JOINT STATEMENT ON THE CHP DIRECTIVE

The European Chemical Industries Association (CEFIC), the Confederation of European Paper Industries (CEPI), the European Association for the Promotion of Cogeneration (COGEN Europe), and the International Federation of Industrial Energy Consumers (IFIEC Europe)[1] provide input jointly on the implementation process of the European CHP Directive[2] and voice their concerns on the paper on reference values presented by the consultants to the Technical Committee on 1 July 2005.

CHP, in industrial, district-heating and individual building applications, is a powerful technology to convert fuels in the most efficient way into electricity and useful heat, helping to meet energy demand with reduced primary energy consumption and less CO_2 emissions in Europe. The key purpose of the CHP Directive is the promotion of CHP across Europe to achieve deeper energy savings and reductions of CO_2 emissions. Achieving a fair and coherent set of reference values is an important building block for the promotion of CHP in Europe.

Industry sectors value the transparent consultation process highly. We are using substantial quantities of CHP, across a wide range of capacities; our installations should continue to provide European industry with a competitive, flexible and environmental solution to their energy requirements. In addition, there is a large potential for future CHP investments. We are offering our constructive cooperation and advice to the CHP Committee in order to achieve decisions based on realistic, demonstrable data and methodologies. We supplement our general comments with more detailed background information in the attached Annex.

Recommendations:

Electricity

Reference values for separate generation of electricity should be based upon publicly available data including Combined Cycle Gas Turbine (CCGT) power plant operation data: **We recommend that the data from the Digest of United Kingdom Energy Statistics (DUKES) are used to set the natural gas fired references for electricity.**

We recommend that the reference values for electricity are set from the net output of the power station. These references will then need to be corrected for climate conditions and grid losses.

For the required **reference comparison** "with the best available and economically justifiable technology for separate production of heat and electricity" **special arrangements** with the supplier of the equipment **and any special governmental support for increasing efficiency must be substracted**. Moreover, a gas turbine technology or new gas turbine model is only fully commercial after it has achieved a minimum of 3 years of highly reliable operation in the field.

[1] The industrial associations of CEFIC, CEPI and IFIEC jointly represent the industries that provide over 75% of the current European industrial CHP capacity. Industrial CHP also comprises between 55 and 60% of the total CHP capacity and has substantial growth potential. COGEN Europe is the European umbrella organisation for the CHP sector, representing all sectors, technologies and applications.
[2] Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC

Setting the reference cases is effectively a **benchmarking** exercise: It is appropriate and standard practice to **remove the best and worst cases**.

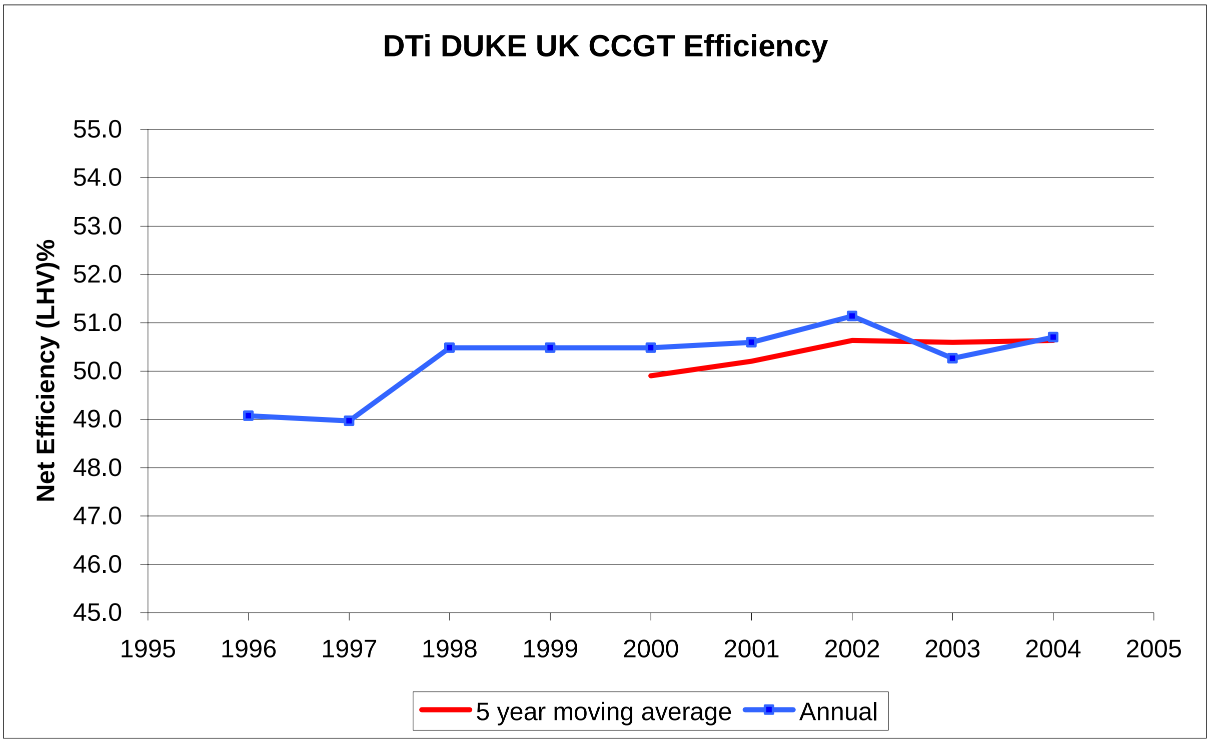
The time periods for setting references should be sufficient to provide statistically valid data. In addition they should not cause abrupt step changes between one period and the next: **Therefore we recommended that the reference plant efficiencies for time periods should be a presented as a curve.**

The **"year of construction" should be the date at which the technology choice for the CHP installation has been fixed**; this is the date of placing the order for the major plant items.

The **10 years reference period** should be **10 years from commencement of operations;** this is the date of commissioning of the plant.

To accommodate **normal variations in plants choices and operations affecting in-house losses and efficiency** (such as: plant size, type of condenser cooling, pollution control, degradation) **we recommend again the use of the operational data from DUKES, corrected to net LHV reference efficiencies.**

The recommended reference efficiencies for electricity production from natural gas-fired CHP are given in the figure below.



If a CHP plant uses more than one fuel, then the reference plants need to reflect this: **We recommend that references are split in proportion to the energy content of the fuels used but we strongly object to the consultants' proposal to introduce a threshold.**

Corrections for Climate conditions and Grid Losses

DUKES data from the UK data will require correction for operation in parts of Europe that vary substantially from climatic conditions of the UK, such as southern Europe.

Because CHP generates electricity near the point of use, the avoided losses from not using or minimising the use of the electricity networks must be accounted for in comparison to centralised electricity production. **We recommend following set of harmonising reference values for avoided grid losses** (see Annex).

Connection Level	Electricity used on-site	Electricity exported from site
High Voltage (> 200 kV)	2.5%	0%
Medium Voltage	6.4%	2.5%
Low Voltage (400 V and below)	12.0%	6.4%

Heat References

The reference values for heat proposed by the consultants are too high, and they mistakenly propose even higher references from industrial process steam than for hot water applications (see Annex).

We recommend using 85% for steam according to the Dutch statistics bureau and 82% for process heating and co-produced fuels in industrial processes.

CEFIC, CEPI and COGEN Europe are happy to discuss any of these recommendations (and further details in the attached Annex) with the members of the Technical Committee for the CHP Directive, the European Commission, the consultants to the Commission for the CHP Directive and other stakeholders.

ANNEX

1. BACKGROUND

This paper is based on extensive discussion and research undertaken by the CEFIC, CEPI, COGEN Europe and IFIEC and is the result of the concerns expressed by each of the organisations following the paper presented by the consultants to the Commission for the Technical Committee process for the CHP Directive on 1 July 2005 (more detailed information is given in the Annexes).

The four organisations have limited their input to industrial CHP and the relevant reference plants. Thus, consideration has been given to natural gas fired CHP plants, gas fired power plants, industrial steam raising boilers and process heat. In addition, consideration has also been given to co-produced fuels in industrial processes, such as refinery gas, blast furnace gas and cracker gas.

2. OVERALL PRINCIPLES

The purpose of the CHP Directive is to promote CHP that provides demonstrable energy saving vis-à-vis separate production of electricity and heat. CHP is and in the vast majority of cases in the past has been an important energy saving solution, providing tailored energy provision to industry, municipal heating and individual buildings alike. Thus any system to compare CHP against its alternatives (a central power station and a heat only boiler) has to be based on real operational data of economically justified plant (cf Article 4). In the market a CHP investment will displace the installed boiler plant of the site in question and the marginal generating plant on the electricity system plus the losses associated with delivering that electricity to the site. The CHP Directive chose a more rigorous comparison criterion, based on the principle of avoided investment. Thus, a CHP investment is assessed against the alternative investment in a central power station and a new boiler at the same time as the CHP investment was made. The assessment is also governed by the following additional criteria:

- Fuel neutrality, in that a gas fired CHP plant is compared against a gas-fired power station and gas-fired boiler, and coal with coal etc;
- The reference plants must be best available and economically justified technology and must be based on real operational performance;
- The reference plants must account for realistic conditions of operation, climate affects and cross-border exchange of electricity.

To qualify as high-efficiency CHP the primary energy savings must exceed 10% when compared to separate production for all plants except schemes smaller than 1 MWe where providing primary energy savings is sufficient.

It should be remembered in this process that there is no single “exact” or “correct” definition of reference values and the choice of methodology used by the Directive is designed to ensure energy savings are achieved and is thus very conservative. It therefore leaves scope to simplify the comparisons without damaging the integrity of the purpose to stimulate the growth of CHP that delivers energy savings.

3. SUPPORTING JUSTIFICATION

3.1. Harmonisation

According to Article 4 the CHP Directive, efficiency reference values must be harmonised across the EU. A high degree of harmonisation is paramount to prevent distortions in the treatment of CHP within the internal market for electricity as well as within the emerging markets for energy efficiency and greenhouse gases. It also increases certainty for investors and it can rule out discriminatory treatment of CHP through national policies.

Climatic variation is the one parameter that has to be based on regional data whereas all other data should be harmonised.

The CHP Directive states that the output of the CHP plant is measured at the generator terminals (this is the gross output of the CHP plant). It is our experience as operators of industrial CHP installations that the operation of the CHP plant uses approximately the same amount of electricity as a boiler house to provide the same heat demand. This electricity is used for pumps, fans and control systems. However, the in house electrical loads of a power station exist solely for the purpose of producing the electricity. Therefore, the appropriate measuring point for a power station is at the station boundary (this is the net output). Using the data from DUKES the internal consumption of the CCGT power station is around 2.5% of the gross output.

We recommend that the reference values for electricity are set from the net output of the power station. These references will then need to be corrected for climate conditions and grid losses (see below).

3.2 Heat References

The reference values for heat proposed by the consultants are too high, and they propose higher references from industrial process steam than for hot water applications and this is mistaken. The Dutch statistics bureau uses a value of 85% for natural gas-fired steam boilers. The use of co-produced fuels from industrial processes (including refinery gas, blast furnace gas and cracker gas) should have lower reference levels due to the nature of these fuels. It is reasonable to set the reference for these at 3% points less than natural gas. In addition the direct use of heat, not through a boiler, in furnaces and drying, should also have a reference value of 82%.

We, therefore, recommend 85% for steam and 82% for process heating and co-produced fuels in industrial processes.

3.3. Economic Justification

The Directive states "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." This principle is very clear in that the alternative must be economically justified. In the industrial sector this means that novel plant options are never installed without special arrangements with the supplier of the equipment. For the required **reference comparison** "with the best available and economically justifiable technology for separate production of heat and electricity" these **special arrangements** with the supplier of the equipment **and any special governmental support must be subtracted.** A plant, be it utility or process, is not deemed to be fully commercial until it has achieved 3 years of highly reliable operation in the field. The same principle must also apply to a competitive electricity industry, where the risk of equipment failure is borne fully by the operating company. Thus, new technology such as the GE H-class CCGT is not yet fully commercial and should not be included as a reference technology.

3.4. Available Data

The availability of data is crucial to setting reference efficiencies. In a fully competitive internal market for electricity in Europe, this data has become commercially sensitive. Thus gathering the data in a transparent way is difficult. However, there are published sources of data. These include data on CCGT operation in the United States and the Digest of United Kingdom Energy Statistics (DUKES).

DUKES covers the operation of some 23 GWe of CCGT plant in the UK. This is by far the largest European population of gas-fired generation, comprising more than 50% of the total European population. This data set is supported by data on CCGT operation in the US, whereby the annual performance UK CCGT plant is very similar to those in the US at similar operating conditions.

Thus we recommend that the data from DUKES are used to set the natural gas fired references for electricity.

Setting the reference cases is effectively a **benchmarking** exercise: It is appropriate and standard practice to **remove the best and worst cases** as they can distort the picture through special circumstances. Typical European CCGTs are operated in mid-merrit and reference efficiencies need to reflect the efficiency impact of frequent start-up, part load and shut-down of these units.

3.5. Time Periods

It is important to keep the data as simple as possible. The consultants are proposing 3-year periods (1997-1999; 2000-2002; 2003-2005). This poses three problems:

- The availability of data is any one of the time periods.
- The step change of efficiencies that could occur between one period and another.
- The lack of operating data for the period of construction of a new CHP plant. This provides uncertainty and therefore may suppress investment.

Recommendation: The reference plant efficiencies should be presented as a 5 year moving average curve to avoid step changes. This curve can be used by CHP industry to indicate potential future trends in reference efficiencies as a part of their planning and development activities for future cogeneration facilities.

3.6. Time of Construction

The year of construction is a vague term, but is used in the CHP Directive Annex III, f2. The appropriate date is the date at which the decision to construct a CHP plant is made and when the technology choice has been fixed. This is the date of placing the order for the main technology components, gas turbine and / or heat recovery steam generator. Thus, it is recommended that this date is used to set the comparison date for the references.

In addition, to allow for a suitable stable investment climate for each investment (Whereas 30) it is recommended that reference value is fixed for as long as possible. The Directive states (Annex III, f3) that the period is fixed for 10 years. It is recommended that this is 10 years from commencement of operations; that is the date of commissioning of the plant.

3.7. Issues that cause difficulties

There are a number of issues that cause difficulties with setting reference values for electricity. These include:

- The type of condenser cooling used by the power plant. This can change the efficiency by several percentage points depending on whether the cooling is once through cold water, wet cooling towers or dry cooling towers. For the last few years the permitting of UK power plants has been on the basis of dry cooling towers, due to water use issues. This has the highest parasitic losses, but the lowest environmental footprint. Thus it is the best available proven technology.

- Plant size. The size of the power station, which is built as an alternative to CHP is not a fixed block size. In the case of natural gas-fired CCGT power stations this can vary from 120 MWe to 2000 MWe depending on location, power demand growth, network constraints etc.. It is thus arbitrary to pick any one size of plant, but this choice makes a considerable difference in efficiency.
- Degradation: CCGTs suffer reductions in performance caused by fouling of the compressor and turbines blades between turbine washes and permanent efficiency loss during the first 24,000 hours of operation. Typically, the fouling will cause a loss in efficiency of 1% on average a year. The loss caused by plant age is around 1.5% with some slight variation depending on the manufacturer.
- Pollution Control: the type of pollution control equipment will have an influence on the efficiency of power plants. The greater the level of emission reduction required the higher the parasitic loss of output.

To accommodate all these normal variations in plants choices and operations for the electricity reference values we strongly **recommend the use of a large statistical data set of real operational data.** Thus, again we recommend the use of the **data from DUKES.**

Reference efficiencies need to be based on historical performance and we recommend to use an average of the last 5 years from the DUKE report of operating CCGT in the UK which is consistent with the full maintenance cycle of a CCGT, versus using the most recent DUKE numbers.

Using the data from DUKES and including the in-house electricity consumption at the power station the natural gas efficiencies should be set as net CCGT values.

3.8. Fuel neutrality

Article 4 and Annex III (f) of the CHP Directive determine that efficiency reference values must be determined on fuel categories corresponding to the fuels used by the CHP plant.

The list of fuels should include, but may not be limited to: natural gas, hard coal, lignite, peat, heavy fuel oil, light oil, biomass, biogas, bio-liquid, co-produced fuels from industrial processes (refinery gas, blast furnace gas and cracker gas), municipal waste and hydrogen.

3.9. Fuel Splitting

If a CHP plant uses more than one fuel, then the reference plants need to reflect this. The consultants propose split the references in proportion to the fuel used. Thus a CHP plant with 20% of fuel A and 80% fuel B will be compared to 20% of the reference for fuel A and 80% of the reference of fuel B. This is a pragmatic solution to this problem.

However, the consultants also propose a *de minimis* limit of 5%. Whereby any fuel used that comprise less than 5% of the total fuel burnt in any one year will be excluded. There is no justification for this and it could lead to problems with some industrial CHP plants. A plant designed to use co-produced fuels from industrial processes will compromise on peak efficiency to utilise these fuels. Thus even at a few percentage points these fuels should be accounted for. There is no real administrative reason to exclude fuels on the basis of volume consumed, therefore, there is no reason for the *de mininis* limit and it should be removed.

We recommend that references are split is proportion to the energy content of the fuels used and that no threshold is set.

3.10. Climatic Conditions

Climatic conditions, notably the ambient temperature, humidity and altitude range widely across Europe and this affects the performance of some CHP technologies and reference power plant technologies.

The reference plant data will need to be adjusted for the climatic conditions. This may be simplified by choosing broad zones for Europe, based on mean temperature, humidity and altitude conditions.

3.11. Available information on reference data of operational use of CCGTs

The Digest of UK Energy Statistics

The UK Department of Trade and Industry (DTI) produces a large number of energy statistics, amongst which is the annual Digest of UK Energy Statistics. DUKES also reports efficiencies of CCGT plants in the UK (www.dti.gov.uk/energy/inform/dukes/), which is based upon operational data from the UK power producers.

This paper uses the data from DUKES 2004, which is for power station performance in 2003. On 29 July 2005 the 2005 report was published. This new data has not yet been fully analysed.

Statistics on efficiency can be found in Table 5.10 of the report. The CCGT plants in operation in 2003 are found in Table 5.11. In total 33 CCGT sites are in the report with a total capacity of 23000 MW.

Figure 1 gives the increase of CCGT capacity in the UK over the years from 1991 to 2004. The CCGT capacity grew from 1800 MW in 1991 to 23000 MW in 2003. The UK has by far the largest and most modern state-of-the-art CCGT capacity, so it is a good source for reference efficiency values, and the official DUKES report fulfils the above mentioned criteria for defining the reference values.

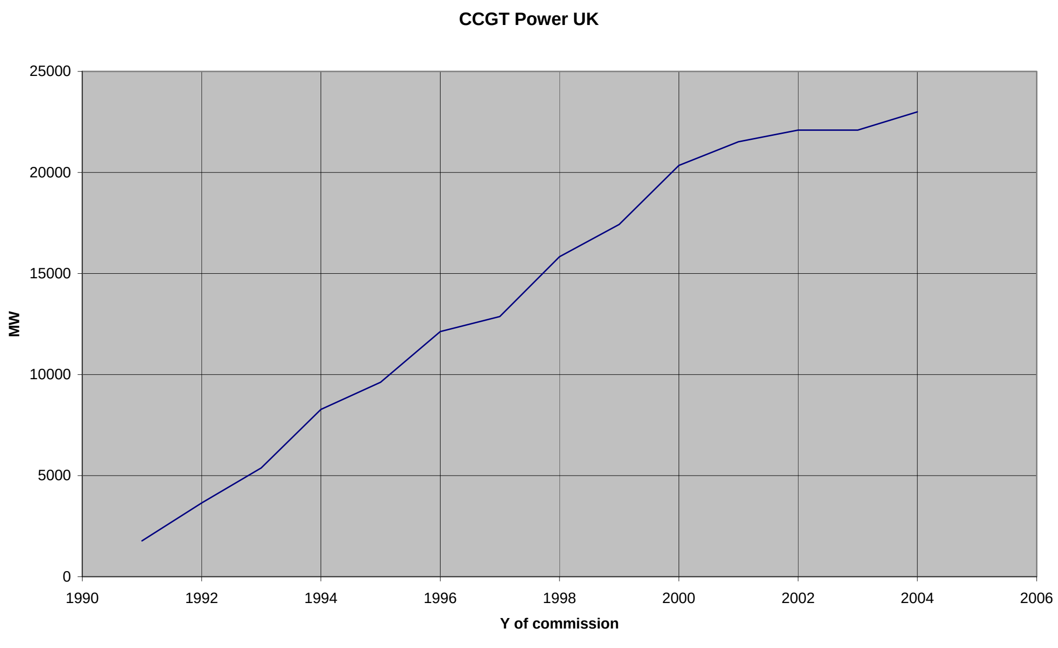


Figure 1: CCGT capacity in the UK in 2004 (source DUKES 2004)

In conclusion, DUKES reporting on CCGT efficiencies is the only public European report that reports real operational data and fulfils the criteria of the Directive. Therefore it is proposed to use these data as input for the reference efficiency values for electricity production of gas fired CHP.

DUKES report on CCGT operation efficiency

The CCGT efficiencies can be found in Table 5.10 of the report. These figures are gross efficiencies on gross calorific basis. The reporting period is from 1996 to 2003.

Figure 2 gives the reported efficiency of the UK CCGT plants as net efficiencies based on lower heating value. They have been corrected as follows:

- LHV = HHV / 0.90
- net efficiency = 0.975 * gross efficiency

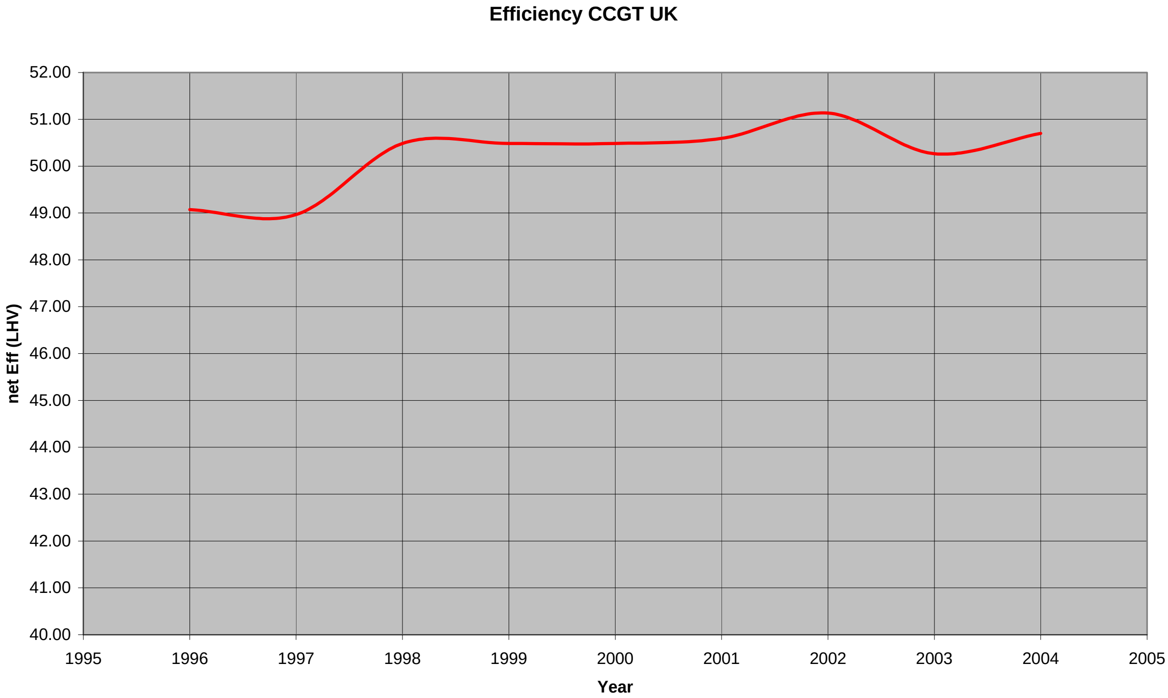


Figure 2: net CCGT efficiency (source DUKES 2003)

From these data it can be concluded that the huge increase of CCGT capacity with new state-of-the-art CCGT units has resulted in only a slight increase of CCGT operational gross HHV efficiency from 49 % in 1996 to 50.7 % in 2004.

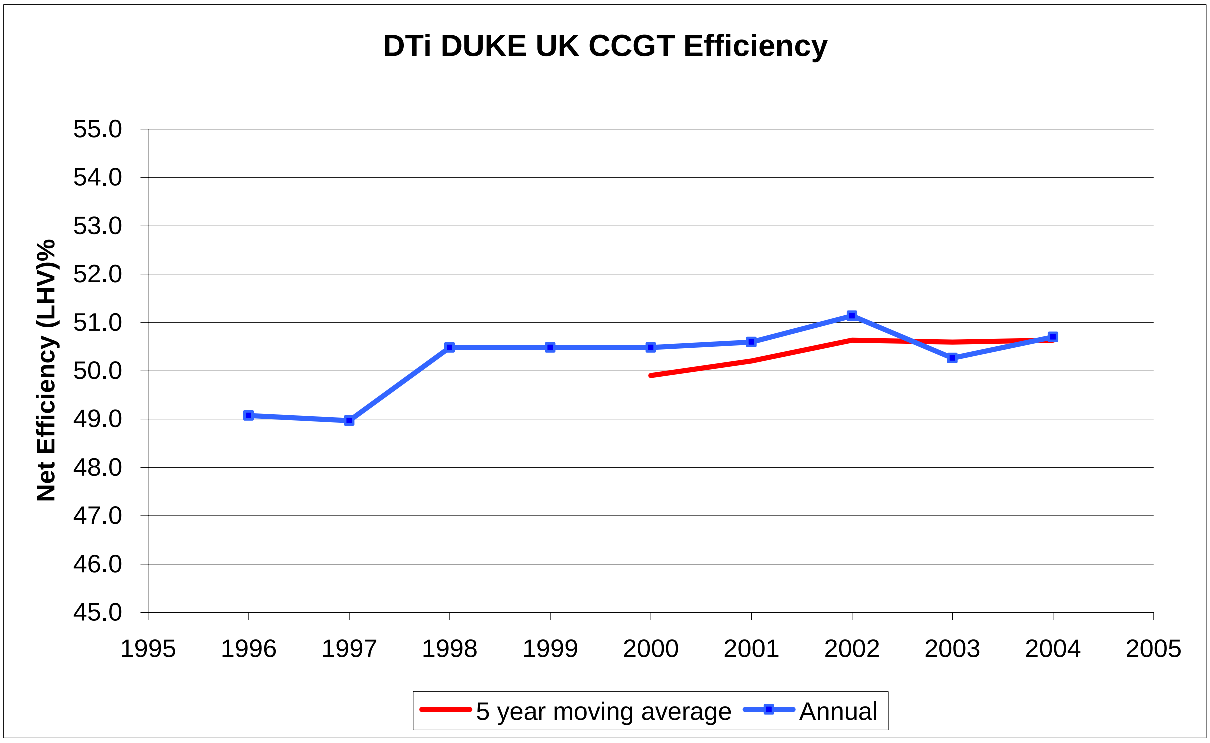
The effect of older less efficient CCGTs on the reported average annual efficiency is small, because the older capacity is small compared to the newly installed capacity, and due to market forces the production of the older units will have decreased in favour of the new units. Also, some of the older CCGT have upgraded their units to incorporate newer technology such as upgrading a GE9F to FA technology.

Table 5.10 also shows that after 2000 the CCGT plant load factor has decreased. This is an illustration of the more cycling operation of CCGT plants, because of market conditions, instead of baseload operation in the past.

3.12 Proposal for reference efficiency values gas fired CCGT electricity production

Harmonised reference values

Harmonised CCGT reference efficiency values should be based upon the DUKES report in the form of a curve as net efficiencies.



These reference values are considered to be on the basis of ISO climate conditions, and the use of wet cooling tower condenser cooling and take into account the effect of CCGT plant size on efficiency. As to plant size, it is important to note that the Dukes data are dominated by the largest size CCGTs, but in Europe also 100 MWe CCGTs are being built like in Italy and Belgium.

To keep it simple it is proposed to apply only two corrections for specific local CHP conditions, if using the entire UK DTi DUKE CCGT net plant efficiency data, otherwise a third correction needs to be made for CHP plant size:

- for different climate conditions;
- for grid losses

Correction for load conditions is not necessary, as the reference values reflect already the mix of baseload, mid-merit and peak load, and most of the gas fired

3.13. Avoided Grid Losses

Finally, the CHP Directive requires accounting for avoided grid losses, as it is a fundamental condition to determine the operational use under realistic conditions of thermal power plants as stipulated in Article 4 of the Directive.

Because CHP generates electricity near the point of use, the avoided losses from not using or minimising the use of the electricity networks must be accounted for in comparison to larger/centralised electricity production. Typically, a large CHP plant connected at high voltage would avoid around 2.5% network losses, whilst a CHP plant in a house connected at low voltage would avoid network losses of at least 10%.

Electricity grid systems, both transmission and distribution show considerable variation across Europe, thus it will be necessary using a simple and workable method to correct for national circumstances. The French approach to this issue is very useful in this context. It defines a standard grid loss for each voltage level of the French system. Depending on the voltage level a CHP unit is connected to it is thus easy to determine the total avoided grid losses of the unit. A similar system of default grid losses should be established for the EU.

The variation in grid losses from one country to the next is a function of: system design; voltage levels; the proportions of centralised versus decentralised electricity production; system loading; and capacity constraints. The key factor in this set of variables is the proportion of decentralised generation, which is mostly CHP presently. Thus it is reasonable to use one set of grid losses for the delivery of electricity from centralised power station to end consumers and thus the avoided losses using CHP instead of central power stations.

Using the best available technology for grid systems the following losses are likely:

Grid Losses			
Average Grid Losses Reported by DUKES	%	8,70%	2003 Data
Theoretical Calculations			
Transformation losses	%	0,8%	per transformation
Power Station to High Voltage Grid	N°	1	
High Voltage to Medium Voltage	N°	1	
Medium to Low Voltage	N°	1	
Low Voltage to Consumer	N°	1	
Heating losses HV	%	1,0%	
Heating losses MV	%	3,0%	
Heating losses LV	%	5,0%	
T&D Losses for HV connected customers	%	2,6%	
T&D Losses for MV connected customers	%	6,4%	
T&D Losses for LV connected customers	%	12,2%	

Delivered Efficiency	
HV Connected Customer	
Baseload Power	48,7%
Grid Losses for import	2,6%
Grid Losses for export	0,0%
Electricity import efficiency	47,4%
Electricity export efficiency	48,7%
MV Connected Customer	
Mid-Merit Power	46,2%
Grid Losses for import	6,4%
Grid Losses for export	2,6%
Electricity import efficiency	43,3%
Electricity export efficiency	45,0%
LV Connected Customer	
Mid-Merit Power	46,2%
Grid Losses for import	12,2%
Grid Losses for export	6,4%
Electricity import efficiency	40,6%
Electricity export efficiency	43,3%

Grid losses

We recommend that one set of grid losses is used:

Connection Level	Electricity used on-site	Electricity exported from site
High Voltage (> 200 kV)	2.5%	0%
Medium Voltage	6.4%	2.5%
Low Voltage (400 V and below)	12.0%	6.4%