NEGOCIADO DE ENERGÍA DE PUERTO RICO

Wanda Cordero <wcordero@energia.pr.gov>

AB - Comments to Case No. CEPR-MI-2016-0001

1 message

Carlos Pabon (AB) <Carlos.Pabon@gruppoab.com> Mon, Dec 14, 2020 at 11:00 AM
To: "comentarios@energia.pr.gov" <comentarios@energia.pr.gov>
Cc: "Enzo Losito Bellavigna (AB)" <Enzo.Losito@gruppoab.it>, "Daniel White (AB)" <Daniel.White@gruppoab.com>

Dear Sirs,

Regarding **Case No. CEPR-MI-2016-0001 - Resolution initiating the process for the adoption of a definition of the term "Highly Efficient Fossil Fuel Generation"** -, here reattached for your convenience and as per its Chapter IV., we hereby submit the attached comments (incl. Annex) for your consideration.

We kindly ask you to acknowledge receipt and remain at your complete disposal for further discussion.

Best regards,

Carlos Pabon
Regional Sales Manager

AB Energy USA, LLC

West Coast: 8910 University Center Lane, Suite 400, San Diego, CA 92122, USA

East Coast: 26 Chapin Road, Unit 1108, Pine Brook, NJ 07058, USA

Mob. +1 (310) 710-2215

Tel. +1 (973) 957-0418
@ Carlos.Pabon@gruppoab.com
Web www.gruppoab.com/en/

AB COGENERATION WORLD

3 attachments

Resolution-CEPR-MI-2016-0001.pdf
3316K

AB - Comments to Case No. CEPR-MI-2016-0001.pdf
311K

AB - Comments to Case No. CEPR-MI-2016-0001 - Annex.pdf
555K

Puerto Rico Energy Bureau (PREB) - Clerk's Office
268 Munoz Rivera Ave, World Plaza Building, Suite 202
San Juan, PR 00918
Puerto Rico

December 11th, 2020

Re.: Comments to Case No. CEPR-MI-2016-0001 Resolution initiating the process for the adoption of a definition of the term "Highly Efficient Fossil Fuel Generation", for the purposes of Act 60-2019 (the "Resolution").

Dear Sirs,

AB Group, herein represented by its subsidiary AB Energy USA, LLC ("AB"), is an industrial group specialized in the design, construction, supply and maintenance of packaged Combined Heat and Power ("CHP") / Distributed Generation ("DG") systems using Internal Combustion Gas Engines. AB Group is composed of 26 companies operating in 22 countries (including Puerto Rico) on four continents, with nearly 1,500 units installed and a current fleet of more than 1,300 units maintained. For more than 30 years, CHP / DG has been AB's single core business. As of today, is one of the main representatives of the CHP Industry worldwide.

In AB's opinion, the Resolution presented by PREB addresses relevant definitions related to emissions and/or efficiency that have already been studied, discussed, agreed-upon, reviewed and continuously improved by multi-stakeholder organizations across the world in multiple previous occasions. Such organizations include, but are not limited to:

- U.S. Environmental Protection Agency ("EPA");
- U.S. Federal Energy Regulatory Commission ("FERC");
- U.S. Department of Energy ("DOE");
- U.S. Internal Revenue Service ("IRS");
- U.S. CHP Alliance ("CHPA");
- European Union ("EU").
- COGEN Europe.

By way of an example, the EU's high efficiency cogeneration framework – as currently defined in the EU's Energy Efficiency Directive - has been implemented successfully by industry and regulators across all 27 European Union Member Countries for more than 15 years. Such framework, continuously reviewed in multi-stakeholder processes, provides best-practices that can be considered outside the EUR context. Among other qualifying features, the framework accounts for performance parameters of best-in-class available technologies, as well as emission and efficiency benefits of distributed generation when compared to centralized generation (taking into account avoided transmission & distribution losses). Furthermore, the EU framework is sufficiently ambitious, implementing clauses to regularly revise reference efficiency values.

In addition, in AB's opinion, the definitions currently proposed in the Resolution:

- fail to consider the thermodynamic linkage between electrical and thermal efficiencies;
- fail to consider performance parameters of best-in-class available technologies;
- fail to provide clear definitions of relevant reference conditions; by way of an example: gross vs. net electrical output, gross vs. net thermal output, efficiencies based on low vs. high fuel heating value.

In light of the above, AB seeks to comment on the Resolution by respectfully inviting PREB to review and acknowledge existing methodologies to define Highly Efficient CHP / DG - as thoroughly studied, discussed, agreed-upon, reviewed and continuously improved by multi-stakeholder organizations across the world in multiple previous occasions -, in lieu of the definitions as currently proposed in the Resolution. More information on the above-mentioned existing methodologies can be found on:

- European methodologies: attached letter by COGEN Europe;
- U.S. methodologies: comments to the Resolution as provided by the CHPA in representation of multiple industry stakeholders.

AB strongly believes that the proposed changes will lead to more efficient and resilient electricity supply for the industries and citizens of Puerto Rico through the implementation of best-in-class CHP and DG technologies.

We remain at your disposal for clarifications and further discussion.

Best regards,

Vincenzo Losito Bellavigna
CEO

COGEN EUROPE

Mr. Carlos Pabon
AB Energy USA, LLC
26 Chapin Road, Unit 1108,
Pine Brook, NJ 07058,
USA

Brussels, 2 December 2020

REF: 2020/M/C/08

Subject: European Union (EU) Best Practice: Energy efficiency Criteria for Cogeneration

Dear Mr. Pabon,

Upon your request in relation to the Puerto Rico Energy Bureau (PREB) Resolution, under Docket Case No. CEPR-MI-2016-0001, COGEN Europe would like to provide the following evidence on the European Union (EU) approach to high efficiency cogeneration.

The EU high efficiency cogeneration framework, further explained below and in the annexes to this letter, has been implemented successfully by industry and regulators across all 27 EU countries for more than 15 years. In the EU, high efficiency cogeneration contributes towards higher efficiency, system reliability and decarbonisation, covering 11.7% of EU's electricity and 16.5% of its heat. Thanks to the policy measures in place, and the efficiency standard introduced, more than 80% of EU installed cogeneration qualifies as high efficiency cogeneration.

To ensure that cogeneration systems are best in class, EU legislation introduced in 2004 the "high efficiency cogeneration" standard, currently defined in the Energy Efficiency Directive (EED) and related regulations[1]. The energy efficiency framework ensures that a robust methodology can be applied for cogeneration system to access any type of support.

To qualify as a "high efficiency", a cogeneration system must achieve at least 75% in total efficiency, as well as save more than 10% of primary energy compared to a best in class power-only plant and best in class heat-only boiler (see annexes below). The reference values for the separate production of heat and electricity[2] are based on a thorough assessment of best available technologies and are revised regularly to account for technological progress. Reference values and the cogeneration efficiency requirements are differentiated by energy source and technology employed.

[1] Energy Efficiency Directive (2021/27/EU).
[2] Harmonised Reference Values Regulation (EU) 2015/2402.

COGEN Europe considers the "high efficiency cogeneration" methodology as a best practice to be considered outside the EU context. It provides the flexibility to account for different power to heat ratios, reflecting the range of cogeneration technologies and user needs. In addition, it captures the grid efficiency benefits of cogeneration, accounting for avoided power grid losses by cogeneration plants installed at different voltage levels. Moreover, the methodology is sufficiently ambitious, given the clause to regularly revise reference efficiency values.

COGEN Europe has gathered extensive expertise in the assessment and implementation of the high efficiency cogeneration standard. We would be happy to provide further support, where necessary.

Yours faithfully,

Hans Korteweg

Managing Director
COGEN Europe

Annex I: Energy Efficiency Directive "High efficiency CHP" Methodology

Below are provided the details of the high efficiency cogeneration methodology, outlined in Annexes I and II of the Energy Efficiency Directive 2012/27/EU.

[Energy Efficiency Directive 2012/27/EU] ANNEX I

GENERAL PRINCIPLES FOR THE CALCULATION OF ELECTRICITY FROM COGENERATION

Part I

General principles

Values used for calculation of electricity from cogeneration shall be determined on the basis of the expected or actual operation of the unit under normal conditions of use. For micro- cogeneration units the calculation may be based on certified values.

(a)Electricity production from cogeneration shall be considered equal to total annual electricity production of the unit measured at the outlet of the main generators;

(i)in cogeneration units of types (b), (d), (e), (f), (g) and (h) referred to in Part II with an annual overall efficiency set by Member States at a level of at least 75 %, and

(ii)in cogeneration units of types (a) and (c) referred to in Part II with an annual overall efficiency set by Member States at a level of at least 80 %.

(b)In cogeneration units with an annual overall efficiency below the value referred to in point (i) of point (a) (cogeneration units of types (b), (d), (e), (f), (g), and (h) referred to in Part II) or with an annual overall efficiency below the value referred to in point (ii) of point (a) (cogeneration units of types (a) and (c) referred to in Part II) cogeneration is calculated according to the following formula:

$E_{CHP}=H_{CHP}*C$

where:

E_{CHP} is the amount of electricity from cogeneration;

C is the power-to-heat ratio;

H_{CHP} is the amount of useful heat from cogeneration (calculated for this purpose as total heat production minus any heat produced in separate boilers or by live steam extraction from the steam generator before the turbine).

The calculation of electricity from cogeneration must be based on the actual power-to-heat ratio. If the actual power-to-heat ratio of a cogeneration unit is not known, the following default values may be used, in particular for statistical purposes, for units of types (a), (b), (c), (d) and (e) referred to in Part II provided that the calculated cogeneration electricity is less or equal to total electricity production of the unit:

Type of the unit	Default power to heat ratio, C
Combined cycle gas turbine with heat recovery	0,95
Steam back pressure turbine	0,45
Steam condensing extraction turbine	0,45
Gas turbine with heat recovery	0,55
Internal combustion engine	0,75

If Member States introduce default values for power-to-heat ratios for units of types (f), (g), (h), (i), (j) and (k) referred to in Part II, such default values shall be published and shall be notified to the Commission.

(c) If a share of the energy content of the fuel input to the cogeneration process is recovered in chemicals and recycled this share can be subtracted from the fuel input before calculating the overall efficiency used in points (a) and (b).

(d) Member States may determine the power-to-heat ratio as the ratio of electricity to useful heat when operating in cogeneration mode at a lower capacity using operational data of the specific unit.

(e) Member States may use other reporting periods than one year for the purpose of the calculations according to points (a) and (b).

Part II

Cogeneration technologies covered by this Directive

(a) Combined cycle gas turbine with heat recovery

(b) Steam back pressure turbine

(c) Steam condensing extraction turbine

(d) Gas turbine with heat recovery

(e) Internal combustion engine

(f) Microturbines

(g) Stirling engines

(h) Fuel cells

(i) Steam engines

(j) Organic Rankine cycles

(k) Any other type of technology or combination thereof falling under the definition laid down in Article 2(30).

When implementing and applying the general principles for the calculation of electricity from cogeneration, Member States shall use the detailed Guidelines established by Commission Decision 2008/952/EC of 19 November 2008 establishing detailed guidelines for the implementation and application of Annex II to Directive 2004/8/EC of the European Parliament and of the Council (1).

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(1) OJ L 338, 17.12.2008, p. 55.

[Energy Efficiency Directive 2012/27/EU] ANNEX II

METHODOLOGY FOR DETERMINING THE EFFICIENCY OF THE COGENERATION PROCESS

Values used for calculation of efficiency of cogeneration and primary energy savings shall be determined on the basis of the expected or actual operation of the unit under normal conditions of use.

(a) High-efficiency cogeneration

For the purpose of this Directive high-efficiency cogeneration shall fulfil the following criteria:

— cogeneration production from cogeneration units shall provide primary energy savings calculated according to point (b) of at least 10 % compared with the references for separate production of heat and electricity,

— production from small-scale and micro-cogeneration units providing primary energy savings may qualify as high-efficiency cogeneration.

(b) Calculation of primary energy savings

The amount of primary energy savings provided by cogeneration production defined in accordance with Annex I shall be calculated on the basis of the following formula:

$$PES = \left(1 - \frac{1}{\frac{CHP\,H\eta}{Ref\,H\eta} + \frac{CHP\,E\eta}{Ref\,E\eta}}\right) \times 100\,\%$$

Where:

PES is primary energy savings.

CHP Hη is the heat efficiency of the cogeneration production defined as annual useful heat output divided by the fuel input used to produce the sum of useful heat output and electricity from cogeneration.

Ref Hη is the efficiency reference value for separate heat production.

CHP Eη is the electrical efficiency of the cogeneration production defined as annual electricity from cogeneration divided by the fuel input used to produce the sum of useful heat output and electricity from cogeneration. Where a cogeneration unit generates mechanical energy, the annual electricity from cogeneration may be increased by an additional element representing the amount of electricity which is equivalent to that of mechanical energy. This additional element does not create a right to issue guarantees of origin in accordance with Article 14(10).

Ref Eη is the efficiency reference value for separate electricity production.

(c) Calculations of energy savings using alternative calculation

Member States may calculate primary energy savings from a production of heat and electricity and mechanical energy as indicated below without applying Annex I to exclude the non-cogenerated heat and electricity parts of the same process. Such a production can be regarded as high-efficiency cogeneration provided it fulfils the efficiency criteria in point (a) of this Annex and, for cogeneration units with an electrical capacity larger than 25 MW, the overall efficiency is above 70 %. However, specification of the quantity of electricity from cogeneration produced in such a production, for issuing a guarantee of origin and for statistical purposes, shall be determined in accordance with Annex I.

If primary energy savings for a process are calculated using alternative calculation as indicated above the primary energy savings shall be calculated using the formula in point (b) of this Annex replacing: 'CHP Hη' with 'Hη' and 'CHP Eη' with 'Eη', where:

Hη shall mean the heat efficiency of the process, defined as the annual heat output divided by the fuel input used to produce the sum of heat output and electricity output.

Eη shall mean the electricity efficiency of the process, defined as the annual electricity output divided by the fuel input used to produce the sum of heat output and electricity output. Where a cogeneration unit generates mechanical energy, the annual electricity from cogeneration may be increased by an additional element representing the amount of electricity which is equivalent to that of mechanical energy. This additional element will not create a right to issue guarantees of origin in accordance with Article 14(10).

(d) Member States may use other reporting periods than one year for the purpose of the calculations according to points (b) and (c) of this Annex.

(e) For micro-cogeneration units the calculation of primary energy savings may be based on certified data.

(f) Efficiency reference values for separate production of heat and electricity

The harmonised efficiency reference values shall consist of a matrix of values differentiated by relevant factors, including year of construction and types of fuel, and must be based on a well-documented analysis taking, inter alia, into account data from operational use under realistic conditions, fuel mix and climate conditions as well as applied cogeneration technologies.

The efficiency reference values for separate production of heat and electricity in accordance with the formula set out in point (b) shall establish the operating efficiency of the separate heat and electricity production that cogeneration is intended to substitute.

The efficiency reference values shall be calculated according to the following principles:

1. For cogeneration units the comparison with separate electricity production shall be based on the principle that the same fuel categories are compared.
2. Each cogeneration unit shall be compared with the best available and economically justifiable technology for separate production of heat and electricity on the market in the year of construction of the cogeneration unit.
3. The efficiency reference values for cogeneration units older than 10 years of age shall be fixed on the reference values of units of 10 years of age.
4. The efficiency reference values for separate electricity production and heat production shall reflect the climatic differences between Member States.

Annex II: Detailed guidelines for the implementation "High efficiency CHP" Methodology

Below are provided the EU guidelines on how to implement the high efficiency cogeneration methodology, outlined the European Commission Decision 2008/952/EC

ANNEX

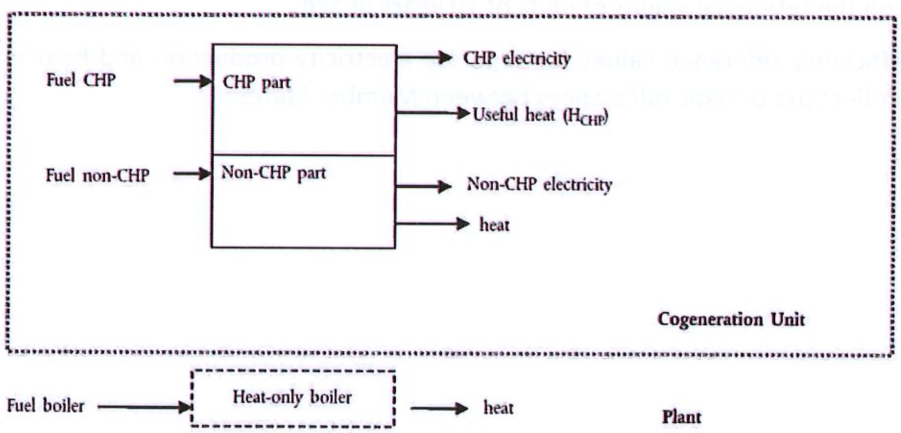
I. Calculation of the electricity from cogeneration

1. A cogeneration unit operating with maximum technically possible heat recovery from the cogeneration unit itself is said to be operating in *full cogeneration mode*. The heat has to be produced at the site pressure and temperature levels required for the specific useful heat demand or market. In the case of full cogeneration mode, all electricity is considered combined heat and power (CHP) electricity (see Figure 1).

2. For cases in which the plant does not operate in full cogeneration mode under normal conditions of use, it is necessary to identify the electricity and heat not produced under cogeneration mode, and to distinguish it from the CHP production. This is to be done based on the principles defining the CHP boundaries described in Section II. The energy input and output of the heat-only-boilers (top-up, back-up boilers) which in many cases are part of the on-site technical installations are to be excluded, as illustrated in Figure 1. The arrows inside the 'Cogeneration Unit' box illustrate the energy flow over system boundaries.

Figure 1

CHP part, non-CHP part and heat-only boilers within a plant



3. For micro-cogeneration units, the certified values have to be issued, approved or supervised by the national authority or competent body appointed by each Member State as referred to in Article 5(2) of Directive 2004/8/EC.

4. The electricity from cogeneration is calculated in accordance with the following steps.

5. **Step 1**

5.1. To distinguish which part of the electricity produced is not recognised as electricity from cogeneration, it is first necessary to calculate the overall efficiency of the cogeneration unit.

5.2. The overall efficiency of a cogeneration unit is determined in the following way: the energy output of the CHP plant (electricity, mechanical [1] energy and useful heat) over a defined reporting period shall be divided by the fuel input to the cogeneration unit over the same reporting period, i.e.

Overall efficiency = (energy output)/(fuel input)

5.3. The calculation of overall efficiency has to be based on the actual operational data taken from real/registered measured values of the specific cogeneration unit, collected over the reporting period. Generic or certified values provided by the manufacturer (according to the specific technology) cannot be used [2].

5.4. The *reporting period* means the period of operation of the cogeneration unit for which the electricity output has to be established. Normally, reporting will be done on an annual basis. However, shorter periods are permissible. The maximum period is one year and the minimum period is one hour. Reporting periods may differ from the frequency of measurements.

5.5. The *energy output* means the total electrical energy (CHP and non-CHP) and useful heat (H_{CHP}) generated in the CHP plant over a reporting period.

5.6. In accordance with the definitions in Article 3(b) and 3(c) of Directive 2004/8/EC, the following heat can be regarded as useful heat (H_{CHP}): heat that is used for process heating or space heating and/or delivered for subsequent cooling purposes; heat delivered to district heating/cooling networks; exhaust gases from a cogeneration process that are used for direct heating and drying purposes.

5.7. Examples of heat other than useful heat are the following: heat rejected to the environment without any beneficial use [3]; heat lost from chimneys or exhausts; heat rejected in equipment such as condensers or heat-dump radiators; heat used internally for de-aeration, condensate heating, make-up water and boiler feed-water heating used in the operation of boilers within the boundaries of the cogeneration unit, such as heat recovery boilers. The heat content of the returned condensate to the cogeneration plant (e.g. after being used for district heating or in an industrial process) is not considered as useful heat and may be subtracted from the heat flow associated with the steam production in line with the Member States practices.

5.8. Exported heat used in power generation on another site does not qualify as useful heat but is considered as a part of the internal heat transfer within a cogeneration unit. In this case, the electricity generated from this exported heat is included in the total electricity output (see Figure 4).

5.9.*Non-CHP electricity* means the electrical energy generated by a cogeneration unit in a reporting period at times when one of the following situations occurs: no related heat produced by the cogeneration process or part of the heat produced cannot be considered as useful heat.

5.10.Non-CHP electricity generation might occur in the following cases:

(a)in processes with insufficient useful heat demand or no generation of useful heat energy (for example, gas turbines, internal combustion engines and fuel cells with insufficient or no utilisation of heat);

(b)in processes with heat rejection facilities (for example, in the condensing part of steam cycle power plants and in combined-cycle power plants with extraction-condensing steam turbines).

5.11.The *fuel input* means the total (CHP and non-CHP) fuel energy based on the lower heating value needed to generate (CHP and non-CHP) electrical energy and heat produced in the cogeneration process during the reporting period. Examples of fuel inputs are any combustibles, steam and other heat imports, and process waste heat used in the cogeneration unit for electricity generation [4]. Returned condensate from the cogeneration process (in the case of steam output) is not considered to be fuel input.

5.12.CHP fuel energy means the fuel energy based on lower heating value needed in a cogeneration process to co-generate CHP electrical energy and useful heat energy in a reporting period (see Figure 1).

5.13.Non-CHP fuel energy means the fuel energy, based on lower heating value, needed in a CHP unit for heat production not considered to be useful heat and/or non-CHP electrical energy in a reporting period (see Figure 1).

6. Step 2

6.1.All the measured electrical energy output and all the measured useful heat output can be taken into account when applying the methodology for determining the efficiency of the cogeneration process if the overall efficiency of the cogeneration unit is equal or higher than

(a)80 % for 'Combined cycle gas turbines with heat recovery' and 'Steam condensing extraction turbines-based plants', and

(b) 75 % for the other types of cogeneration units,

as indicated in Annex II of the Directive,

6.2.For micro-cogeneration units (up to 50 kW_e) with actual operation under cogeneration mode, it is allowed to compare the calculated overall efficiency (according to Step 1) with the certified values provided by the manufacturer as long as the primary energy savings (PES), as defined in Annex III point (b) to Directive 2004/8/EC, are higher than zero.

7. Step 3

COGEN Europe • The European Association for the Promotion of Cogeneration
Avenue des Arts 3-4-5, 1210 Brussels, Belgium
T +32 (0)2 772 82 90 | F +32 (0)2 772 50 44 | info@cogeneurope.eu

7.1. If the overall efficiency of the cogeneration unit is lower than the threshold values (75 %-80 %), non-CHP electricity generation may take place and the unit can be split into two virtual parts, the CHP part and the non-CHP part.

7.2. For the CHP part, the plant operator shall check the load pattern (useful heat demand) and evaluate whether the unit operates in full cogeneration mode during certain periods. If this is the case, the plant operator shall measure actual heat and electrical energy output from the cogeneration unit for this situation and during these periods. These data will allow him to determine the actual 'power to heat ratio' (C_{actual}) (5).

7.3. This actual 'power to heat ratio' will allow the operator to calculate which part of the electricity measured during the reporting period is recognised as CHP electricity according to the formula $E_{CHP} = H_{CHP} \times C_{actual}$.

7.4. For cogeneration units under development or in the first year of operation, where measured data cannot be established, the design 'power to heat ratio' (C_{design}) in full cogeneration mode can be used. The CHP electricity is calculated according to the formula $E_{CHP} = H_{CHP} \times C_{design}$.

8. **Step 4**

8.1. If the actual 'power to heat ratio' of the cogeneration unit is not known, the plant operator can use the default 'power to heat ratio' ($C_{default}$), as specified in Annex II to Directive 2004/8/EC, to calculate CHP electricity. The CHP electricity is calculated according to the formula $E_{CHP} = H_{CHP} \times C_{default}$.

8.2. In that case however, the operator has to notify to the national authority or to the competent body appointed by each Member State as referred to in Article 5 of the Directive the reasons for not having a known actual 'power to heat ratio', the period for which data are lacking and the measures taken to remedy the situation.

9. **Step 5**

9.1. The calculated electricity in Step 3 and Step 4 will then be taken into account when applying the methodology for determining the efficiency of the cogeneration process including the calculation of the primary energy savings (PES) of the cogeneration process.

9.2. To calculate the primary energy savings, it is necessary to determine the non-CHP fuel consumption. The non-CHP fuel consumption is calculated as the amount of 'non-CHP electricity production' divided by 'the plant specific efficiency value for electricity production'.

II. Cogeneration system boundaries

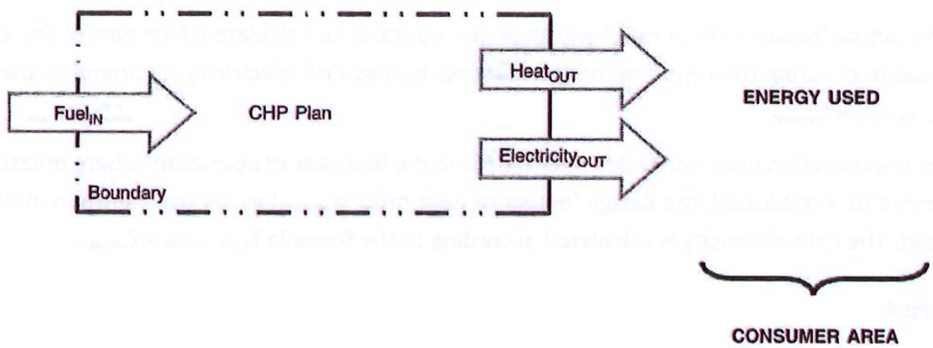
1. The boundaries of a cogeneration system shall be laid around the cogeneration process itself. Meters for defining input and output shall be available for monitoring and should be placed on these boundaries.

2. A cogeneration unit supplies energy products to a consumer area. The consumer area does not belong to the cogeneration unit, but consumes the energy outputs generated by the cogeneration

unit. The two areas are not necessarily distinct geographical areas within the site but, rather, areas that may be represented as shown below. The consumer area can be an industrial process, an individual heat and electricity consumer, a district heating/cooling system, and/or the electric grid. In all cases the consumer area uses the energy outputs from the cogeneration unit (See Figure 2).

Figure 2

Area of cogeneration unit



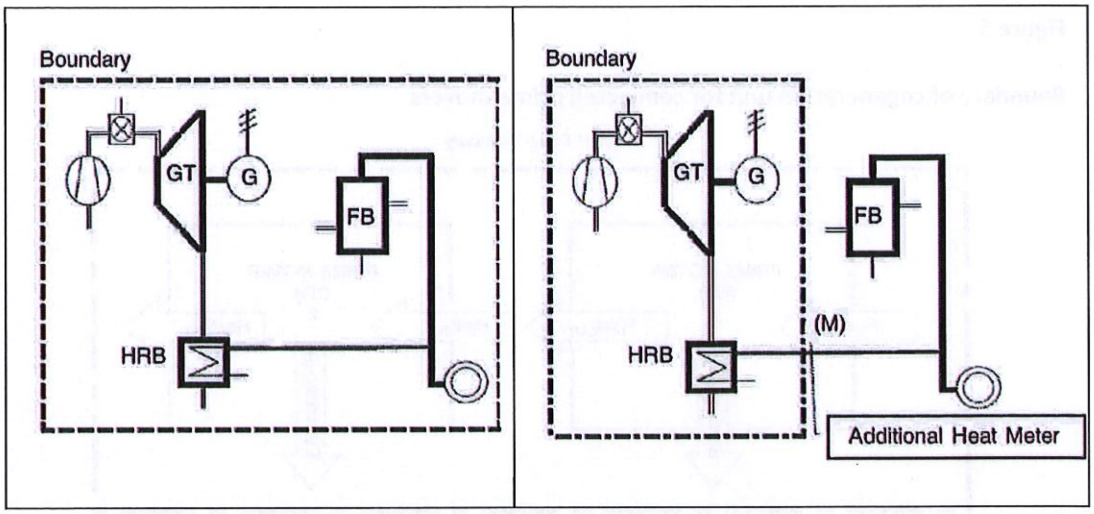
3. The CHP electricity output shall be measured at the generator terminals and any internal consumption for the operation of the cogeneration unit shall not be removed. The power output shall not be reduced by the electrical power used internally.

4. Other heat or electricity production equipment such as heat-only-boilers and electricity-only-power units that do not contribute to a cogeneration process shall not be included as part of the cogeneration unit as illustrated in Figure 3.

Figure 3

Selection of the correct system boundaries in case of auxiliary/stand by boilers (GT: Gas Turbine; G: Generator; FB: Fuel Boiler; HRB: Heat Recovery Boiler)

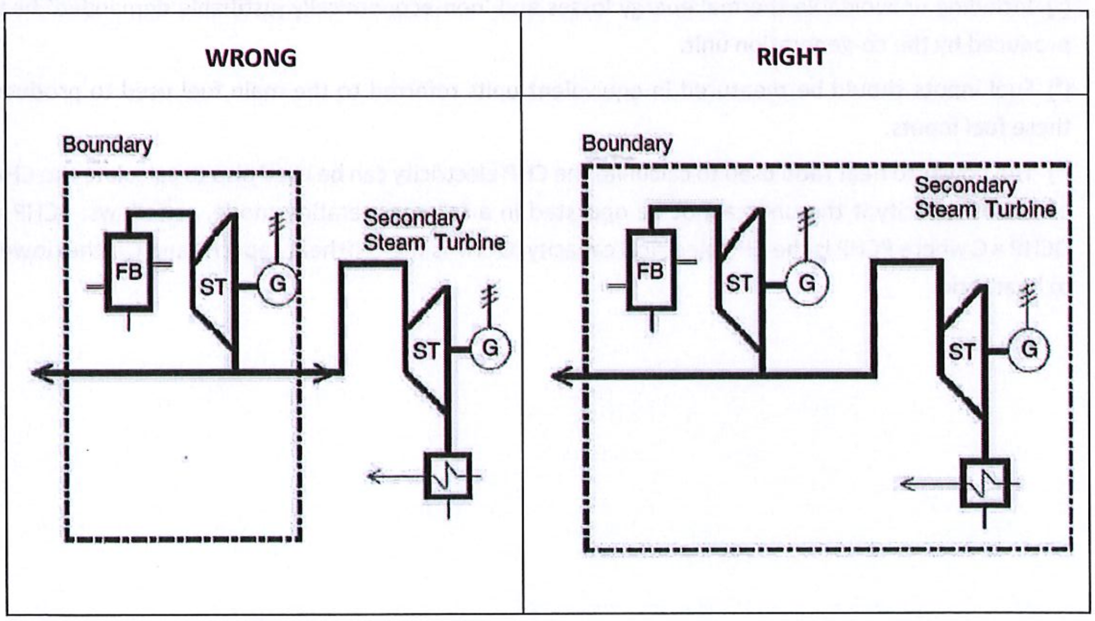
WRONG	RIGHT



5. The secondary steam turbines (see Figure 4) must be included as part of the cogeneration unit. The electrical energy output of a secondary steam turbine forms part of the energy outputs from the cogeneration unit. The thermal energy required to produce these additional electrical energy outputs has to be excluded from the useful heat output of the cogeneration unit as a whole.

Figure 4

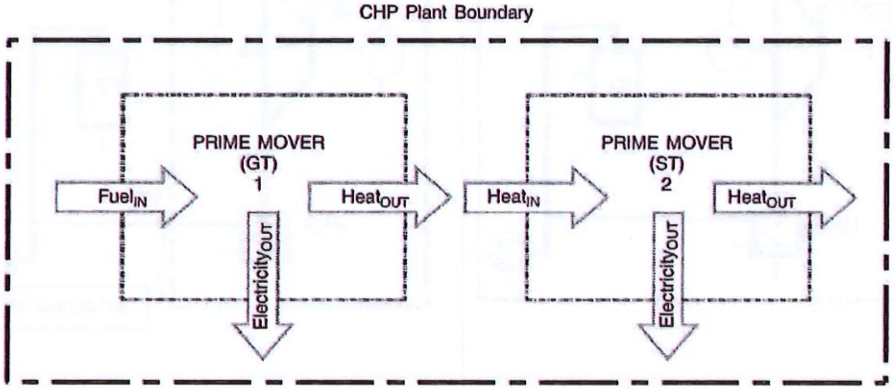
Selection of the correct system boundaries in the case of secondary steam turbines (ST: Steam Turbine)



6. Where prime movers (i.e. engine or turbine) are connected in series (where the heat from one prime mover is converted to steam to supply a steam turbine), the prime movers cannot be considered separately, even if the steam turbine is located on a different site (see Figure 5).

Figure 5

Boundary of cogeneration unit for connected prime movers



7. When the first prime mover is not producing electricity or mechanical energy, the boundary of the cogeneration unit is around the second prime mover. The fuel input for this second prime mover is the heat output of the first prime mover.

(¹) The mechanical energy is treated thermodynamically equivalent to electricity with a factor of 1.

(²) Except for micro-cogeneration units, see Step 2 (point 6.2).

(³) Including unavoidable thermal energy losses and 'non-economically justifiable demanded' heat produced by the co-generation unit.

(⁴) Fuel inputs should be measured in equivalent units referred to the main fuel used to produce these fuel inputs.

(⁵) The power to heat ratio used to calculate the CHP electricity can be used also to calculate the CHP electrical capacity if the unit cannot be operated in a full cogeneration mode, as follows: PCHP = QCHP × C where PCHP is the CHP electrical capacity, QCHP is the CHP heat capacity and C is the power to heat ratio.