historical and forward-looking data may differ. Although the approach for selecting data sources is similar, operators must bear in mind that they may need to install additional measuring instruments or perform analyses for subsequent monitoring under the FAR.

Selection process:[45] As has been mentioned in section 3.2 on the development of the MMP, operators should first list all available data sources for each parameter (data set) required. Where they need to use indirect determination methods, it is usually useful to consider several different options. Even when direct measurement is possible, it is important for operators to think of other data sources to carry out corroborative checks. Whenever the operator has more than one option for monitoring, Article 7 and section 4.3 of Annex VII to the FAR require the operator to select the "best" data source as the primary data source (i.e. the source used for baseline data or activity level reporting), and where possible to select a "second best" source as a corroborating data source. The importance of a corroborating data source is outlined in sections 3.5 and 3.6 of this document. The description of the hierarchy of data sources below applies to both primary and corroborating data sources.

"Best" data sources are those that rank highest in the hierarchy of approaches (section 4.6.1 below). However, operators should note that the chosen sources shall "ensure a clear data flow with lowest inherent risk and control risk".[46] The operator must provide relevant justification in the MMP for deviating from the hierarchy of data sources.

Note: Operators must provide annual data for all parameters. These data should align with the boundary between calendar years (midnight of 31 December) as closely as reasonably possible (see Section 5 of Annex VII to the FAR for the relevant provisions). Since these provisions are identical to the relevant MRR provisions, no further guidance is given here. Section 5.1.2 of 'UKETS01 MRR – General guidance for installations'

[45] This process applies essentially to both, historical and subsequent monitoring data. However, "available" data sources include the option to purchase new measuring instruments, while this option is obviously excluded for historical data.
[46] From section 4.3 of Annex VII to the FAR.

provides the required information for emissions monitoring, which can be applied following similar principles to all FAR data sets.

4.6.1 Hierarchy of data sources

A hierarchy of different generic types of data sets is provided in sections 4.4 to 4.6 of Annex VII to the FAR. It is a “hierarchy”, because the FAR state that the first one or two approaches are considered “highest accuracy”, the others being second-best to worst in descending order. An operator must determine which level in the hierarchy each data source fits and use the one that meets the highest possible level. Ideally, operators would use data sources from only the highest levels of the hierarchy (i.e. only data sources from the first two categories). However, for limiting operators’ costs, Article 7 allows the following deviations:

- A data source of lower assumed accuracy may be used if the operator can demonstrate that data sources of higher accuracy would be technically infeasible or would incur unreasonable costs (see section 4.6.2), or
- If based on a (simplified) uncertainty assessment the chosen data source has equivalent or lower level of associated uncertainty compared to the alternative (see section 4.6.3).

The hierarchy is further explained below, to make the underlying assumptions clearer. In case of doubt the text of the FAR is relevant.

4.6.1.1 Quantity of materials and fuels

Section 4.4 of Annex VII of the FAR is applicable to all types of material inputs and outputs at the installation and sub-installation levels. In MRR terminology the section applies to “activity data of source streams”. For FAR purposes, it covers activity data of internal source streams and waste gases, as well as production levels of sub-installations.

- The preferred approach is to follow the MRR’s approach for source streams. Where data is needed at installation level, data in conformance with the approved MP under the MRR is considered best quality and should always be used. This avoids inconsistencies and reduces the administrative burden by using the same data sources.
- However, for material flows not reported under the MRR (i.e. only flows between sub-installations, i.e. “internal source streams”), this “best” source is not available.
- Data collected under the FAR only, have less stringent requirements compared to data collected under the MRR, as there is no requirement for a tiered approach and

choices are based on more qualitative criteria. For direct determination of data sets, the following applies:

- Measuring instruments complying with the Measuring Instruments Regulation 2016 or Non-Automatic Weighing Instruments Regulation 2016 are preferred over other instruments, independent of their uncertainty characteristics. Instruments can be under the operator's own control or not (this is because legal metrological control is often applied in cases regarding commercial transactions and are usually trusted by both trade partners).[47]

- Next best are other instruments under the operator's control, independent of their uncertainty characteristics. When instruments fall under the operator's own control, the responsibility for calibration and maintenance of the instruments lies with the operator who will be able to provide the required evidence to their verifier.

- If there are no instruments under the operator's control to collect the required data, then the next best solution is using measuring instruments not under their control (e.g. the fuel supplier's instruments).

- Next in the hierarchy are measuring instruments for indirect determination of data sets in combination with appropriate correlations (see section 4.4). Although not explicitly mentioned in the FAR, the operator may need to choose between different instruments for indirect determination of data and should apply the same hierarchy as per direct determination above to make their choice.

- Finally, the FAR allows "other methods", particularly for historical data. This would be comparable to the "No-tier approaches" of the MRR.[48]

4.6.1.2 Quantification of energy flows

Section 4.5 of Annex VII to the FAR applies to "energy flows", i.e. (net) flows of measurable heat and electricity. It does not apply to non-measurable heat, which should be monitored using the energy value associated with the fuel input (see previous sub-heading and section 4.4 of Annex VII to the FAR).

The hierarchy is similar to that for quantifying materials and fuels, but there is no reference to approved MPs (as such energy flows are not relevant under the MRR). The

[47] Evidence for compliance with MID or NAWI Directive is usually the appropriate CE marking on the instruments. Compliance with NLMC can be demonstrated by different forms of verification markings. Examples are given in the training material on uncertainty assessment, see https://ec.europa.eu/clima/document/download/ad89f9c2-10f4-47c0-b234-988e3165608f_en.

[48] Note however that the no-tier approaches under the MRR require a full uncertainty assessment, which is not required under the FAR.

highest level in the hierarchy is set out in section 4.4 of Annex VII to the FAR and refers to "*readings of measuring instruments that comply with the Non-automatic Weighing Instruments Regulations 2016 or the Measuring Instruments Regulations 2016(MIR)*". At this time, the MIR does not cover steam meters, hence steam networks cannot meet the highest level of the hierarchy in practice. To avoid undue burden (demonstrating unreasonable cost etc.), regulators will consider the highest level of the hierarchy as "technically infeasible" for steam networks, without requesting further evidence from operators.

To determine measurable heat, the last paragraph of section 4.5 of Annex VII to the FAR contains provisions for more complex determinations. In cases when not all the required parameters are measured, operators must apply section 7 of Annex VII (see section 4.9 of this document). For justifying a monitoring approach using an uncertainty assessment, operators should assess the uncertainty of all appropriate parameters, not just a single parameter (e.g. not just temperature or flow when determining net heat flows).

Furthermore, the hierarchy shows that method 3 for measurable heat determination (based on a proxy, see section 7.2 of Annex VII to the FAR, explained in section 4.9 of this document) and method 4 (based on the reference efficiency) are considered of lower quality compared to other methods.

4.6.1.3 Properties of materials

Section 4.6 of Annex VII to the FAR details the hierarchy of approaches for "properties of materials", meaning the composition and other chemical or physical properties of the materials. In MRR terminology this includes the determination of the calculation factors.[49] Materials include all fuels, inputs and outputs of the installation and its sub-installations (including waste gases), as well as the products to which benchmarks apply.

The following hierarchy applies:

1. Best data are determined in accordance with the approved MP under the MRR.
2. Laboratory analyses in accordance with section 6.1 of Annex VII to the FAR are considered equally "best" if the parameter under consideration is not included in the MP. Section 6.1 requires that Articles 32 to 35 of the MRR are applied. A suitable frequency of analyses (i.e. the size of the batch from which representative samples are to be taken) must be agreed with the regulator based on the heterogeneity of the material. Please refer to 'UKETS07 MRR – Sampling and analyses' for more information.
3. Next best are simplified laboratory analyses in accordance with section 6.2 of Annex VII to the FAR. Methods based on industry best practice instead of

[49] Emission factor, NCV, carbon content, biomass fraction, etc.

European (CEN) or other standards, of lower frequency (at least once per year), and using laboratories which don't meet the MRR's requirements may be allowed.

4. Constant values as per MRR Article 31(1) points b, c and d (values used by the UK in its national GHG inventory, literature values agreed with the regulator, values guaranteed by the fuel / material supplier).
5. Constant values as per MRR Article 31(1) points a and e (values found in Annex VI to the MRR, other standard factors found in the IPCC guidelines, values based on analyses carried out in the past, other values based on scientific evidence).

4.6.1.4 Additional guidance for historical data

As mentioned before, the FAR do not differentiate between historical and (new) monitoring data with regard to the hierarchy of data sources. However, operators may have difficulty when deciding which documents to use for historical data. Therefore, the following guidance may be useful for document-based evidence, where no information on the measuring instruments is available that would allow a classification of the data source according to the hierarchies given in sections 4.4 to 4.6 of Annex VII to the FAR:

- Best are documents or electronic data such as invoices, issued for commercial transactions between two independent trade partners (because it is assumed that the trade partners exert mutual quality control of their data).
- Equally useful are documents or electronic data such as sales data and parts of production protocols which have undergone an audit (such as financial audits for taxation or corporate reporting).
- Next best are documents such as internal cost attributions or pro forma invoices used to allocate energy or raw material costs to different products or business units within an installation. In these cases, trade partners are not independent entities, but still have an interest in data quality and therefore perform independent reviews (4-eyes principle).
- Least accurate data are found in documents or electronic data such as production protocols which have not undergone audits or dedicated control activities.[50]

[50] Further criteria include whether documents are complete, transparent, noted down at the time when data were created and not corrected later, etc.

4.6.2 Technical feasibility and unreasonable costs

As in the MRR and VR, cost effectiveness is an important principle enshrined in the FAR. Operators can justify using data sources lower in the hierarchy of approaches by claiming either "technical feasibility" and / or "unreasonable costs".

4.6.2.1 Technical feasibility

Section 4.1 of Annex VII to the FAR outlines the conditions under which the operator may claim that a monitoring methodology is "technically not feasible": The operator must provide evidence which the regulator will review to assess whether the claim is justified. To clarify, "technically feasible" means that the operator has "*technical resources capable of meeting the needs of a proposed system or requirement that can be implemented in the required time for the purposes of this Regulation. Those technical resources shall include availability of required techniques and technology*." The concept is not about costs, but whether a measure is possible (within reasonable time). Typical reasons for technical infeasibility include:

- There is not enough space available for the installation of a certain measuring instrument.
- An instrument of lower uncertainty (or one falling under legal metrological control) is currently not available on the market.
- Installing a required instrument would require a (prolonged) shutdown of the installation. In this case, a better justification would be that the installation would incur unreasonable costs.

For historical data only, in cases when data have not been monitored, an appropriate justification would be "the use of that source is technically not feasible". However, for future monitoring data such a situation must be treated as a data gap, i.e. the operator must put in place measures to avoid it.

4.6.2.2 Unreasonable costs

An operator can justify avoiding selecting a data source higher in the hierarchy outlined in section 4.6.1, such as installing more expensive metering equipment or performing more frequent analyses, if such measures would incur unreasonable costs. Similarly to cases of technically infeasibility, the operator must provide appropriate evidence with the MMP so the regulator can assess whether the derogation is justified. As with the MRR, section 4.2 of Annex VII to the FAR provide clear rules for determining if costs are unreasonable. Operators must compare the costs arising from installing or using the "better" data source to the "benefit" when compared to a data source of lower quality. The data source for comparison is usually a source already available (and/or in use) at the installation, or a data source which the operator proposes to use instead of the data source of highest accuracy according to the hierarchy of approaches. Where the costs exceed the benefit, costs are considered unreasonable. However, there is a de minimis threshold defined. If the total of all appropriate costs, as defined below, do not exceed the threshold, then they are considered reasonable. The threshold is £2,000 per year, or £500 for "installations with low emissions" as defined by Article 47 of the MRR.

Costs: As is the case under the MRR, "costs" refer only to additional costs compared to the alternative data source. All relevant costs should be considered, i.e. investment (annual depreciation based on the reasonable lifetime of the equipment) capital costs based on a realistic interest rate, operation costs, including maintenance, spare parts, personnel costs etc. An example is given in section 4.6.1 of 'UKETS01 MRR - General guidance for installations', and further information can be found in the user instructions of the Excel tool[51] for calculating unreasonable costs under the FAR.

Benefit: The benefit is expressed based on an assumption that the improved accuracy of monitoring can be expressed as the financial value of allowances. As in cases under the MRR, the allowance price is fixed[52] at £20 for this purpose. The price is multiplied by an "improvement factor" (expressed as allowances or as tonnes CO_2 per year). However, the MRR's approach based on uncertainty thresholds for the different tiers is not applicable under the FAR, because no tiers are defined. The improvement factor can refer to several different types of data sets. The provisions in the FAR are therefore more diverse than the provisions in the MRR:

- The default rule is that the improvement factor is "1% of the most recently determined sub-installation's annual allocation free of charge". This is relatively simple to determine and should be based on the operator's BDR or ALR submission.
- As the value calculated above t may be relatively high, operators can choose other, more specific improvement factors based on "1% of the affected CO2 equivalent":
  - In case of source streams (including waste gases or other internal source streams), the improvement factor is 1% of its CO2 "content" (i.e. carbon content multiplied by 3.664 [t CO2 / t C])
  - For emissions determined by CEMS the improvement factor is 1% of the emissions of the respective emission source

[51] Operators should contact their regulator for a copy of this tool.
[52] Such fixed amount reduces administrative burden for checking market prices and provides certainty over time on whether a particular monitoring approach incurs unreasonable costs: The situation whether the measure incurs unreasonable costs changes over time only due to changing costs of the measure, but not due to the benefit.

- For measurable heat, the improvement factor is 1% of heat multiplied by the heat benchmark[53]
- For electricity quantities, 1% of the relevant annual amount of electricity multiplied by 0.376 t CO_2 /MWh[54]
- For activity levels of product benchmark sub-installations (i.e. for the amounts of production): 1% of the activity level multiplied by the product benchmark.[55]

The FAR does not specify the data range for determining the improvement factor. However, for making the data representative, operators are advised to use the MRR approach (i.e. average data of the last three years, or – where such data are not available or not representative – a conservative estimate thereof).

4.6.3 Simplified uncertainty assessment

The concept of determining the uncertainty of a measuring instrument is a well-established feature of emissions trading monitoring and reporting. Nevertheless, the topic of uncertainty assessment is often perceived as one of the most complicated areas of monitoring under the MRR. See guidance document 'UKETS02 MRR/FAR - Uncertainty assessments for installations' which includes the treatment of uncertainty for allocation data.

Under the FAR, uncertainty assessments are of less importance as the monitoring principles do not require meeting a certain tier but rather set out a hierarchy of different monitoring approaches. An uncertainty assessment is only required if an operator wants to demonstrate that an approach lower in the hierarchy (see section 4.6.1) is "better" than an approach higher in the hierarchy, where the higher approach would be technically feasible without incurring unreasonable costs. "Better" in this context means that the uncertainty would be lower. Examples for such situations might be, e.g.:

- The uncertainty associated with an operator's own measuring instruments is lower than the uncertainty associated with a trade partner's instruments.
- The operator would like to use an indirect monitoring approach, because existing measuring instruments for direct determination of the data set are known to be unreliable (e.g. requiring unusually frequent adjustment).

[53] In this case it seems justified for practical reasons to use the latest known benchmark value, i.e. the value used for the previous allocation period, unless the new value has already been published.
[54] This is the "factor specified in Article 22(3)" mentioned in FAR Annex VII section 4.2 point (e).
[55] The FAR specify here that in case the benchmark has not yet been updated, the values of the previous phase should be used.

- The operator wants to use an instrument that allows automatic data collection, while another instrument is available that is under national legal metrological control.

In such situations the operator must carry out a (simplified) uncertainty assessment (for further information operators should consult ‘UKETS02 MRR/FAR - Uncertainty assessments for installations’). However, the FAR do not specify what “simplified” means. Therefore, the following suggestions may be useful:

- A “full” uncertainty assessment must consider:
    - How the instrument’s readings are used for calculating the parameter under consideration (e.g. how individual measurements contribute to the uncertainty over the whole reporting year). In case of indirect determinations, the error propagation law must be applied accordingly for individual measurements.
    - The instrument’s specified uncertainty, based on maximum permissible error (MPE) given in legislation, or the producer’s specifications, or taken from a calibration certificate, etc.
    - Factors that influence the uncertainty in use e.g. whether the environment in which the instrument is used is appropriate, whether ageing, corrosion, or other systematic sources of error play a role, etc.
    - Further factors, such as “safety margins” for unknown sources of error.

When carrying out a simplified uncertainty assessment, the operator should use expert judgement (such as the operator’s experience gathered from uncertainty assessments performed for the MP under the MRR) to decide which of the above factors mentioned in the last two bullet points can be disregarded, if not easily accessible. For example, an operator can use the “maximum permissible error in service” (MPES) as the uncertainty of a single measurement, if they hold this information. The MPES contains a safety margin compared to the MPE. Where more doubt exists (e.g. when the environment in which an instrument sits is much more disturbed than allowed by the instrument’s specification), the operator should apply reasonable efforts to assess the most important influencing factors.

4.7 Handling of units used by several sub-installations

As already mentioned in the example presented in section 2.5, physical units are not attributed to individual sub-installations in the same way as inputs, outputs and emissions. However, it is useful to list all relevant physical units for each sub-installation in the MMP (they should be listed as part of the description of the installation and its processes) and in the relevant diagrams (e.g. for identifying when data must split between sub-installations).

In cases when physical units are used by several sub-installations, the attribution of data to sub-installations – for completing the BDR and ALR – can, on occasion, be accomplished in different ways. Therefore, the BDR and ALR templates contain a special option to handle relevant data (heat flows, but also source streams / related emission factors) separately from data which can be immediately attributed to sub-installations. However, it is important to note that such shared units should not be considered as separate from the sub-installations, or even as sub-installations on their own.

Example MH-4 in section 5.3.3 shows that when heat produced from the same unit (a boiler) is used in 2 separate sub-installations, the amount of measurable heat used in each sub-installation is attributed to each respective sub-installation, but the related fuel input is set to 0 in the reporting template for each sub-installation. This is needed for consistency checking, and to ensure that operators report these data in the same way. However, operators can determine fuel input and related emissions for the heat using the detailed heat balance for each sub-installation. In this case, heat coming from a unit serving several sub-installations would be considered an “import”. Note that the above only relates to how the template is to be completed. It does not contradict the fact that fuels and their emissions must be attributed to sub-installations.

In practical terms, in particular for the attribution of measurable heat from one boiler/CHP to several sub-installations, the precise split between the different heat benchmark sub-installations is determined using the heat balance (section E.II of the template), and the related fuel input emissions are thereafter determined proportionally to the heat split, applying the last point of section 10.1.1 of Annex VII to the FAR (mentioned in section 4.4 and footnote 44).

4.8 Monitoring of production levels

The FAR does not contain many rules for monitoring production levels. However, production levels are at the very core of FAR monitoring. The following summary sets out the requirements here:

- As already explained in section 2.2 and in the example presented in section 2.5, the following items must be monitored for each sub-installation:

  - Product type/quality ("what is produced?", including which PRODCOM code or other parameter is applicable for ensuring the product complies with the product definition of the specific sub-installation)[56], and
  - The quantity of the product. In case of product benchmarks, this is based on the reference state as defined by Annex I to the FAR. Operators may need to monitor further parameters in accordance with Annexes II and III to the FAR. In case of fall-back sub-installations, products must be listed per PRODCOM code (or NACE code in cases where PRODCOMs are not applicable) used in the CLL.
- Operators should note that when selecting monitoring approaches, the hierarchy for "materials and fuels" applies (see section 4.6.1); In many cases invoices to clients or other data used for financial purposes (and so audited; this may include data on product stocks) will be useful data sources.

For product benchmarks, the following detailed step-by-step approach should be considered. The operator should:

- Identify all products relevant to the sub-installation in accordance with Annex I to the FAR
- Determine the annual uncorrected production in tonnes per year[57] [58]
- Where Annex I to the FAR refers to a specific moisture content, purity, concentration, or other specific state -
  - determine the actual state (see section 4.6.1.3)
  - determine the corrected production to be reported as annual activity level
- Where data for several products falling within the same sub-installation are determined separately, operators must sum corrected annual production data for reporting as annual activity level
- Where further parameters are required to determine the annual activity level of the sub-installation, in accordance with Annex II or III to the FAR, operators should determine the annual or annual average values, as required, for these specific

[56] FAR Annex VI requires that for each sub-installation (i.e. including the fall-back sub-installations), the operator has a procedure for keeping track of the products produced and their PRODCOM codes. Detailed requirements for that procedure are outlined in Annex VII section 9.
[57] Or another relevant unit per year (e.g. m^3 etc.).
[58] Section 5 of Annex VII to the FAR contains the relevant provisions for that purpose. Since they are identical to similar MRR provisions, no further guidance is given here - see section 5.1.2 of 'UKETS01 MRR - General guidance for installations' for more information.

parameters and then calculate the annual activity levels required for the BDR and ALR

- To avoid double counting, the operator shall ensure that products returned to the production process are deducted from annual activity levels, as appropriate, in line with the product definitions set out in Annex I to the FAR.

4.9 Monitoring of measurable heat

As already briefly explained in section 2.7, all measurable heat under the FAR is to be understood as “net heat”, i.e. the difference between the enthalpy entering a heat consuming process and the enthalpy returning from that process.[59] Therefore, precise monitoring of such heat requires the determination of several parameters:

- Flow rate of the heat medium (most appropriate is the mass flow) to the process
- State of the medium entering the heat consuming process, where “state” includes all parameters relevant for determining the specific enthalpy of the medium:
    - Type of the medium (hot water, steam, molten salt or metal, solutions or dispersions of diverse materials, etc.)
    - Temperature
    - Pressure (in case of steam or other gases)
    - Information on saturation/super-heating in case of steam
    - Concentration for solutions
    - Other information as appropriate
- State of the medium leaving the heat consuming process
- If the flow rate of the returned medium is different from the forward flow or unknown, suitable assumptions for its enthalpy are required.

Such determination is a difficult task, because industrial installations may have complex heat networks with several heat sources and a multitude of consumers.

[59] As also mentioned in section 2.7, the heat consumer can be a process within the installation, in the same or another sub-installation, or outside the installation. The production of “cooling” (by using an absorption heat pump) is also considered a heat consuming process.

Therefore, section 7.2 of Annex VII to the FAR provides the following methodologies for determining net amounts of measurable heat:[60]

- Method 1: Using measurements: For this method, all necessary parameters[61] must be known (refer to list above). In case the condensate is not returned, or its flow unknown, operators should assume all condensate is returned at a reference temperature of 90°C
- Method 2: This method is meant for historical data only, as it refers to "documents based on metering or estimation methods". The guidance provided in section 4.6.1.4 should be referred to in this case
- Method 3: This builds on the energy input of all fuels and determines the net heat flow based on the known efficiency of the boiler. It refers to "measured efficiency" because the operator is advised to measure it "over a reasonably long period". Alternatively, the efficiency can be taken from the boiler manufacturer's documentation (which is the less preferred approach, considering the generic hierarchy of approaches). Method 3 is considered to be of a much lower accuracy than Method 1 (see section 4.6.1.2)
- Method 4 is meant for situation where "all else fails"; it is the same as Method 3, but for unknown boiler efficiencies. The rather conservative assumption is that the efficiency would be 70%.

4.10 Rules on CHP

In addition to the rules on heat monitoring explained in section 4.9, there is another aspect that operators must consider when using a CHP unit as the total emissions must be split between emissions associated with heat production and those associated with electricity production. The relevant formulae for this calculation are set out in section 8 of Annex VII to the FAR. As heat and electricity production in the CHP is one inseparable process, assumptions must be made. Operators can use the cogeneration tool in Sheet D of the BDR and ALR which uses the formulae in the FAR to split emissions between heat and electricity.

[60] Section 7.2 of Annex VII to the FAR is written using technical rather than legal language, so it should be clear without too much additional guidance. It is therefore not replicated in full here. Furthermore, it is assumed that operators are familiar with the methods listed there.

[61] The relevant parameters are temperature, pressure, state (saturation or degree of superheating) of the transmitted as well as the returned heat medium, and the (volumetric) flow rate of the heat transfer medium. Based on the measured values, the operator determines the enthalpy and the specific volume of the heat transfer medium using suitable steam tables or engineering software.

As section 8 of Annex VII to the FAR is quite self-explanatory it is not replicated in full here. However, for MRV purposes, the operator should detail the reference efficiencies used in the split emissions calculations in their MMP.

4.11 Rules on cross-boundary heat flows

The transfer of measurable heat across the installation's boundaries can have significant impacts on the installation's free allocation. Guidance document 'UKETS15 FAR - Cross-Boundary Heat Flows' provides further information on this subject.

For MRV purposes, the operator must ensure that the MMP contains all the necessary information for the following:

- Where an installation imports measurable heat, the operator shall determine separately the quantity of heat imported from installations covered by the UK ETS, and heat imported from non-UK ETS entities such as district heating networks.
- Where an installation consumes measurable heat exported from a nitric acid product benchmark sub-installation,[62] the operator shall determine the amount of heat consumed separately from other measurable heat.
- Where an installation exports measurable heat, the operator shall determine separately the quantity of heat exported to installations covered by the UK ETS, and heat exported to non-UK ETS entities (in the latter case a distinction for CL and non-CL heat use is required). Furthermore, the operator shall determine separately quantities of heat qualifying as district heating. Note the rules applicable for the distinction of those heat exports are discussed in section 4.12, step 2.

4.12 Detailed heat balance

Note: This section is relevant only for

- installations that have flows of measurable heat which are not attributed to product benchmark sub-installations
- installations that have imports or exports of measurable heat
- installations where measurable heat is transferred between sub-installations, or
- installations where heat from nitric acid production is used.

[62] This sub-installation can be part of the same installation.

Since under the FAR some types of imports and exports of measurable heat are not eligible for allocation, the exact determination of the eligible heat can be demanding. The operator must ensure that each parameter in the following step-by-step approach is monitored (and detailed in the MMP appropriately) if it is relevant at the installation. The steps for determining the boundaries and the annual activity level of the heat BM sub-installations are:

Step 1. Heat balance

- Determine the annual amounts of all flows of measurable heat as required for the calculation below

- Determine Q_{prod} as the total annual amount of measurable heat produced within the installation, except for measurable heat produced in a nitric acid product benchmark sub-installation

- Determine Q_{ETS_import} as the sum of annual amounts of measurable heat imported from installations included in the UK ETS

- Determine Q_{nonETS_import} as the sum of annual amounts of measurable heat imported from entities not included in the UK ETS. Where measurable heat produced in a nitric acid product benchmark sub-installation is either produced in the installation or imported from an installation included in the UK ETS, the respective amount of heat is included in the amount Q_{nonETS_import}

- Calculate the total available measurable heat (Equation 3)

$$Q_{total} = Q_{prod} + Q_{ETS\_import} + Q_{nonETS\_import}$$

- Calculate the total available annual amount of “ETS heat” (Equation 4)

$$Q_{ETS} = Q_{prod} + Q_{ETS\_import}$$

  and the total available annual amount of “non ETS heat” (Equation 5)

$$Q_{non-ETS} = Q_{nonETS\_import}$$

- Calculate the ratio of “ETS heat” to “total heat” in (Equation 6)

$$R_{ETS} = Q_{ETS} / Q_{total}$$

- If electricity is produced in the installation from measurable heat, subtract the associated amount of measurable heat $Q_{El.prod}$ from Q_{total} to give (Equation 7)

$$Q_{total,1} = Q_{total} - Q_{El.prod}$$

- If the heat amount $Q_{El.prod}$ can be distinguished as either "ETS heat" or "non-ETS heat" based on the heat transfer medium used or its parameters (temperature, pressure, etc.), it should be deducted from the respective amount of heat, as appropriate (Equation 8):

  $$Q_{ETS,1} = Q_{ETS} - Q_{El.prod}$$ or

  $$Q_{non-ETS,1} = Q_{non-ETS} - Q_{El.prod}$$

- If such distinction is not possible, the "ETS heat" and "non-ETS heat" are adjusted using the ETS heat ratio as follows (Equation 9):

  $$Q_{ETS,1} = Q_{ETS} - R_{ETS} \times Q_{El.prod}$$ and

  $$Q_{non-ETS,1} = Q_{non-ETS} - (1 - R_{ETS}) \times Q_{El.prod}$$

- Determine the annual amounts of measurable heat consumed by product benchmark sub-installations. Because the calculation of free allocation requires the identification of any "non-ETS heat" consumed in product benchmark sub-installations, the respective calculation is to be performed as follows (Equation 10):

  $$Q_{ETS,2} = Q_{ETS,1} - \sum Q_{ETS,prodBM,j}$$ and

  $$Q_{non-ETS,2} = Q_{non-ETS,1} - \sum Q_{non-ETS,prodBM,j}$$

  where $Q_{ETS,prodBM,j}$ are the amounts of "ETS heat" consumed by product benchmark sub-installation j, and $Q_{non-ETS,prodBM,j}$ are the amounts of "non-ETS heat" consumed by product benchmark sub-installation *j*.

- If measurable heat is exported to installations included in the UK ETS, the related annual amount of measurable heat is to be deducted from the "ETS heat" as follows (Equation 11):

  $$Q_{ETS,3} = Q_{ETS,2} - \sum Q_{export.ETS,n}$$

  where $Q_{export.ETS,n}$ are the annual amounts of measurable heat exported to installation n.

- A corrected "ETS ratio" is calculated as follows (Equation 12):

  $$R_{ETS,corr} = Q_{ETS,3} \div (Q_{ETS,3} + Q_{non-ETS,2})$$

- The annual amount of measurable heat consumed within the installation eligible for the heat benchmark is determined as (Equation 13):

$$Q_{cons.heatBM} = Q_{cons.total} - Q_{El.prod} - \sum Q_{ETS,prodBM,j} - Q_{loss}$$

where $Q_{cons.total}$ is the total amount of measurable heat consumed within the installation and Q_{loss} is the value for estimated annual heat losses within the installation. Alternatively, the amount $Q_{cons.heatBM}$ may be determined based on direct measurements, and Q_{loss} is determined based on that equation for the purpose of plausibility checking.

- The sum of annual amounts of measurable heat exported to non-ETS entities *m* is determined as (Equation 14)

$$Q_{export.nonETS} = \sum Q_{export.nonETS,m}$$

- The total annual amount of measurable heat eligible for allocation (under the carbon leakage heat benchmark sub-installation, the non-carbon leakage heat benchmark sub-installation or the district heating sub-installation), Q_{heatBM} is determined as follows (Equation 15):

$$Q_{heatBM} = R_{ETS,corr} \times (Q_{cons.heatBM} + Q_{export.nonETS})$$

Where an amount of heat Q is calculated as negative at any point above, it is set to zero, to avoid negative allocation values. Thereafter the split into CL and non-CL heat benchmark or district heating sub-installation can be made as follows.

Step 2. Split of measurable heat into the appropriate sub-installations

Where the operator does not use the “95% rule” as derogation (see section 2.4), the operator should split the eligible annual amount of measurable heat Q_{heatBM} in order to determine the annual activity levels of the carbon leakage heat benchmark sub-installation, the non-carbon leakage heat benchmark sub-installation and the district heating sub-installation taking into account the following process, as required by Article 10(4) of the FAR:

- The operator should identify the relevant fraction of measurable heat exported for the purpose of district heating, and attribute it to the district heating sub-installation only to the extent that the operator can provide evidence to the regulator that the heat use complies with the definition of district heating given by the FAR (see section 2.7 for the definition). Such evidence may be e.g. invoices sent to the heat consumers, as long as it is evident that the heat use is for space heating and warm water production, and not for industrial production purposes.[63]

- For other heat exports to non-UK ETS entities, the operator should include the heat within a non-CL heat benchmark sub-installation, unless they can provide evidence that the consumer of the measurable heat uses the heat to produce products deemed to be exposed to a significant risk of carbon leakage (i.e. a sector found on the CLL).
- For measurable heat consumed within the installation, the operator should determine whether the heat consuming processes serve sectors found on the CLL. The operator should use the PRODCOM codes that they have determined as per the related procedure described in their MMP.[64]

4.13 Determining the boundaries of the fuel BM sub-installations

Step 1: Determine eligible fuel quantities

For determining the boundaries and annual activity levels of fuel benchmark sub-installations, before carrying out the split according to the CL risk, the operator should determine the “eligible” amount of non-measurable heat expressed in TJ as follows:

- Starting point is the total energy input to the installation in the form of fuels (including waste gases imported from other installations) calculated using net calorific values, as set out in the MP approved under the MRR. Energy contained in source streams exported from the installation will need to be deducted, if a mass balance approach is applied
- Deduct the following from the total energy input as determined above (without double counting):

[63] Guidance document ‘UKETS11 FAR - Determining the allocation at the installation level’ specifies the following pragmatic approach for providing suitable evidence:

- In cases of low temperature heat (with a design temperature below 130°C at the heat producer’s entry point to the district heating network) delivered to a district heating network, it can be assumed that the conditions of the definition of district heating are fulfilled.
- In case of a design temperature of 130°C and more, the heat will only be considered as delivered to district heating in cases when the heat producer provides appropriate evidence, e.g. via annual sales figures (for the entire baseline period) clearly indicating the amount of heat sold for the purposes of heating or cooling of space or the production of domestic hot water.

In both cases the heat producer must confirm that heat reported as district heating is not subject to free allocation for other UK ETS installations.

[64] Annex VI of the FAR requires that for each sub-installation (i.e. including the fall-back sub-installations), the operator has a procedure for keeping track of the products produced and their PRODCOM codes. Detailed requirements of that procedure are outlined in section 9 of Annex VII.

  - the energy content of fuels used to produce electricity
  - the energy content of fuels used to produce measurable heat
  - the energy content of all fuels attributed to product benchmark sub-installations
- Further deductions should be made for the energy content of gas flared and the associated supporting fuels used for the flare when flaring other than safety flaring takes place outside a product benchmark sub-installation

For corroboration purposes, the operator should ensure that the energy content of fuels included within the boundaries of fuel BM sub-installations is used only for the following purposes:

- to produce products not covered by a product BM
- to produce mechanical energy other than used for the production of electricity, or
- for heating[65] or cooling (including space heating or cooling, heating of water, process heating, etc.).

Other fuel uses (e.g. for waste treatment without heat recovery) will not qualify for the fuel benchmark sub-installations.

Furthermore, the operator shall ensure that – to avoid double counting –

- Fuels used as reducing agent or for chemical syntheses should not be considered as fuel input into a fuel benchmark sub-installation
- Any fuel which will ultimately end up in a waste gas is not included.

Where measurable heat is recovered from the flue gas after the fuel has been used to produce non-measurable heat, to avoid double counting, the operator shall subtract the relevant amount of net measurable heat (i.e. the heat gained from this recovery process) divided by a reference efficiency of 90% from the fuel input (Article 10(5)(k) of the FAR).

The resulting energy input is considered the annual production of non-measurable heat eligible for allocation under the fuel benchmark sub-installations.

Step 2: Split of the fuel BM into CL and non-CL sub-installations
Where the operator does not use the “95% rule” as derogation (see section 2.4), the operator should split the eligible annual amount of non-measurable heat, as determined

[65] Pre-heating of fuels is considered part of the heat generation process, i.e. counting it here separately as “heating” would lead to double counting of that heat amount.

above, according to the CL exposure of the processes in which the heat is consumed. The operator should use the PRODCOM codes that they have determined as per the related procedure described in their MMP.

Step 3: Defining monitoring needs

After performing steps 1 and 2, the operator must determine which fuels require additional monitoring, considering their MP under the MRR. Note that the calculation factors will rarely need separate determination. A very rare unlikely case of this happening could be where two different coal types were used in physical units assigned to different sub-installations, but these two coal types were treated as one single source stream in the MP (consisting of a mixture of both coal types). In most cases, however, only the quantities of fuels must be split per sub-installation. Each fuel needs separate monitoring at sub-installation level only if it is relevant for more than one sub-installation.

4.14 Determining the boundaries of the process emissions sub-installations

Step 1: System boundaries

For determining the system boundaries and the annual activity levels of process emissions sub-installations, before carrying out the split in accordance with CL exposure, the operator should determine the eligible amount of emissions expressed in t CO_2(e) as follows:

- Starting point is the total emissions of the installation monitored as per the MP approved under the MRR, excluding emissions from the combustion of waste gases
- Emissions attributed to product benchmark sub installations, heat benchmark sub-installations and fuel benchmark sub-installations, including emissions produced by source streams used for flue gas cleaning, must be deducted from the total emissions calculated as above
- Emissions resulting from the production of electricity, emissions related to the recovery of measurable heat (in line with FAR Article 10(5)(k), see section 2.4), emissions relating to production of measurable heat exported to UK ETS installations, and emissions resulting from flaring other than safety flaring which is not included in product benchmark sub-installations must be deducted from the remaining emissions (after deductions as per the above)
- The remaining emissions are considered for the next step, provided that the operator provides evidence to the satisfaction of the regulator that the emissions comply with at least one of the following criteria:

  - The emissions consist of greenhouse gases other than CO2, or
  - The emissions are caused by processes listed in Article 2(10) of the FAR and not caused by flue gas cleaning processes.

- Where the installation produces waste gases[66] [67] which are not produced within a product benchmark sub-installation, a relevant quantity of such emissions EM_{WG} is added[68] to the emissions determined under the previous points. EM_{WG} is calculated as follows:

$$EM_{WG} = V_{WG} \times NCV_{WG} \times (EF_{WG} - EF_{NG} \times Corr_{\eta})$$

Where V_{WG} is the volume of waste gas produced (which is not flared) expressed as $\mathrm{Nm_3}$ or t, NCV_{WG} is the net calorific value of the waste gas expressed as TJ/$\mathrm{Nm_3}$ or TJ/t, EF_{WG} is the emission factor of the waste gas expressed as t CO_2/TJ, EF_{NG} is the emission factor of natural gas (56.1 t CO_2/TJ), and $Corr$ is a factor that accounts for the difference in efficiencies between the use of waste gas and the use of the reference fuel natural gas. The default value for this factor is 0.667.

The resulting emissions are considered as the annual process emissions eligible for allocation under the process emissions sub-installations. Operators should use the waste gas tool in Sheet D of the BDR and ALR in which the formula above is used to calculate process emissions if waste gases are produced outside product benchmarks.

Step 2: Split of the process emissions into CL and non-CL sub-installations

Where the operator does not use the "95% rule" as derogation (see section 2.4), the operator must split the eligible annual process emissions determined above according to the CL exposure of the processes in which the heat is consumed. The operator should use the PRODCOM codes that they have determined as per the related procedure described in their MMP.

Step 3: Defining monitoring needs

After performing steps 1 and 2, the operator must determine which source streams require additional monitoring, considering their MP under the MRR. Similarly to the case with the fuel BM sub-installation, it will rarely be necessary to determine the calculation

[66] Where the emission factor of the waste gas is lower than the emission factor of natural gas multiplied by the efficiency correction factor, this formula would result in a negative value to be added. Therefore, such waste gases should be treated like normal fuels.
[67] A specific rule applies where waste gases occurring outside the boundaries of product benchmarks are not used, mainly in cases of open furnaces (Article 10(5)(i) of the FAR). More information is presented in guidance document 'UKETS17 FAR - Waste gases and process emissions sub-installation'.
[68] Note that the approach is presented in a different way than in section 5.3 on attributed emissions. Here the waste gases are added relatively late (in the first bullet point it is said "excluding the emissions from waste gases"). However, in section 5.3 the approach is to start from the emissions in accordance with the MP under the MRR, and a correction is made thereafter for export of waste gases. Both approaches are fully consistent.

factors separately per sub-installation. Usually only the quantities of source streams must be split, and only if they are relevant to more than one sub-installation.

4.15 Rules for waste gases

The importance of waste gases is explained in this document in sections 2.2, 5.3 and 4.14. Their treatment in terms of allocation rules is elaborated in guidance document 'UKETS17 FAR - Waste gases and process emissions sub-installation'. From an MRV perspective, the following can be summarised:

- Waste gases are source streams like other fuels and can therefore be monitored using the rules provided by the MRR (note the rule on "inherent CO2" i.e. CO2 already contained in the source stream is accounted for by inclusion in its emission factor). However, where waste gases are relevant for more than one sub-installation, relevant splits need to be determined.

- Waste gases may occur as "internal source streams" which are not mentioned in the MP under the MRR. In this case no tier requirements of the MRR apply. However, the hierarchy of approaches (see section 4.6.1) regarding most accurate data sources applies.

4.16 Monitoring of electricity

There are two reasons why electricity must be monitored under the FAR:

- If electricity is produced at the installation, a balance of all electricity imported, produced, consumed, and exported at installation level is required. This enables operators to check fuel and heat data at the installation, since when electricity is produced less than 100% of inputs, outputs and emissions are attributed to sub-installations (see also section 2.2.1).

- If a product benchmark sub-installation for which Annex I to the FAR specify that "exchangeability of electricity and fuels" is relevant, the respective exchangeable electricity must be monitored.

For MRV purposes this has the following consequences:

- Electricity meters must be installed at appropriate measurement points. In the absence of meters, the most appropriate estimation method is a combination of operating hours with a nominal efficiency (for electricity production) or nominal power of the consumers (for electricity consumption).

- Although not specified by the FAR, metering should apply to real power, not apparent power (complex power) i.e. only the active power component should be metered, and the reactive power should be disregarded.[69]
- Regarding sub-installations where exchangeability of electricity and fuels is relevant, the operator should ensure that:
  - the measurement points relate to particular parts of the sub-installation only, which are specified in Annex I to the FAR, and
  - the operator must establish, document, implement, and maintain a procedure for regular checking whether changes have occurred at the installation such that relevant electricity consuming units have been added or removed from the installation, and for modifying the MMP accordingly, if relevant.

[69] Should a very high phase displacement lead an operator to conclude that monitoring complex power would be more appropriate, a justification should be provided to the regulator. If the regulator agrees, this should be detailed in the MMP, and the complete electricity balance should be consistently based on that type of measurement.

5 Central concepts

5.1 What are benchmarks and sub-installations in the UK ETS?

Benchmarks are a means to compare the performance of peers with a reference value, which is called the benchmark.[70] Due to the restriction to "peers" it is important to ensure that only similar activities are compared to each other. For example, it is not useful to compare the energy consumption of paper production to that of cement. In the UK ETS, the benchmarks are related to the GHG efficiency of production processes, expressed as GHG emission intensity, more specifically as "direct emissions [t CO_2(e)] per tonne of product". Benchmarks are set as the average GHG efficiency of the 10% best installations in the sector in the EU.[71] Due to this definition, there is no differentiation by installation size (i.e. all bars in the graph are the same width).

Furthermore, products are the basis for the benchmarks, and differentiation does not account for factors such as different technologies, raw materials, fuels or heat sources, installation age, geographical or climatic circumstances, etc.[72] Such an approach requires a sound method to ensure equal treatment of installations across a wide range of circumstances, which is outlined in this section.

Where only one product (or a homogeneous group of products) is produced at an installation, it is relatively simple to determine GHG efficiency, as shown in Figure 5. Operators should monitor the emissions (when using the MRR's "standard methodology" this means monitoring of the amounts and quality of the input materials and fuels), as well as the quantity of (saleable) product. It is important that operators regularly check whether the product quality still complies with the original product definition, as the benchmark applies only if like-with-like is compared.

[70] For emissions trading purposes, a benchmark is not an emission limit value that must be achieved by an installation. The benchmark is just one of several input values required for sharing the total available number of allowances among UK ETS participants.
[71] The UK ETS utilises the EU ETS benchmarks for the first free allocation period (2021 – 2026) as set under Article 10a(2) of the EU ETS Directive.
[72] These principles were developed in a study by Ecofys and Fraunhofer ISI on benchmarking principles for the European Commission, see https://ec.europa.eu/clima/system/files/2016-11/bm_study-project_approach_and_general_issues_en.pdf

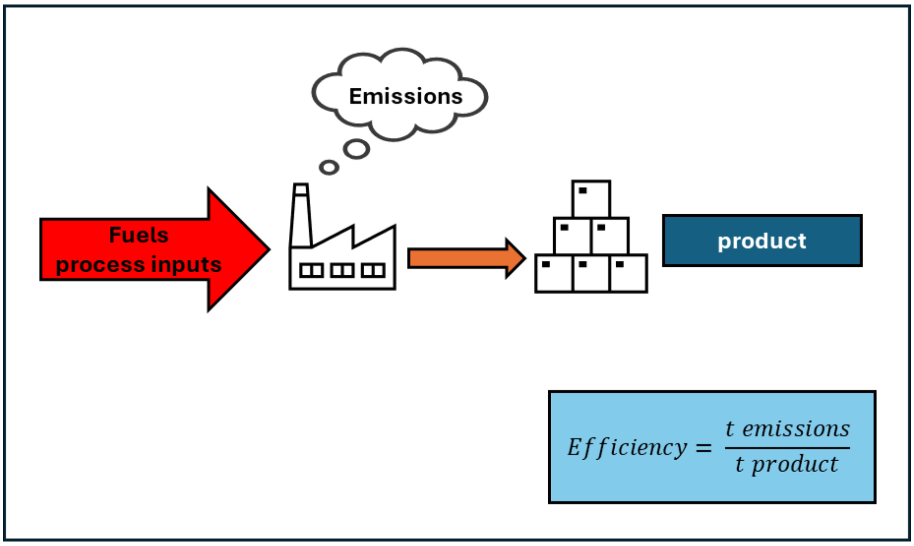


Figure 5: Approach to benchmarking of a simple production process in an installation producing only one type of product

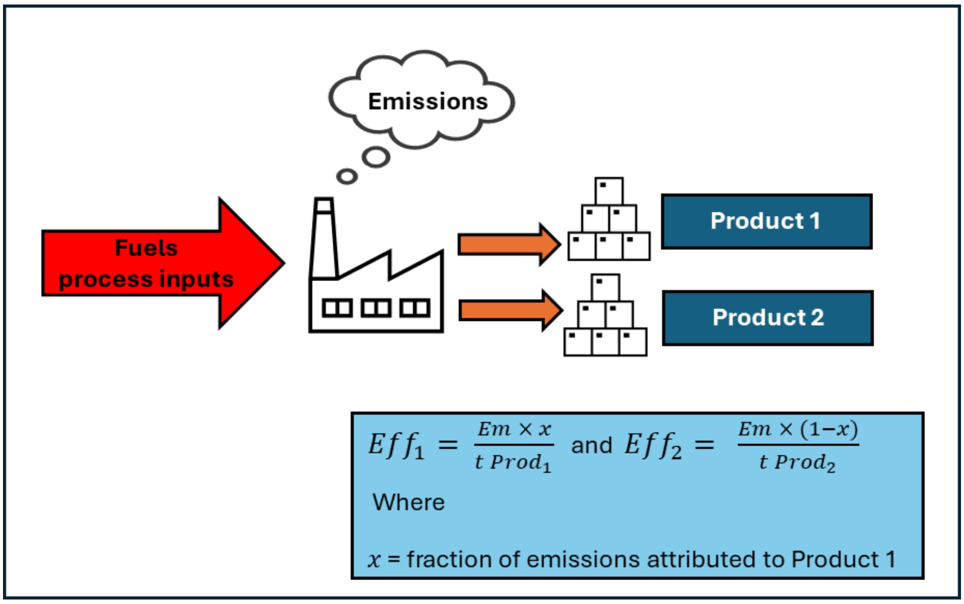


Figure 6: Approach to attributing emissions when benchmarking an installation producing two products (where *Eff* is efficiency; *Em* is emissions)

However, the typical installation in the UK ETS produces more than one product. In this context ("measurable") heat[73] used for other processes rather than producing the main

[73] For more information on the term "measurable heat" see sections 2.7 and 4.9.

product and electricity should also be considered "products". In such case, as illustrated by Figure 6, it is necessary to split the emissions by making meaningful measurements or assumptions, before the GHG efficiency (emissions/production) can be calculated.

In the UK ETS, the way to split emissions is through "sub-installations". Sub-installations have been designed to enable different installations (that produce the same product or homogeneous groups of products listed under the same PRODCOM) comparable within a single benchmark, such as:

- Installations which produce only one product (which have only one sub-installation) as compared to installations with several sub-installations
- Installations that use fuels directly in the process, as compared to installations that use fuels for producing measurable heat, or import heat from other installations, before the heat is used in the production process

Furthermore, the concept allows the split between product-related emissions in both of the following situations:

- Production processes happen consecutively, i.e. product A is used to produce product B
- Production processes which happen simultaneously, e.g. where one chemical reaction gives two separate products, but at least one of these products might also be produced separately (e.g. from other raw materials).

Sub-installations are a different concept to just an assignment of physical units within an installation, although there is some overlap between these concepts. The shortest possible description of a sub-installation would be:

> A sub-installation is described as the system boundaries of a mass and energy balance, encompassing inputs, outputs and emissions to determine benchmarks for a product or group of products, independent of other products (including heat or electricity) produced in the same installation.

The same concept is further developed for the FAR "fall-back approaches", i.e. rules for allocation to parts of installations that are not covered by product benchmarks (see section 5.2).

The above definition shows that the idea of "sub-installations" is rather more abstract than other methods of dividing installations, in particular splitting an installation based on physical units such as boilers, kilns, distillation columns, CHP units, etc. The difference can be spatial (one sub-installation can encompass several units,[74] but also one physical unit can serve several sub-installations)[75], but also temporal (one and the same physical unit can be used consecutively for different sub-installations.[76] A detailed example of the split of an installation into sub-installations is presented in section 2.5. Further examples (including how to calculate the allocation) can be found in guidance document 'UKETS11 FAR - Guidance on determining the allocation at installation level'.

5.2 Product benchmarks and "fall-back" sub-installations

There are too many different products produced in EU and UK ETS installations to reasonably establish benchmarks for all of them. Indeed, the list of 52 product benchmarks found in the FAR, as agreed with the relevant industry associations, covers only two thirds of the allocations. For the remaining products, other pragmatic approaches ("fall-back" approaches) were developed.

The FAR establish a clear hierarchy between the product benchmark sub-installation approach and the fall-back approach. This is because the product benchmark approach enables the GHG efficiency of most of the production process to be assessed, including the efficiency of the energy consumption in the production process, the efficiency of the energy conversion from fuel to heat, as well as the GHG intensity of the fuels used and compared across different installations.

The "fall-back" approaches take fewer elements of GHG efficiency into account, as summarised by Table 2:

- Since most energy-intensive industrial processes consume heat (in the form of steam, hot water etc.), a "**heat benchmark**" can be applied to such processes. This does not provide a complete efficiency benchmark in relation to the final product, because the element of "amount of heat consumed per tonne of product" is not within its scope. It does, however, reward efficiency in heat generation as well as the GHG emission factor of the fuel mix.

- In many cases heat is consumed in the main production process, but without first generating "measurable heat" in a heat medium. Instead, heat is provided directly to the process, e.g. by a burner located directly in a kiln, oven, dryer, etc. This "non-measurable heat" is accounted for in the "**fuel benchmark**". The fuel benchmark

[74] E.g. the mineral oil refinery benchmark may encompass a dozen or more units situated on a site of some km².
[75] E.g. where a boiler produces steam that is used for heating several production processes belonging to different other sub-installations.
[76] E.g. where in one reactor different chemicals are produced throughout the year, or where a paper machine can be switched between various paper grades.

accounts for the GHG intensity of the fuels used but does not reward efficiency of energy conversion or specific energy consumption levels.

- Finally, for **process emissions**, which are not related to energy consumption, but to chemical reactions other than combustion, no efficiency criterion is applied.

Therefore, the product benchmark is the preferred approach, as product benchmarks take into account greater GHG efficiencies, and must be applied as the first option when splitting an installation into sub-installations. The heat benchmark is the next in the hierarchy, followed by the fuel benchmark, whereas the process emissions sub-installation should be used only for filling gaps, if all other options are exhausted.

Table 2 Comparison of product benchmark and fall-back approaches regarding which GHG efficiency elements they account for

	Final energy consumption	Energy conversion efficiency	Fuel choice
Product benchmark	Yes	Yes	Yes
Heat benchmark	No	Yes	Yes
Fuel benchmark	No	No	Yes
Historic emissions	No	No	No

5.3 Attributed emissions

To update the benchmark values (i.e. for generating new benchmark curves), further data other than just the direct emissions of a sub-installation need to be taken into account. Regulators must be able to compare an installation's "real" emissions (to the extent these are known) for the whole production process to those of its peers, but only for the production of this one product. The aim is that the specific GHG emissions per tonne of product must be made comparable to each other across all installations, i.e. system boundaries must be strictly consistent, and related rules must be strictly followed by operators.

The methodology for attributing emissions to the sub-installation (i.e. to the benchmarked product) must ensure that efficiency measures are reflected appropriately. This means that a more efficient installation has less GHG emissions per tonne of product. In the case of exported heat, for example, all heat exported must be deducted from the attributed emissions of the sub-installation concerned. The reason being that heat is a second product, with its own allocation (either under a heat benchmark or as part of another product benchmark sub-installation where the heat is imported and consumed, and to which an emissions equivalent for this imported heat must be added). The rules are consistent in that the total emissions attributed to sub-installations must equal the total emissions of the installation (with the exceptions mentioned in section 2.2.1).

Furthermore, the methodology must enable regulators to compare different circumstances such as production in a stand-alone installation (where only one product is produced) and production in a more integrated installation. Heat production must be accounted for in the same way, regardless of whether it is produced by direct heating using fuels (e.g. direct firing) or if delivered via a heat transfer medium ("measurable heat"). Additionally, heat must be treated the same whether it is produced in the installation by a boiler or a CHP process, or if the heat is imported from another installation.

Therefore, methods for calculating the "attributed emissions" of each sub-installation are as follows (not all terms are relevant for all types of sub-installations) (equation 16):

$$AttrEm = DirEm^{*} + Em_{H,import} - Em_{H,export} + WG_{corr,import} - WG_{corr,export} + Em_{el,exch} - Em_{el,produced}$$

The variables of this equation are explained as follows:

$AttrEm$ Attributed emissions of the sub-installation.

$DirEm^{*}$ Directly attributable emissions[77] as linked to source streams of the MP under the MRR, with the following exceptions:

- Measurable heat: Wherever fuels are used to produce measurable heat which is consumed in more than one sub-installation (including when heat is imported from and exported to other installations), the fuels are not included in the directly attributable emissions of the sub-installation. Instead, the approach outlined below (under "$EmH, import$") is applied. Only when heat is used exclusively in one sub-installation, can the emissions be directly attributed to the sub-installation via the fuel's

[77] The alternative term "direct emissions" could be perceived confusing, as in the FAR the term is used only in the context of electricity exchangeability. It must however be kept in mind that the term is used here in a very specific way for the purpose of this formula only. This is the reason why it is designated with an asterisk (*), indicating that a specific meaning has been given to *DirEm**.

emissions. This is the case if the technical unit,[78] in which the heat is produced, is clearly within the boundaries of only one sub-installation.

- Waste gases imported from other installations are usually included in the MP. However, only a portion, of their emissions are attributable, the portion related to “consumption”. This portion, the parameter “$WG_{corr,import}$" in the formula above, is calculated below and must be excluded from the calculation of $DirEm*$. However, waste gases which are produced and fully consumed within the sub-installation are included here.[79] [80] The emissions from waste gases which are produced in and exported from the sub-installation are included here but only as a first step. They are subsequently corrected using the term "$WGcorr, export$” (see below).
- Therefore, the following equation applies (equation 17):

$$DirEm^* = DirEm_{total} - EM_{F,heat\ suppl} - EM_{WG,inst.import}$$

Where:

$DirEm_{total}$ are the total directly attributable emissions from source streams (including “internal source streams” if applicable, see below)

$Em_{F,heat\ \ suppl}$ are the emissions from fuels used to supply measurable heat, where the heat is not consumed by only one sub-installation

$EM_{WG,inst.import}$are emissions related to waste gases imported at installation level.

The directly attributable emissions are monitored in line with the MP approved under the MRR, i.e. accounting for the emissions from calculation-based methodologies (using source streams), measurement-based methodologies (CEMS) as well as no-tier approaches (“fall-backs”). Where the resulting emissions need to be split between several sub-installations, the operator must use additional measuring instruments for determining the quantities of

[78] If it is a CHP unit, the rules for splitting its emissions into those attributable to heat and to electricity need to be applied, see section 4.10.
[79] Because the waste gas is produced and consumed within the same system boundaries, the direct emissions of the waste gas are net zero. This can be illustrated by the following example: In an organic chemical process raw material R is partially oxidised for giving product P and a waste gas W. W is incinerated for providing energy to the process. Thus, the mass balance under the MRR would give:
Em = $M(CO_2)/M(C)$ × [C(R) – C(W) + C(W) – C(P)] = $M(CO_2)/M(C)$ × [C(R) – C(P)], where

- M(CO2)/M(C) is the ratio of molar mass of CO2 and carbon, respectively, and
- C(x) is the carbon contained in material x

As can be seen, the waste gas W does not have to be monitored.
[80] In this specific case, it does not matter whether waste gases are flared or used within the process.

source streams used in each sub-installation or establish calculation or estimation methods for performing the split.

Additional monitoring is required for “internal source streams”, i.e. source streams that are produced within one sub-installation and used in another, except for waste gases which are corrected for as outlined below. Such source streams usually do not appear in the MP,[81] such as coke produced in the coke sub-installation and consumed in a hot metal sub-installation within the same installation. Appropriate methods for monitoring internal source streams must be included in the MMP. The BDR and ALR templates refer to “internal source streams” also, with specific input fields for each sub-installation.

$Em_{H,import}$ This parameter refers to attributable emissions for measurable heat imported to the sub-installation. Such heat can be imported from other installations, other sub-installations or include heat received from a technical unit (for example, a central energy centre at the installation, or a more complex steam network with several heat producing units) that supplies heat to more than one sub-installation. The heat from such units is included under “import” for transparency purposes.

Emissions from heat imported are calculated, as applicable, by one of the following methods:

- Where the quantity of fuel used and the emission factor of the fuel mix used for the heat production are known (which is usually the case where the heat is produced within the installation), the respective emissions are attributed by the operator accordingly.
- The same applies when heat is imported from other installations, and the operator of the heat consuming installation receives relevant fuel mix information from the heat producer.
- For imports of heat from non-UK ETS installations and for heat recovered from other processes (other sub-installations), the real emissions might either be unknown or not clearly defined, because data such as generation efficiency and emission factor of the fuel mix are often unknown. In these

[81] In some installations these source streams are already monitored, e.g. where significant stockpiles exist which help levelling different production between reporting years.

cases, the FAR require the operator to report only the quantity of heat without attributing the emissions.[82]

- The same applies for heat produced within a nitric acid sub-installation and heat from electrical boilers. Note, however, that such heat is treated like non-UK ETS heat for the purpose of allocation, i.e. not eligible for allocation.

$Em_{H,export}$ Emissions related to the attribution of measurable heat exported from the sub-installation. In contrast to the above for $Em_{H,import}$, the emissions attributed to exported heat are always determined based on the (updated) heat benchmark. As is the case with $Em_{H,import}$, the real emissions might either be unknown or not clearly defined for heat recovered and exported from a product benchmark or fuel benchmark sub-installation. In these cases, the FAR require the operator to report only the quantity of heat without attributing the emissions.

$WG_{corr,import}$ Correction for imported waste gases: Under the MRR the direct emitter is fully responsible for the emissions, meaning that a unit combusting a waste gas must report the emissions from the waste gas in full. However, for the purposes of the FAR, emissions from waste gases are split between the producing and the consuming sub-installation. In the case of the importing sub-installation in which the waste gas is used, the relevant attributable emissions are not included under $DirEm$* above but are calculated as follows (equation 18):

$$WG_{corr,import} = V_{WG} \times NCV_{WG} \times BM_F$$

With:

V_{WG} volume of the waste gas imported

NCV_{WG} net calorific value

BM_F (updated) fuel benchmark.

Note that in cases when the waste gas is not directly consumed in a sub-installation but used to produce measurable heat as an intermediate product, this rule does not apply. Instead, the rule for attributing emissions related to import of measurable heat applies (see $Em_{H,import}$ above).

[82] Note that in such cases a "qualitative attribution" of the emissions take place: The obligation to carry out the attribution to the sub-installation should be considered as fulfilled, even though they are not quantified.

Note that in the case of the fuel benchmark sub-installation, the volume of waste gas that is flared for non-safety flaring purposes is not included (that is, it is subtracted from the volume imported).

$WG_{corr,export}$ Correction for exported waste gases: For the purposes of the FAR, emissions of waste gases are split between the producing and the consuming sub-installation. Where a waste gas is produced in the sub-installation, its full emissions are already included in the sub-installation's attributed emissions, because of the source streams included in $DirEm$*. Therefore, a correction is only required for any volume exported.[83] The formula for calculating the relevant attributable emissions that must be subtracted for waste gas exported and used elsewhere is as follows (equation 19):

$$Em_{WG} = V_{WG,exported} \times NCV_{WG} \times EF_{NG} \times Corr_{\eta}$$

Where:

$V_{WG,exported}$ is the volume of waste gas exported from the sub-installation, expressed as Nm^3 or t

NCV_{WG} is the net calorific value of the waste gas expressed as TJ/Nm3 or TJ/t as consistent with the unit used for V

EF_{NG} is the emission factor of natural gas (56.1 t CO_2/TJ)

$Corr_{\eta}$ is a factor that accounts for the difference in efficiencies between the use of waste gas and the use of the reference fuel, natural gas. The default value of this factor is 0.667.

$Em_{el,exch}$ Emissions equivalent to the "exchangeable" electricity quantity. There are processes in the UK ETS for which different installations consume heat either produced by fuel or produced by electricity. This situation is termed "exchangeability of fuels and electricity", and a specific allocation rule aims at treating these situations equally (Article 22 of the FAR). Several product benchmarks include "exchangeability of fuels and electricity" and these can be identified in Annex I to the FAR, which sets out the boundaries for the relevant processes.

The amount of electricity consumed within the boundaries defined in Annex I to the FAR must be monitored and reported by the operator, to ensure

[83] The correction takes into account that the consumer of the waste gas should be put on equal footing with other installations using natural gas and correcting for the two different efficiencies typical for the use of the gases.

emissions are attributed correctly for updating the benchmark values. The attributable emissions $Em_{el,exch}$ (termed "indirect emissions" in the FAR) are calculated as follows (equation 20):

$$Em_{el,exch} = El_{cons,exch} \times EF_{El}$$

Where:

$El_{cons,exch}$ is the amount of exchangeable electricity consumed, expressed in MWh

EF_{El} is the average emission factor for electricity production,[84] which is given by the FAR as EF_{El} = 0.376 t CO_2 / MWh.

$Em_{el,produced}$ Emissions equivalent to the electricity produced in a sub-installation. It must be noted that this only covers electricity that is produced from other means than via the intermediate production of measurable heat (for example, via steam). This includes electricity that is produced from expansion of compressed gases via an expansion turbine. Any electricity that is produced via measurable heat has already been deducted under $Em_{H,export}$ above.

The attributable emissions $Em_{el,produced}$ are calculated as follows (equation 21):

$$Em_{el,produced} = El_{produced} \times EF_{El}$$

Where:

$El_{,produced}$ is the amount of electricity produced other than electricity produced via measurable heat, expressed in MWh

EF_{El} is the average emission factor for electricity production, which is given by the FAR as EF_{El} = 0.376 t CO_2 / MWh.

5.3.1 Examples: General introduction

The table below links each element of the $Attr_{Em}$ formula above with the relevant sections in the BDR and MMP templates, as well as with the relevant examples shown in this section.

[84] This factor is the EU-wide average emission factor for electricity production and has been adopted by the UK ETS Authority for UK ETS.

Table 3 Relationship between the different variables of $AttrEm$ and the relevant sections in the BDR, ALR and MMP templates.

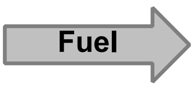
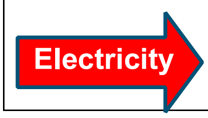
(Further parameters included in the table concern entries that must be provided in the "BM update" section of the BDR template for consistency checks or other purposes, but do not have a direct impact on $AttrEm$).

Attributed emissions ($AttrEm$)	Relevant section in the BDR & ALR templates		Relevant section in the MMP Template		Relevant examples in this section
	Product BM	Fallback BM[85]	Product BM	Fallback BM	
$DirEm*$ (MP source streams)	F.g	G.c	F.e.i	G.c	All
$DirEm*$ (Internal source streams)	F.i	–	F.e.ii	–	WG-1
$DirEm*$ (CO2 feedstock)	F.j	–	F.e.iii	–	–
$Em_{H,import}$	F.k.i	G.1.f	F.g	G.1.f	MH(all), WG-3, Elec-2
$Em_{H,export}$	F.k.v	G.4.e	F.g	G.4.e	MH(all)
$WG_{corr,import}$	F.l.xx	G.4.d	F.h	G.4.d	WG(all)
$WG_{corr,export}$	F.l.xxv	–	F.h	–	WG(all)
$Em_{el,exch}$	F.c	–	F.c	–	Elec-1
$Em_{el,produced}$	F.m	–	F.c	–	Elec-2
Parameter: Fuel input	F.h	G.d.i	F.f	G.d	All
Parameter: Fuel input from waste gases (WG)	_	G.d.iii	_	G.d.i.(4)	WG(all)
Parameter: Heat produced	–	G.1.e	–	G.1.e	MH-5
Parameter: Heat from pulp	F.k.iii	G.1.f	F.g	G.1.f	MH-3
Parameter: Heat from nitric acid	F.k.iv	–	–	–	MH-3
Parameter: Waste gases produced	F.l.v	–	F.h	–	WG(all)
Parameter: Waste gases consumed	F.l.x	–	F.h	–	WG(all)
Parameter: Waste gases flared	F.l.xv	–	F.h	–	WG(all)

85 Where reference is made to the specific type of fall-back benchmark, relevant sections apply to all sub-installations with the same benchmark, e.g. "G.1.f" means that this is the relevant section for the heat and district heating sub-installations; "G.4.d" means this is the relevant section for the fuel BM sub-installations.

Attributed emissions $(AttrEm)$	Relevant section in the BDR & ALR templates		Relevant section in the MMP Template		Relevant examples in this section
	Product BM	Fallback BM[85]	Product BM	Fallback BM	
Parameter: Total pulp produced	F.n	–	F.a	–	MH-3
Parameter: Intermediate products	F.o	–	F.a	–	-

The table below shows the colour-coding for all fuels, material and heat flows used in the examples in this section. The tables in the examples indicate the type of data and in which sections of the BDR and ALR template the data should be entered.

Arrow type	Description
	Green arrows are used for source streams[86] found in the MP under the MRR ("MP source streams").
	Grey arrows are used for fuels which are combusted outside the system boundaries of the installation, i.e. not covered by the MP under the MRR.
	Light red arrows are used for "internal source streams" which are not covered by the MP (e.g. because a mass balance is applied over the whole installation).
	Dark blue arrows are used for measurable heat flows.
	Blue arrows are used for products, e.g. product BM products.
	Red arrows are used for electricity flows.

[86] This includes all source streams, regardless of whether a standard methodology in accordance with Article 24 of the MRR (fuel and process material) or a mass balance approach in accordance with Article 25 of the MRR is applied.

5.3.2 Examples: Fuel and material input only (FM)

The figure and table below set out the general case of an installation that is consuming fuels directly (non-measurable heat excluding fuel input from waste gases)[87] and how emissions should be attributed to each sub-installation in the BDR and ALR templates. Fuel type 2 in the example is used in two different sub-installations, where the respective energy inputs are $Fuel_{2,1}$ and $Fuel_{2,2}$.

The set up would be applicable across a broad range of sectors, for example, in the cement industry (e.g. sub-installation A = clinker, sub-installation B = a fuel benchmark sub-installation e.g. a cement mill), the ceramic industry (e.g. sub-installation A = bricks, pavers, or tiles), or the glass industry (e.g. sub-installation A = float glass or coloured/colourless glass), etc.

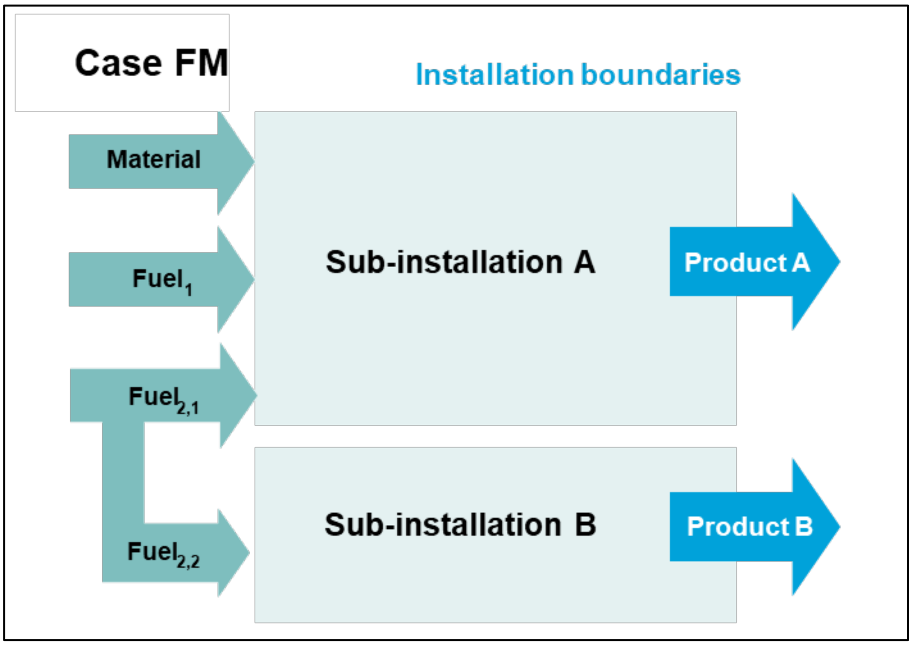


Figure 5 Example case FM

Table 4 Calculation of attribution of emissions for case FM

Attributed emissions	Sub-installation A	Sub-installation B
$DirEm*$	$Fuel_1 \times EF_{F1} + Fuel_{2,1} \times EF_{F2} + Material \times EF_{material}$	$Fuel_{2,2} \times EF_{F2}$
All other parameters	0 or "not relevant"	0 or "not relevant"
$AttrEm$	Sum of the above	–

[87] Rules for measurable heat and waste gas flows are shown in examples MH and WG.

Parameter: Fuel input	$Fuel_1 + Fuel_{2,1}$	$Fuel_{2,2}$
Parameter: Fuel input (weighted EF)	$(Fuel_1 \times EF_{F1} + Fuel_{2,1} \times EF_{F2}) \div "Fuel\ input"$	EF_{F2}

5.3.3 Examples: Measurable heat flows (MH)

5.3.3.1 Rules for import and export of measurable heat – Introduction

The figures and tables below set out how fuels and heat should be attributed to each sub-installation in the BDR and ALR templates. In each case, sub-installations consume fuels (non-measurable heat) or (measurable) heat. The cases are as follows:

- Case MH-1: The installation has only one sub-installation. Heat is imported from another installation.
- Case MH-2: As in case MH-1, but the heat is produced within the same installation.
- Case MH-3: Heat is exported from one sub-installation (e.g. recovery of waste heat) and consumed by another sub-installation within the same installation.
- Case MH-4: As in case MH-2, but the heat produced is consumed by two sub-installations.
- Case MH-5: As in case MH-4, but there are heat losses.
- Case MH-6: As in case MH-2, but the heat is produced by a CHP.

Similar situations would apply across a broad range of sectors, for example, in the pulp and paper industry (e.g. case MH-1 heat imported from a connected CHP plant for paper production), gas transport industry (e.g. case MH-3, sub-installation A = fuel benchmark sub-installation for gas compressor station, sub-installation B = district heating sub-installation from recovered waste heat), etc.

5.3.3.2 Case MH-1 - rules for import and export of measurable heat

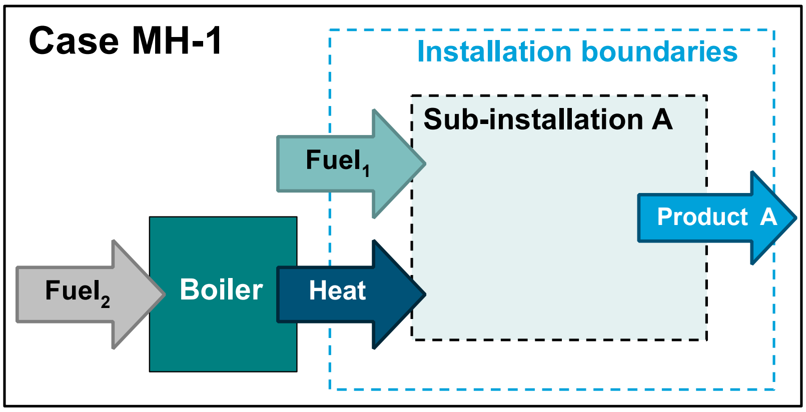


Figure 6 Example MH-1 regarding attributed emissions (measurable heat)

Table 5 Calculation of attribution of emissions for case MH-1 (measurable heat)

Attributed emissions	Sub-installation A	Sub-installation B
$DirEm*$	$Fuel_1 \times EF_{F1}$	–
$Em_{H,import}$	$+Heat \times EF_{imported\ heat}$ (†)	–
$Em_{H,export}$	0	–
All other parameters	0 or “not relevant”	0 or “not relevant”
AttrEm	Sum of the above	–
Parameter: Fuel input	$Fuel_1$	–
Parameter: Fuel input (weighted EF)	EF_{F1}	–

† $EF_{imported\ heat}$ requires information from the heat supplier. If this information is not provided, or not sufficiently supported by corresponding evidence, entries for the emission factor should be left empty. This is also the case if the EF cannot be determined, e.g. if it concerns measurable heat recovered from product benchmark sub-installations. Note that data entries would not change if the heat supplier was not covered by the UK ETS or if the heat came from nitric acid production. Such circumstances would impact the allocation, but not the attributable emissions.

5.3.3.3 Case MH-2 - rules for import and export of measurable heat

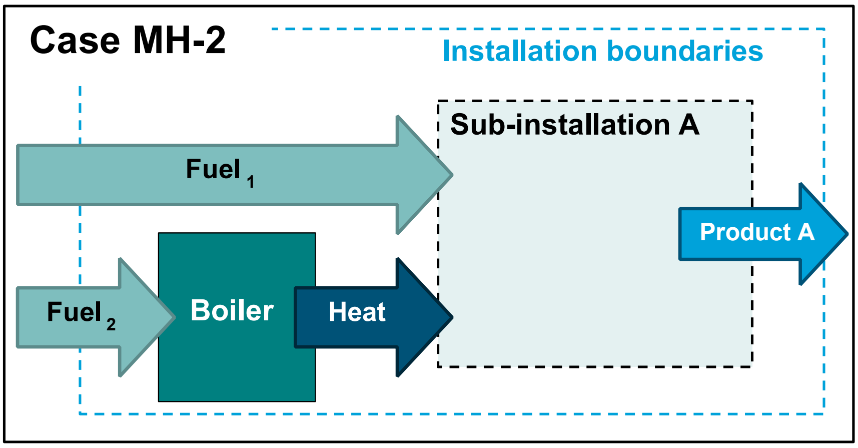


Figure 7 Example MH-2 regarding attributed emissions (measurable heat)

Table 6 Calculation of attribution of emissions for example MH-2 (measurable heat)

Attributed emissions	Sub-installation A	Sub-installation B
DirEm*	$Fuel_1 \times EF_{F1} + Fuel_2 \times EF_{F2}$	–
$Em_{H,import}$	0	–
$Em_{H,export}$	0	–
All other parameters	0 or "not relevant"	0 or "not relevant"
$AttrEm$	Sum of the above	–
Parameter: Fuel input	$Fuel_1 + Fuel_2$	–
Parameter: Fuel input (weighted EF)	$(Fuel_1 \times EF_{F1} + Fuel_2 \times EF_{F2}) \div \text{"Fuel input"}$	–

5.3.3.4 Case MH-3 - rules for import and export of measurable heat

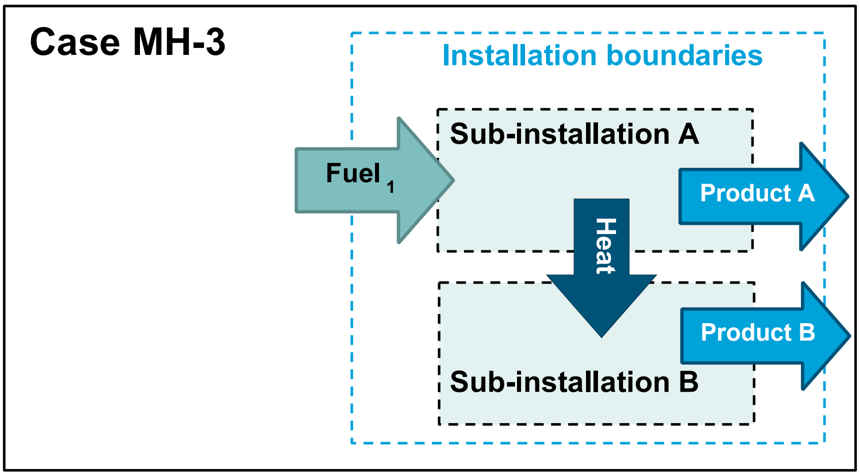


Figure 8 Example MH-3 regarding attributed emissions (measurable heat)

Table 7 Calculation of attribution of emissions for example MH-3 (measurable heat)

Attributed emissions	Sub-installation A	Sub-installation B
DirEm^*	$Fuel_1 \times EF_{F1}$	0
$Em_{H,import}$	0	$\mathrm{Heat} \times EF_{exported\ heat}$
$Em_{H,export}$	$-\mathrm{Heat} \times EF_{exported\ heat}$ (†)	0
All other parameters	0 or "not relevant"	0 or "not relevant"
$AttrEm$	Sum of the above	Sum of the above
Parameter: Fuel input	$Fuel_1$	0
Parameter: Fuel input (weighted EF)	EF_{F1}	0

† $EF_{exported\ heat}$: In some cases, the emission factor associated with the heat export is not known or cannot be determined, e.g. if it concerns recovered heat from flue gases from product benchmark sub-installations. In such cases the entry field for the emission factor should be left blank. If sub A is a fuel benchmark sub-installation from which heat is recovered for e.g. district heating (sub B), the emission factor should be determined by assuming a virtual efficiency of the heat production of 90% ($EF_{exported\ heat} = EF_{F1}$/ 90%).

Further parameters: If sub-installation A were producing pulp or nitric acid, imported amounts (Heat) would also have to be listed for sub-installation B under "Parameter: Heat from pulp", or "Parameter: Heat from nitric acid", respectively. In the case of sub-installation A producing pulp, "Parameter: Total pulp produced" must be provided.

5.3.3.5 Case MH-4 - rules for import and export of measurable heat

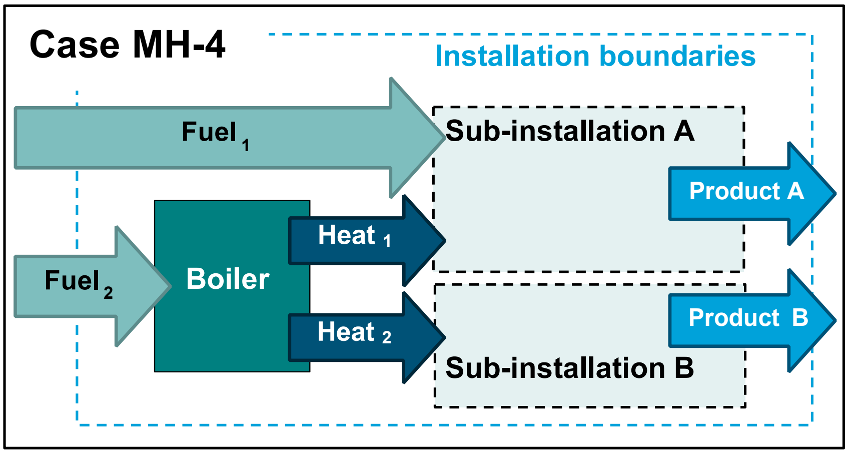


Figure 9 Example MH-4 regarding attributed emissions (measurable heat)

Table 8 Calculation of attribution of emissions for example MH-4 (measurable heat)

Attributed emissions	Sub-installation A	Sub-installation B
$DirEm^*$	$Fuel_1 \times EF_{F1}$	0
$Em_{H,import}$	$+\mathrm{Heat}_1 \times EF_{heat}$(†)	$+\mathrm{Heat}_2 \times \mathrm{EF}_{\mathrm{heat}}$ (††)
$Em_{H,export}$	0	0
All other parameters	0 or “not relevant”	0 or “not relevant”
$AttrEm$	Sum of the above	Sum of the above
Parameter: Fuel input	$Fuel_1$	0
Parameter: Fuel input (weighted EF)	$\mathrm{EF}_{\mathrm{F1}}$	0

†With $EF_{heat} = EF_{F2} / \eta_H$

††The same EF_{heat} applies to both sub-installations, and $Heat_2$ can be calculated as the difference from the total heat. Therefore $\mathrm{Heat}_2 \times EF_{heat} = (Fuel_2 \times \eta_H - \mathrm{Heat}_1) \times EF_{heat}$

5.3.3.6 Case MH-5 - rules for import and export of measurable heat

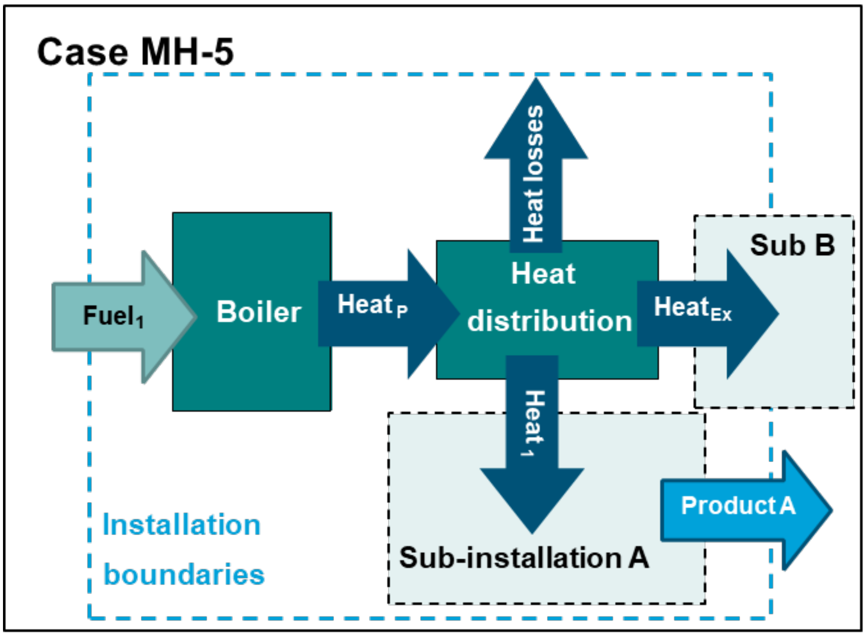


Figure 10 Example MH-5 regarding attributed emissions (measurable heat)

Table 9 Calculation of attribution of emissions for example MH-5 (measurable heat)

Attributed emissions	**Sub-installation A**	**Sub-installation B**
$DirEm^*$	0	0
$Em_{H,import}$	$+ Heat_1 \times EF_{heat,P} \times [Heat_P \div (Heat_1 + Heat_{EX})]$ (†)	$+ Heat_{EX} \times EF_{heat,P} \times [Heat_P \div (Heat_1 + Heat_{EX})]$ (††)
$Em_{H,export}$	0	0
All other parameters	0 or "not relevant"	0 or "not relevant"
$AttrEm$	Sum of the above	Sum of the above
Parameter: Fuel input	0	0
Parameter: Fuel input (weighted EF)	0	0
Parameter: Heat produced (†††)	$Heat_1 \times [Heat_P \div (Heat_1 + Heat_{EX})]$	$Heat_{EX} \times [Heat_P \div (Heat_1 + Heat_{EX})]$

†With $EF_{heat,P} = EF_{F1} / \eta_H$

††The same $\mathrm{EF_{heat,P}}$ applies to both sub-installations. The term $\mathrm{Heat_P} \div (\mathrm{Heat_1} + \mathrm{Heat_{EX}})$ is to account for heat losses in accordance with section 10.1.3 of Annex VII to the FAR.

†††For sub-installation A, this parameter is only relevant if it concerns a heat BM or district heating sub-installation. Sub-installation B is per definition always one of these sub-installations.[88]

Case MH-6 - rules for import and export of measurable heat

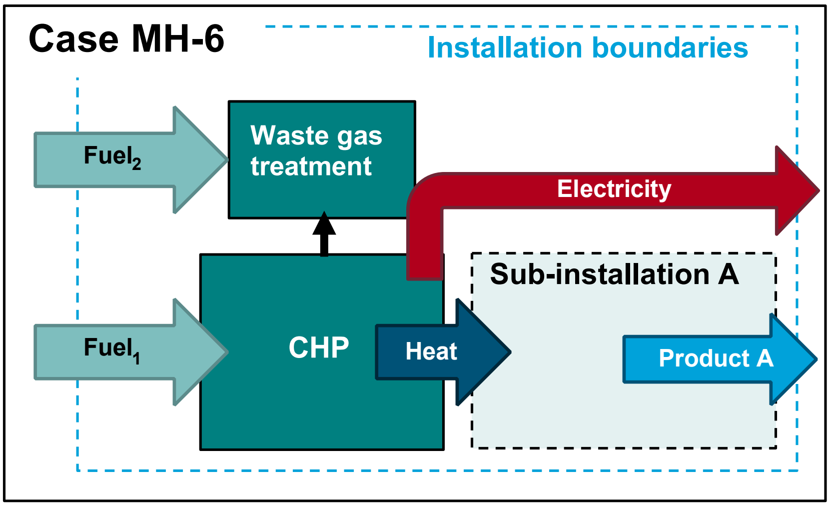


Figure 11 Example MH-6 regarding attributed emissions (measurable heat)

Table 10 Calculation of attribution of emissions for example MH-6 (measurable heat)

Attributed emissions	Sub-installation A	Sub-installation B
DirEm^*	$\mathrm{Em_{CHP,heat}}$ (†)	–
$Em_{H,import}$	0	–
$Em_{H,export}$	0	–
All other parameters	0 or “not relevant”	–
AttrEm	Sum of the above	–
Parameter: Fuel input	$\mathrm{Fuel_{CHP,heat}}$ (††)	–
Parameter: Fuel input (weighted EF)	$\mathrm{Em_{CHP,heat}} \div \mathrm{Fuel_{CHP,heat}}$	–

[88] Note: even if measurable heat is exported such as in the case of the district heating sub-installation (which is reflected in the activity level), for the purpose of attributing emissions, the associated emissions have to be considered as “input” (“imported”) under $Em_{H,import}$ following the visual display of the system boundaries as depicted in MH-5.

Parameter: Heat produced	Heat	–

†$\mathrm{Em}_{\mathrm{CHP,heat}}$ are the emissions associated with the heat output of the CHP and are determined in accordance with the methodology described in section 4.10. The emissions associated with heat output from the CHP, is one of the main outputs of the "CHP Tool" in the BDR and ALR template (see example below).

††$\mathrm{Fuel}_{\mathrm{CHP,heat}}$ is the share of the fuel input that is attributable to heat production (see example below).

To correctly calculate the parameters above, operators should apply the rules for splitting fuel input and emissions between heat and electricity production in accordance with chapter 8 of Annex VII to the FAR. These rules are explained in section 4.10, and the following example sets out the data requirements of the "Cogeneration Tool" in the BDR and ALR templates which will calculate the fuel and emissions split.

Example: $Fuel_1$ and $Fuel_2$ are natural gas of which 100 TJ are fired in the CHP and 2 TJ are used for flue gas cleaning. The annual output of heat and electricity is 60 TJ and 20 TJ, respectively. The total emissions of both fuels correspond to 5,712 t CO2 per year using the emission factor of natural gas. Figure 15 below shows the results that should be entered in table 10 above:

- $\mathrm{Em}_{\mathrm{CHP,heat}}$ the emissions attributable to the heat output [(h).i.] corresponds to 3,634.91 t CO2
- $\mathrm{Fuel}_{\mathrm{CHP,heat}}$ fuel input for heat [(i).i.] corresponds to 64.91 TJ

If the CHP sat outside the boundaries of the installation and heat from the CHP was imported into it, (as in case MH-1), the corresponding emissions, $Em_{H,import}$, would be calculated as '$Heat \times EF_{heat}$'. EF_{heat} in this case would correspond to 60.58 t CO_2 / TJ as provided under (h).ii.

Table 11

(a) Total amount of fuel input into CHP units

	Unit	2014
Fuel input into CHP	TJ / year	102.00

(b) Heat output from CHP

	Unit	2014
Heat output from CHP	TJ / year	60.00

(c) Electricity output from CHP

	Unit	2014

		TJ / year	20.00
(d)	**Total emissions from CHP**		
		Unit	**2014**
i	From fuel input to CHP	t CO2 / year	5,600.00
ii	From flue gas cleaning	t CO2 / year	112.00
iii	Total emissions	t CO2 / year	5,172.00
(e)	**Default efficiencies**		Heat
(f)	**Efficiencies for heat and electricity**		
		Unit	**2014**
i	Heat production	-	0.5882
ii	Electricity production	-	0.1961
(g)	**Reference efficiencies**		
		Unit	**2014**
i	Heat production	-	90%
ii	Electricity production	-	52.5%
(h)	**Emissions attributable to heat production from CHP**		
		Unit	**2014**
i	Emissions attributable to heat output	t CO2 / year	3,634.91
ii	Emission factor, heat	t CO2 / TJ	60.58
(i)	**Fuel input attributable to heat and electricity production**		
		Unit	**2014**
i	Fuel input for heat	TJ / year	64.91
ii	Fuel input for electricity	TJ / year	37.09

Figure 12: Example 'screenshot' of the "CHP Tool" in the BDR and ALR templates for example MH-6

5.3.4 Examples: Waste gases (WG)

The figures and tables below set out how source streams and waste gases should be attributed to each sub-installation in the BDR and ALR templates. The examples are as follows:

- **Case WG-1**: The installation comprises two sub-installations. Sub-installation A exports some of its waste gas to sub-installation B. To report its annual emissions in accordance with the MRR, the installation uses a mass balance approach (C_{input}

and C_{output} denote source streams as contained in the MP under the MRR). $C_{internal}$ is an internal source stream that is not reportable under the MRR. Internal source streams are any carbon-containing material that is transferred between sub-installations and subsequently leads to emissions.

- **Case WG-2**: As example 1, but each sub-installation is part of a different installation. Therefore, the material $C_{internal}$ is considered a source stream under both installation's MP, referred to as $C_{output,3}$ here.
- **Case WG-3**: As example 2, but the consumer of the waste gas produces measurable heat from the waste gas which is subsequently consumed in sub-installation B. This situation would occur, for example, in the iron & steel industry (e.g. sub-installation A = coke, sub-installation B = hot metal) or bulk organic chemical industry, where waste gases arise and emissions are monitored using a mass balance approach, pursuant to Article 25 of the MRR.

5.3.4.1 Example WG-1 - rules for imported and exported waste gases

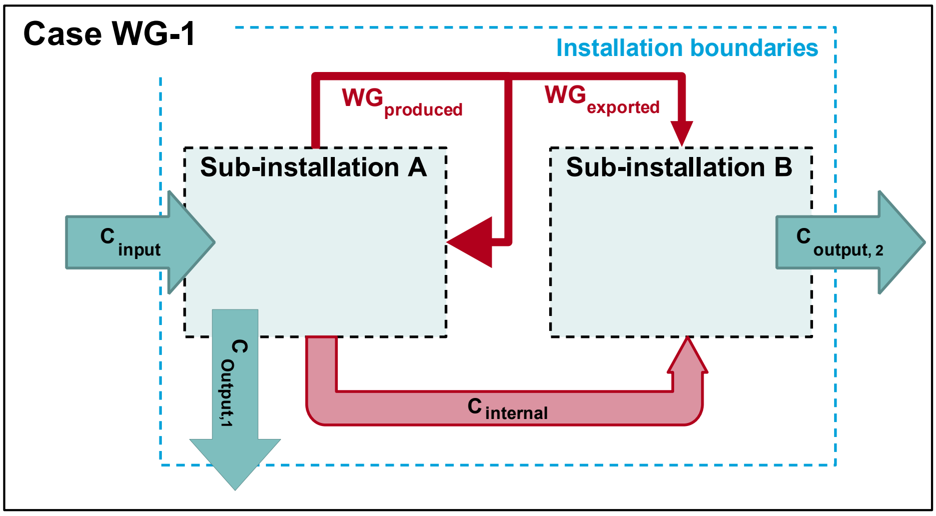


Figure 13: Example WG-1 regarding attributed emissions (waste gases)

Table 11 Example WG-1 Calculation of attribution of emissions (waste gases)

Attributed emissions	Sub-installation A	Sub-installation B
DirEm* *(MP source streams)*	$3.664 \times (C_{input} - C_{output,1})$	$-3.664 \times C_{output,2}$
DirEm* *(Internal source streams)*	$-3.664 \times C_{internal}$	$+3.664 \times C_{internal}$
$WG_{corr,import}$	0	$+WG_{exported} \times BM_{fuel}$ (††)

$\mathrm{WG}_{\mathrm{corr,export}}$	$-\mathrm{WG}_{\mathrm{exported}} \times \mathrm{EF}_{\mathrm{NG}} \times CorrF$ (†)	0
All other parameters	0 or "not relevant"	0 or "not relevant"
AttrEm	Sum of the above	Sum of the above
Parameter: Fuel input	$Fuel_{C,input}$	$\mathrm{WG}_{\mathrm{exported}} + Fuel_{C,internal}$
Parameter: Fuel input (weighted EF)	$EF_{C,input}$	$(\mathrm{WG}_{\mathrm{exported}} \times \mathrm{EF}_{\mathrm{WG,exported}} + Fuel_{C,internal} \times EF_{C,internal}) \div$ "Fuel input"
Parameter: Fuel input from WG	0	$WG_{exported}$
Parameter: Fuel input from WG (EF)	0	$\mathrm{EF}_{\mathrm{WG,exported}}$
Parameter: Waste gases produced	$WG_{produced}$	0
Parameter: Waste gases produced (EF)	$\mathrm{EF}_{\mathrm{WG,produced}} = \mathrm{EF}_{\mathrm{WG,exported}}$	0
Parameter: Waste gases consumed	$WG_{produced} - WG_{exported}$	$WG_{exported}$
Parameter: Waste gases consumed (EF)	$\mathrm{EF}_{\mathrm{WG,produced}} = \mathrm{EF}_{\mathrm{WG,exported}}$	$\mathrm{EF}_{\mathrm{WG,produced}} = \mathrm{EF}_{\mathrm{WG,exported}}$
Parameter: Waste gases flared	0	0

†EF_{NG} and $CorrF$ will be applied automatically and do not need to be provided in the template. However, the corresponding emissions factor $\mathrm{EF}_{\mathrm{WG,exported}}$ needs to be provided for consistency checking

††$BMfuel$ will be applied automatically and does not need to be provided in the template. However, the corresponding emissions factor $\mathrm{EF}_{\mathrm{WG,exported}}$ needs to be provided for consistency checking

5.3.4.2 Example WG-2 - rules for imported and exported waste gases

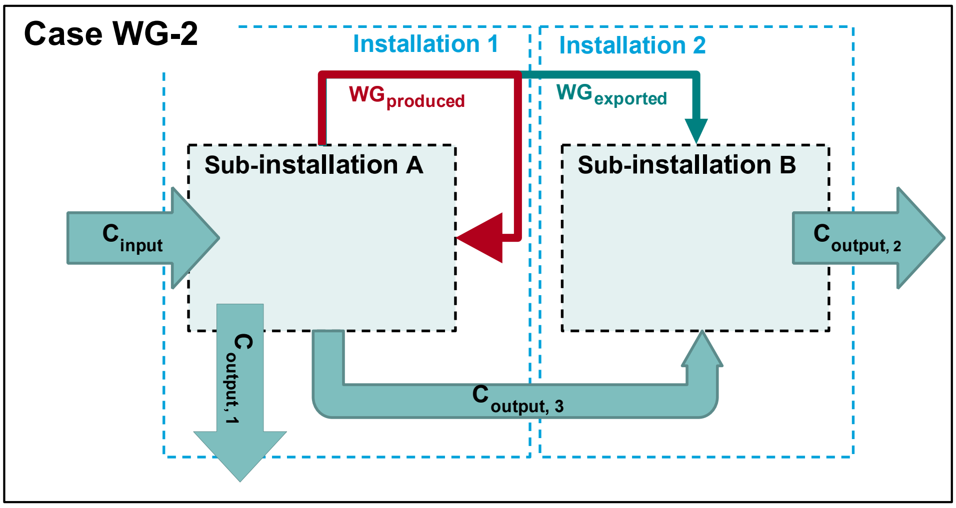


Figure 14: Example WG-2 regarding attributed emissions (waste gases)

Table 12: Calculation of attribution of emissions for example WG-2 (waste gases)

Attributed emissions	Sub-installation A	Sub-installation B
DirEm^* *(MP source streams)*	$3.664 \times (\text{C}_{\text{input}} - \text{C}_{\text{output,1}} - \text{C}_{\text{output,3}})$	$3.664 \times (\text{C}_{\text{output,3}} - \text{C}_{\text{output,2}})$
DirEm^* *(Internal source streams)*	0	0
$WG_{corr,import}$	0	$+WG_{exported} \times BM_{fuel}$ (††)
$WG_{corr,export}$	$-WG_{exported} \times EF_{NG} \times CorrF$ (†)	0
All other parameters	0 or "not relevant"	0 or "not relevant"
$AttrEm$	Sum of the above	Sum of the above
Parameter: Fuel input	$Fuel_{C,input}$	$WG_{exported} + Fuel_{C,output,3}$
Parameter: Fuel input (weighted EF)	$EF_{C,input}$	$(WG_{exported} \times \text{EF}_{\text{WG,exported}} + Fuel_{C,output,3} \times EF_{C,output,3}) \div \text{"Fuel input"}$
Parameter: Fuel input from WG	0	$WG_{exported}$

Parameter: Fuel input from WG (EF)	0	$\mathrm{EF}_{\mathrm{WG,exported}}$
Parameter: Waste gases produced	$WG_{produced}$	0
Parameter: Waste gases produced (EF)	$\mathrm{EF}_{\mathrm{WG,produced}} = \mathrm{EF}_{\mathrm{WG,exported}}$	0
Parameter: Waste gases consumed	$WG_{produced} - WG_{exported}$	$WG_{exported}$
Parameter: Waste gases consumed (EF)	$\mathrm{EF}_{\mathrm{WG,produced}} = \mathrm{EF}_{\mathrm{WG,exported}}$	$\mathrm{EF}_{\mathrm{WG,produced}} = \mathrm{EF}_{\mathrm{WG,exported}}$
Parameter: Waste gases flared	0	0

† EF_{NG} and $CorrF$ will be applied automatically and do not need to be provided in the template. However, the corresponding emissions factor, $\mathrm{EF}_{\mathrm{WG,exported}}$, needs to be provided for consistency checking.

†† $BMfuel$ will be applied automatically and does not need to be provided in the template. However, the corresponding emissions factor, $\mathrm{EF}_{\mathrm{WG,exported}}$, needs to be provided for consistency checking.

5.3.4.3 Example WG-3 - rules for imported and exported waste gases

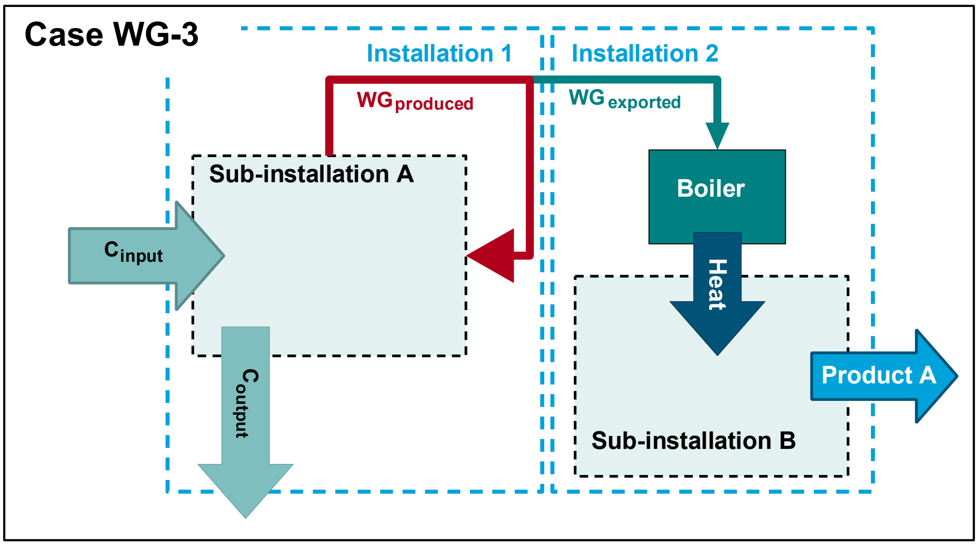


Figure 15 Example WG-3 regarding attributed emissions (waste gases)

Table 13 Calculation of attribution of emissions for example WG-3 (waste gases)

Attributed emissions	Sub-installation A	Sub-installation B
DirEm^* (*MP source streams*)	$3.664 \times (\mathrm{C_{input}} - \mathrm{C_{output}})$	0
DirEm^* *(Internal source streams)*	0	0
$Em_{H,import}$	0	$+ Heat \times BMheat$ (††)
$WG_{corr,import}$	0	0
$WG_{corr,export}$	$- WG_{exported} \times EF_{NG} \times CorrF$ (†)	0
All other parameters	0 or "not relevant"	0 or "not relevant"
$AttrEm$	Sum of the above	Sum of the above
Parameter: Fuel input	$Fuel_{C,input}$	$WG_{exported}$
Parameter: Fuel input (weighted EF)	$EF_{C,input}$	$(WG_{exported} \times \mathrm{EF_{WG,exported}}) \div \text{"Fuel input"}$
Parameter: Fuel input from WG	0	$WG_{exported}$
Parameter: Fuel input from WG (EF)	0	$\mathrm{EF_{WG,exported}}$
Parameter: Waste gases produced	$\mathrm{WG_{produced}}$	0
Parameter: Waste gases produced (EF)	$\mathrm{EF_{WG,produced}} = \mathrm{EF_{WG,exported}}$	0
Parameter: Waste gases consumed	$\mathrm{WG_{produced}} - \mathrm{WG_{exported}}$	$\mathrm{WG_{exported}}$
Parameter: Waste gases consumed (EF)	$\mathrm{EF_{WG,produced}} = \mathrm{EF_{WG,exported}}$	$\mathrm{EF_{WG,produced}} = \mathrm{EF_{WG,exported}}$
Parameter: Waste gases flared	0	0

†EF_{NG} and $CorrF$ will be applied automatically and do not need to be provided in the template. However, the corresponding emissions factor, $\mathrm{EF_{WG,exported}}$, needs to be provided for consistency checking.

††$BMheat$ will be applied automatically and does not need to be provided in the template. To obtain correct results, the field for the corresponding emission factor must be left empty.

5.3.5 Examples: Electricity

5.3.5.1 Rules for consumed and produced electricity – Introduction

The figures and tables below set out how source streams and electricity flows should be attributed to each sub-installation in the BDR and ALR templates. The examples are as follows:

- **Case Elec-1**: The installation produces one benchmarked product for which the exchangeability of fuel and electricity is relevant. The installation consumes fuel and electricity to produce product A. This example sets out the general concept for all product benchmark sub-installations listed in Annex I to the FAR for which the exchangeability of fuels and electricity is relevant.
- **Case Elec-2**: Th installation has only one sub-installation consuming fuel to produce products. Steam is recovered from waste heat and used to produce electricity. Electricity is also produced directly from depressurising gases in the process via an expansion turbine without producing measurable heat.

5.3.5.2 Case Elec-1 - rules for consumed electricity

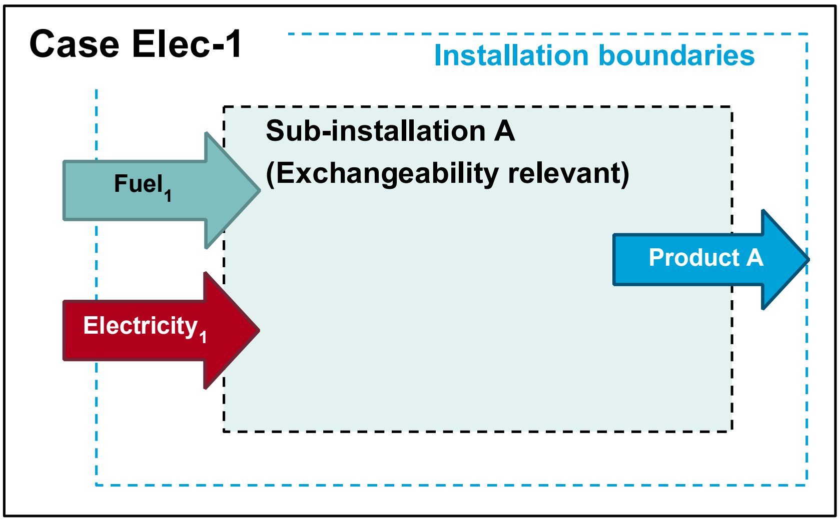


Figure 16: Example Elec-1 regarding attributed emissions (electricity)

Table 14: Calculation of attribution of emissions for example Elec-1 (electricity)

Attributed emissions	Sub-installation A	Sub-installation B
$DirEm^*$	$Fuel_1 \times EF_{F1}$	–
$Em_{H,export}$	0	–
$Em_{el,exch}$	$+ Electricity_1 \times EF_{el}$ (†)	–
$Em_{el,produced}$	0	–
All other parameters	0 or "not relevant"	–
$AttrEm$	Sum of the above	–
Parameter: Fuel input	$Fuel_1$	–
Parameter: Fuel input (weighted EF)	EF_{F1}	–

†EF_{el} will be applied automatically and does not need to be provided in the template.

5.3.5.3 Example Elec-1 - rules for consumed electricity

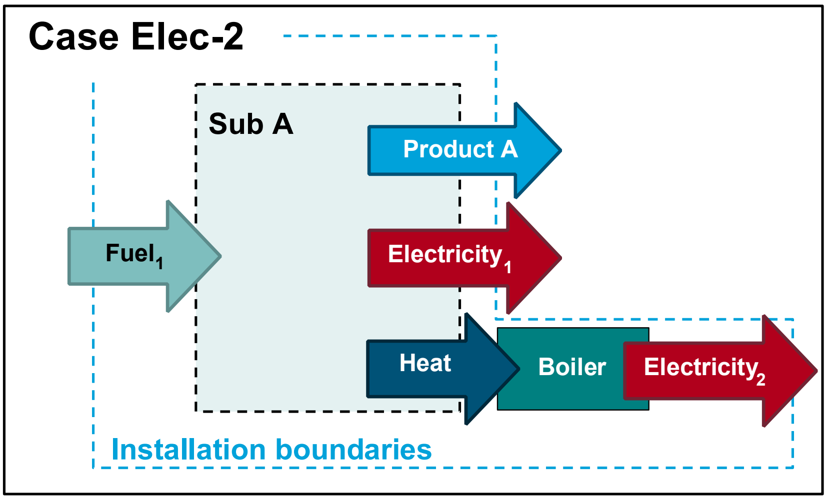


Figure 17: Example Elec-2 regarding attributed emissions (electricity)

Table 15 Calculation of attribution of emissions for case Elec-2 (electricity)

Attributed emissions	Sub-installation A	Sub-installation B
$DirEm^*$	$Fuel_1 \times EF_{F1}$	–
$Em_{H,export}$	$- Heat \times EF_{heat}$ (†)	–
$Em_{el,exch}$	–	–

$Em_{el,produced}$	$-Electricity_1 \times EF_{el}$ (††)	–
All other parameters	0 or "not relevant"	–
$AttrEm$	Sum of the above	–
Parameter: Fuel input	$Fuel_1$	–
Parameter: Fuel input (weighted EF)	EF_{F1}	–

†EF_{heat}: There are cases where the emission factor associated with the heat export is not known or cannot be determined, e.g. when heat is recovered from flue gases from product benchmark sub-installations. In such cases the entry field for the emission factor should be left empty.

††EF_{el} : will be applied automatically and does not need to be provided in the template.

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