Annex I: Comparison of the processes at Facility with the BREF for Large Combustion Plants (published July 2006).

Part 1. Combustion techniques for coal and lignite

Note: This section is not applicable to the proposed development. The gas turbine power plant shall be fuelled with natural gas. The only section applicable for the proposed power plant is Part 4.

Part 2. Combustion techniques for biomass and peat

Note: This section is not applicable to the proposed development. The gas turbine combined cycle power plant shall be fuelled with natural gas.

Part 3. Combustion techniques for liquid fuels

Note: The proposed CCGT power plant shall be fuelled with natural gas. This section is not applicable to the proposed power plant.

Part 4. Combustion techniques for gaseous fuels

Aspect of BAT	BAT	Status at Installation
Supply and handling of gaseous fuels and additives	BAT in preventing releases related to the supply and handling of gaseous fuels, but also for storage and handling of additives such as ammonia etc. are summarised in Figure 22.	**Gas detection system**; a gas detection system will be installed in the CCGT, the GT enclosures and the regasification facility. It will detect fuel leakage and activate the alarm at different levels depending on the gas concentrations. The gas detection signals will be monitor in the Distributed Control System (DCS) and if necessary will activate an emergency shut-down (ESD). **Use of expansion turbines**; The pressure in the natural gas

Aspect of BAT	BAT	Status at Installation
		pipeline is to be around 38bara and the minimum pressure that the GTs can accept is 32bara. This small pressure difference limits the amount of energy which could be recovered in an expansion turbine and it makes it impractical and uneconomical to install one. Besides the site is very congested there isn't sufficient space for installing such a system. **Preheating of fuel gas**; waste heat from the HRSGs where practical is used to preheat the gas to increase the efficiency of the GTs. **Pure Liquefied Ammonia**; The ammonia used within the CCGT process shall not be pure liquefied ammonia it will be a 25% solution and shall be further diluted to around 3% in the ammonia dosing tank. This ammonia solution is injected into the condensate/steam cycle in order control the pH. There is not any other usage of ammonia in D4PP.
Thermal efficiency of gas-fired combustion plants	To reduce greenhouse gases, in particular releases of CO_2 from gas-fired combustion plants such as gas turbines, gas engines and gas-fired boilers, the best available options from today's point of view are techniques and operational measures to increase the thermal efficiency of the plant. Secondary measures, i.e. CO_2 capture and disposal as described in Annex 10.2 of BREF, are at a very early stage of development. These emerging techniques might be available in the future, but they cannot yet be considered as BAT.	Noted. Net electric efficiency of the CCGT will be within the BAT range at MCR ISO conditions. The net electrical efficiency at reference conditions is 54%, At ISO conditions this will be higher. The proposed power plant is not a combined heat and power plant. The new development will not include gas engines. Natural gas preheaters will be included. These will use

Aspect of BAT	BAT	Status at Installation
	The energy efficiency has been considered as heat rate (fuel input energy/energy output at power plant border) and as power plant efficiency, which here is the inverse of heat rate, i.e. the percentage of produced energy/fuel input energy. The fuel energy is measured as the lower heating value. For gas-fired combustion plants, the application of gas turbine combined cycles and the co-generation of heat and power (CHP) are technically the most efficient means of increasing the energy efficiency (fuel utilisation) of an energy supply system. A combined cycle operation and co-generation of heat and power is, therefore, to be considered as the first BAT option, i.e. whenever the local heat demand is great enough to warrant the construction of such a system. The use of an advanced computerised control system in order to achieve a high boiler performance with increased combustion conditions that support the reduction of emissions are also considered as BAT. Improvement of the efficiency can also be obtained by preheating the natural gas, before its supply to the combustion chambers or burners. The heat can be obtained from low temperature sources, such as the exhaust gases from cooling from other regenerative processes. Gas engine driven power plants are suited for both decentralised heat and power production (CHP) as well as	HRSG hot feed-water as hot stream to preheat the natural gas. This system will enhance the efficiency of the plant. This is considered BAT. The gas turbine combustion system and transition ducts will be lined with a proprietary thermal barrier coating to minimize heat losses to the environment. This way, most of the heat developed during the combustion process is converted into shaft work in the turbine gas expansion optimizing the efficiency. This complies with BATs recommendations. The proposed power plant will have three gas turbines which incorporates DLN burners. This burner technology will assure complete combustion of the gas fuel avoiding any unburnt gas. DLN combustion technology is SIEMENS proprietary and unlike the traditional diffusive combustion, it accomplishes a low flame temperature during the combustion process by premixing the fuel with air, resulting in a lean premix flow before entering the combustion chamber. This low flame temperature results in considerably lower NOx generation. This is BAT recommendations. The SGT800 GTs will have SIEMENS proprietary vanes and blades geometry which optimizes the expansion of the gases in the turbine. Many of these vanes and blades geometries are calculated and optimized by using computational fluid-dynamics software.

Aspect of BAT	BAT	Status at Installation
	for bigger base load applications. The BAT associated total efficiencies are up to 60 – 70 % in low pressure steam generation. With supplementary firing (i.e. when the oxygen content of the engine flue-gas acts as the main 'combustion air' in the burner) a large amount of low pressure or high pressure steam can be generated in an efficient way, In hot water production (with outlet temperatures typically in range of 80 – 120ºC), a total efficiency (fuel utilisation) of up to 90 % in gas fuel mode can be seen as BAT, although highly depending on the portion of the engine cooling water energy recovered in the application. Hot water of up to 200ºC can, of course, be produced by utilising the energy in the flue-gas and part of the engine cooling energy. Another advantage is the high thermal efficiency (i.e. low fuel consumption, and consequently low specific CO_2 emissions) of the engines. The BAT electrical efficiency (at alternator terminals) ranges from about 40 to 45 % (depending on the engine size) and is calculated on the lower heating value of the fuel. For existing plants, a number of retrofit and repowering techniques can be applied to improve the thermal efficiency. The technical measures described in BREF Section 2.7.8 should be taken into account as part of BAT options to improve the efficiency of existing plants. By applying the techniques and the measures listed in BREF Section 7.4.2, to improve the thermal efficiency such as double reheat, and using the most advanced high temperature materials for gas	The pressure at the steam turbine is kept as low as possible by making use of the maximum cooling capacity of the cooling seawater. Additional measures: Ø combustion: minimising the heat loss due to unburned gases *Adopted by special lining and insulation of the combustion chamber*. Ø the highest possible pressure and temperature of the working medium gas or steam *Adopted. Steam is generated at two different pressures high and low pressure to optimize heat recovery.* Ø the highest possible pressure drop in the low pressure end of the steam turbine through the lowest possible temperature of the cooling water (fresh water cooling) for boilers and CCGT plants. *Adopted. The pressure at the steam turbine is kept as low as possible by making use of the maximum cooling capacity of the cooling seawater.* Ø minimising the heat loss through the flue-gas (utilisation of residual heat or district heating) *Adopted. Residual heat from flue gas is recovered in the heat recovery steam generator (HRSG)* Ø minimising the heat loss through conduction and radiation with isolation *Incorporated. HRSGs and steam piping are insulated*

Aspect of BAT	BAT	Status at Installation
	turbines and boilers, energy efficiencies associated with the use of BAT can be achieved as summarised in Figure 23. In addition, the following measures also needs to be taken into consideration to increase the efficiency: Ø combustion: minimising the heat loss due to unburned gases of the working medium gas or steam Ø the highest possible pressure drop in the low pressure end of the steam turbine through the lowest possible temperature of the cooling water (fresh water cooling) for boilers and CCGT plants. Ø minimising the heat loss through the flue-gas (utilisation of residual heat or district heating) Ø minimising the heat loss through conduction and radiation with isolation minimising the internal energy consumption by taking appropriate measures, e.g. scorification of the evaporator, greater efficiency of the feed water pump, etc.) Ø preheating the fuel gas and or the boiler feed water with steam Ø improved blade geometry of the turbines.[1] It should be borne in mind that these BAT levels are not achievable in all operation conditions. The energy efficiency is at its best at the design point of the plant. The actual energy efficiencies throughout the	Ø minimising the internal energy consumption by taking appropriate measures, e.g. scorification of the evaporator, greater efficiency of the feed water pump, etc.) *Internal auxiliary consumption is minimized by using Variable frequency drivers for the feedwater pumps which are the largest consumers within the CCGT* Ø preheating the fuel gas and or the boiler feed water with steam *Adopted. Natural gas preheaters will be included. These will use HRSG hot feed-water as hot stream to preheat the natural gas. This system will enhance the efficiency of the plant.* Ø improved blade geometry of the turbines.[2] *The SGT800 GTs will have SIEMENS proprietary vanes and blades geometry which optimizes the expansion of the gases in the turbine. Many of these vanes and blades geometries are calculated and optimized by using computational fluid-dynamics software.* Operation of the CCGT in open cycle will take places during the first six months of commercial operation. After this period open cycle operation shall be limited to unlikely situation when the electrical demand from the Maltese grid be very low demand. The reason for not being able to operate the plant in combined cycle at low loads is that in order to be emission compliant the GT load shall be higher than 70%.

Aspect of BAT	BAT	Status at Installation
	operational period of the plants may also be lower due to changes, for instance changes in the load during the operation, quality of the fuel, etc. The energy efficiency also depends on the cooling system of the power plant, and on the energy consumption of the flue-gas cleaning system. It should also be recognised that high efficiency gas turbine systems may generate problems such as vibration and higher short term NO_X emissions.	
Dust and SO_2 emissions from gas fired combustion plants	For gas-fired combustion plants using natural gas as a fuel, emissions of dust and SO_2 are very low. The emission levels of dust by using natural gas as a fuel are normally well below 5 mg/Nm^3 and SO_2 emissions are well below 10 mg/Nm^3 (15 % O_2), without any additional technical measures being applied. If other industrial gases are used as a fuel such as refinery gas or blast furnace gas, pre treatment gas cleaning measures (such as fabric filters) needs to be applied and considered as BAT, in order to reduce the dust content and the amount of SO_2 in the flue-gas, which may otherwise damage the gas turbines or engines. As mentioned in the Refinery BREF, BAT is to limit the H_2S content of the refinery gas to 20 – 150 mg/Nm^3 leading to an emission of 5 – 20 mg of $SO2/Nm^3$. Such gas does not create particulate emissions. In the case of natural gas refineries, also refer to the Mineral Oil and Gas Refinery BREF.	Minimal SOx emissions are expected as Natural Gas from the regasification of LNG has a low sulphur content even compared to the already low Natural Gas standard. Most of the sulphur contained in the NG prior to liquefaction at source is removed in a gas treatment plant via a gas purification processes. The Sulphur removal efficiency of these processes, although high, doesn't achieve 100%. That is why the LNG could contain traces of sulphur presented as H_2S and COS. These compounds are completely oxidized in the GT combustion chambers to SOx. The concentration of total sulphur in the Natural Gas on site shall always be lower than $30mg/Nm^3$ and will on average not be greater than $5mg/Nm^3$. This sulphur content is then highly diluted with air in the GTs

Aspect of BAT	BAT	Status at Installation
		combustion chambers so that the concentration of sulphur in flue gases at the stacks, based on the maximum value above, shall always be lower than 10mg/Nm3 at 15% O_2 (dry basis) in accordance with these BAT recommendations.
NO_X and CO emissions from gas-fired combustion plants	In general, for gas turbines, gas engines and gas fired boilers, reduction of nitrogen oxides (NO_X) is considered to be BAT. The nitrogen compounds of interest are nitric oxide (NO) and nitrogen dioxide (NO_2), collectively referred to as NO_X. For new gas turbines, dry low NO_X premix burners (DLN) are BAT. Most existing gas turbines can be converted to the dry low NO_X premix burner (DLN) technique, but sometimes the use of water and steam injection can be a better solution. This needs to be decided case by case. Several gas turbine and gas engines operating in Europe, Japan and the US have also applied SCR to reduce the emissions of NO_X. Beside the dry low NO_X premix burner technique (DLN) and the injection of water and steam, SCR is also considered to be part of the BAT conclusion. For new gas turbines, the DLN burners can be seen as the standard technique so that the application of an additional SCR system is, in general, not necessary. For further reduction of NO_X, SCR can be considered where local air quality standards request a further reduction of NO_X emissions compared to the levels given in Figure 24 (e.g. operation in densely populated urban areas). In Figure 24	Noted The proposed power plant will have three gas turbines which incorporates DLN burners (BAT). The GT dry low emission technology guarantees compliance with EU directive 2010/75/EU and the Maltese LN 11/2013 without the necessity of using any post-combustion emission abatement technology such as SCR. The NOx emission guarantees will be lower than or equal to 50 mg/Nm^3 (@15% O2 db.). The CO emission guarantees will be ≤100 mg/Nm3 at 15% vol. O_2. Db. As a result there is no need for an additional CO oxidation catalyst. This value will be only guaranteed for 70-100% GT load operating range. The plant is designed to be operated as a base load plant thus should operate in combined cycle mode at maximum capacity and maximum efficiency. As such start-ups and shut-downs will be minimised, and thus the plant will be operated in a high efficiency mode and reduce the inefficient burning of NG during these start up and shut

Aspect of BAT	BAT	Status at Installation
	emergency machinery has not be taken into account.	downs.
	For existing gas turbines, water and steam injection or conversion to the DLN technique is BAT. Gas turbines of unchanged combustion design, but with higher inlet temperatures, have higher efficiencies and higher NO_X values. In this context, it should be noted that with a higher efficiency the specific NO_X emission per kWh are still lower.	The power plant will ramp up to 70% load in less than 160 minutes. At this load the power plant emissions will meet the guaranteed emissions levels in order to comply with these BAT guidelines. The power plant will shut down from 100% load in circa 20 minutes. Such fast start-up and shut-down transitions will minimise emissions. Refer to start-up curves in Appendix B of section B2.2.2.
	SCR retrofitting is technically feasible, but not economical for existing CCGT plants if the required space in the HRSG was not foreseen in the project and is therefore not available.[3]	Space has been allowed in the HRSG for future retrofitting of a Selective Catalytic Reduction (SCR) system if required. All main stacks and bypass stacks will have a continuous emissions monitoring system (CEMS) connected back to the CCGT Distributed control system (DCS).
	For gas-fired stationary engine plants, the lean-burn approach is BAT analogous to the dry low NO_X technique used in gas turbines. This is an inbuilt method and no extra reagents or water need to be supplied to the site for NO_X reduction. Because gas engines are sometimes equipped with an SCR, these techniques can also be considered as part of BAT. To reduce the CO emissions, the application of oxidation catalysts is BAT with the associated emission levels for natural gas firing mentioned in Figure 25. In the case of buring other gasous fuels such as biogas or landfill gases, the CO emission can be higher due to the specific fuel used.	

Aspect of BAT	BAT	Status at Installation
	The NMVOC emissions from spark ignited lean burn gas (SG) engines and dual fuel (DF) engines in gas mode depend on the composition of natural gas. NMVOC secondary emission reduction techniques might, in some cases, be needed and an oxidation catalyst for simultaneous CO and NMVOC reduction can be applied. CO values kept below 100 mg/Nm^3 (15 % O_2) and formaldehyde values below 23 mg/Nm^3 (15 % O_2) are considered as BAT for a gas-fired engine equipped with an oxidation catalyst. BAT for the minimisation of CO emissions is complete combustion, which goes along with good furnace design, the use of high performance monitoring and process control techniques and maintenance of the combustion system. Besides the combustion conditions, a well optimised system to reduce emissions of NO_X will also keep the CO levels below 100 mg/Nm^3. In addition, the application of an oxidation catalyst for CO can be seen as BAT when it is operated in densely populated urban areas. The BAT conclusion for the prevention and control of NO_X and CO emissions and the associated emission levels are summarised in Figure 24 and Figure 25. Flue-gases from gas turbines and gas engines typically contain about 11 – 16 vol-% O_2 and, therefore, the emission levels associated with the use of BAT for turbines and engines have been based on an O_2 level of 15 vol-%, and standard conditions as the	

Aspect of BAT	BAT	Status at Installation
	reference point. For gas-fired boilers, 3 vol-% O_2 is usually used as a reference level. The BAT associated emission levels are based on daily average, standard conditions and represents a typical load situation. For peak load, start up and shut down periods as well as for operational problems of the flue-gas cleaning systems, short-term peak values, which could be higher have to be regarded. For refinery gas refer to Mineral Oil and Gas Refinery BREF. In the case of Natural gas refineries, also refer to the Mineral Oil and Gas Refinery BREF.	
Water pollution	Different waste water streams (see BREF Chapter 1) are generated by gas-fired combustion plants. To reduce emissions to water and to avoid water contamination, all measures that have been presented in BREF Section 7.4.4 are considered to be BAT. Small amounts of oil contaminated (washing) water cannot be prevented from occurring occasionally at a power plant. Oil separation wells are, in general, sufficient to avoid any environmental damage. The other techniques described for waste water treatment in BREF Chapter 3 can, in general, also be considered as BAT for this sector.	HRSG blowdown waste water stream will be routed as required to the neutralising tanks were they will be tested and treated prior to discharging into the sea (BAT). The pH will be monitored at the outlet of the neutralization process. Only contamination won't occur in this effluent. Oily water will be segregated from rain water runoff and treated in an oil separator before disposal (BAT). Washing water used for servicing activities such as compressor cleaning will be treated before disposal off-site by an authorized carrier. Domestic waste water will be discharge into the Delimara sewer (BAT).

Aspect of BAT	BAT	Status at Installation
		There is not a demin water plant in D4PP. There is a water polishing unit which shall operate when the demin water conductivity from Enemalta demin water plant diverts from a define conductivity value. This polishing unit will require replacement of the activated carbon filtering media and the resin beds in a regular basis. The regeneration and disposal activities won't be conducted on-site.
Combustion residues	A lot of attention has already been paid by industry to the utilisation of combustion residues and by-products instead of depositing them in landfills. Utilisation and re-use is, therefore, the best available option.	No combustion residues will be generated in the Delimara4 as it is a gas fired power plant with no solid combustion residues generation.
BAT for combustion installations operated on offshore platforms	The conclusions on BAT for the offshore sector have taken into account that combustion installations operated offshore are used in a more complex and potentially hazardous environment than in onshore power stations. In addition, space and weight are at a premium, leading to a much higher equipment density than is common in onshore applications. In addition, any undue complexity is generally avoided offshore, because of weight, space, safety and operability factors. Therefore, techniques such as water and steam injection, which require a high quality water treatment plant or SCR with additional storage of ammonia, have not been considered as BAT for offshore applications to reduce NO_X emissions. In general, for new gas turbines operated on offshore platforms, the reduction of nitrogen oxides (NO_X) by using	The proposed power plant will be installed onshore. This section is not applicable to this CCGT installation.

Aspect of BAT	BAT	Status at Installation
	primary measures such as dry low NO_X premix burners (DLN) is considered to be BAT as far as this technique is available. The associated emission level of NO_X by using the dry low NO_X premix burners (DLN) for gas turbines is less than 50 mg/Nm^3. As the flame stability needs to be maintained over the full range of operating conditions, it may not be practical to maintain staged combustion at low rates, such as at start-up and part load operation. The formation of NO_X is not reduced during such periods and hence the occurrence and duration of these periods should be minimised. Retrofitting of existing offshore gas turbines is much more expensive compared to land-based turbines due to the modification work costs. Retrofitting the DLN technology in existing offshore gas turbines is limited due to higher costs and a restriction of space within the turbine package for new fuel manifolds or combustion chambers. For aeroderivative turbines often used offshore, retrofitting to DLN is generally much more complex than for industrial turbines. The whole combustion section has to be replaced, and due to the larger outer diameter of the DLN combustion section, the gas turbine centreline is shifted. The applicability of retrofitting the DLN technology will, therefore, differ from platform to platform due to the type of turbine, the complexity, the age, etc. The BAT level for existing installations has to be determined on a case by case basis.	

Aspect of BAT	BAT	Status at Installation
	To reduce the environmental impact of offshore gas turbines, the following measures are part of the BAT conclusion: Ø for new installations, selecting turbines which can achieve both a high thermal efficiency and a low emissions spectrum Ø using dual fuel turbines only where operationally necessary Ø minimising 'spinning reserve' Ø providing a fuel gas supply from a point in the topside oil and gas process which offers a minimum range of fuel gas combustion parameters, e.g. calorific value, etc. Ø providing a fuel gas supply from a point in the topside oil and gas process which offers minimum concentrations of sulphurous compounds – to minimise SO2 formation Ø operating multiple generator or compressor sets at load points which minimise pollution Ø optimising the maintenance and refurbishment programmes Ø optimise and maintain inlet and exhaust systems in a way that keeps the pressure losses as low as possible Ø optimise the process in order to minimise the mechanical power requirements and pollution Ø utilisation of gas turbine exhaust heat for platform heating purposes.	

Aspect of BAT	BAT	Status at Installation
	Modern ‘diesel’ engines are available with high pressure fuel injection controlled by electronics. Additionally, optimised combustion chambers and portings have been developed. This technology can result in increased fuel economy, reduced NO_X and other gaseous emissions and reduced smoke, particularly during acceleration and start-up. Where available, it represents the BAT for minimising emissions such as SO_2 and NO_X. To reduce the environmental impact of offshore engines, the following measures are part of the BAT conclusion: o for new engines, selecting diesels which achieve both high thermal efficiency and a low emissions spectrum o where process gas is used as fuel, providing a supply from a point in the topside process which will offer minimum emissions of, e.g. SO_2. For liquid distillate fuels, preference should be given to low sulphur types o for larger diesels, considering gas fuelling with a ‘ torch oil’ ignition charge o optimising injection timing o operating multiple generator or compressor sets at load points which minimise pollution o optimising maintenance and refurbishment programmes.	

Aspect of BAT	BAT	Status at Installation
	Low NO_X burners are available for many gas fired heaters, boilers and furnaces. This represents BAT for minimising NO_X, although the effect and trade off with fuel consumption must be evaluated. Other measures to increase the energy efficiency of offshore installations and thus to reduce the emissions per unit of energy used, such as the application of CHP plants, are part of the BAT conclusion. Techniques that assist the optimised use of equipment such as those based on operational monitoring approaches are BAT. In this case, the gas turbine is 'baselined', and predictive software is used to calculate the emissions. This software may also be used to indicate to the offshore operation personnel the optimum operating point(s) for single or multiple turbine installations. Such systems do not remove the need for emission compliance checks, but may assist personnel to operate the overall combustion system more efficiently. Other techniques, like PEMS (parametric emission monitoring system) are BAT for both new and existing combustion installations operating offshore. The system offers cost effective solutions for emission monitoring and calculating the emissions. In addition it can also be used to optimise the combustion processes and maintenance schedule of gas turbines.	

Aspect of BAT	BAT	Status at Installation
	Power integration of multiple fields is BAT and, where applicable, needs to be decided on a platform by platform and field by field basis.	

[1] There was a split view from industry about the efficiency measures applied to CCGT plants, because the proposed measures will only have a marginal improvement of the total combined cycle efficiency. It should be noted that improvements of the gas turbine efficiency may result in a decrease of efficiency of the steam cycle. Therefore, the improvement of efficiency of the total cycle will be less than the improvement of the efficiency of the gas turbine only. Based on the above given rationale, industry is of the opinion that the proposed measures shall not be incorporated in the final draft of the BREF LCP.

[2] There was a split view from industry about the efficiency measures applied to CCGT plants, because the proposed measures will only have a marginal improvement of the total combined cycle efficiency. It should be noted that improvements of the gas turbine efficiency may result in a decrease of efficiency of the steam cycle. Therefore, the improvement of efficiency of the total cycle will be less than the improvement of the efficiency of the gas turbine only. Based on the above given rationale, industry is of the opinion that the proposed measures shall not be incorporated in the final draft of the BREF LCP.

[3] A split view was declared by industry saying that in the case of combined cycles, the HRSG has to be modified, which means dismantled and retrofitted to enable the incorporation of an SCR.
This will increase the already high investments of SCR. Furthermore, the operation and maintenance costs of an SCR are relatively high, therefore, SCR is not cost effective for existing combined cycles. Industry also declared that, in the case of simple cycle gas turbines, SCR is not cost effective, because
a) the gases have to be cooled down. This requires an additional cooler to reduce the gas temperature to a level to enable the SCR to operate. This cooler will increase the already high investments and operational costs, and
b) simple cycle gas turbines in Europe are peak load plants, which run in emergency cases only. The high investment, operation and maintenance costs make the implementation of an SCR in a gas turbine economically unviable.

Figure 22:

Material	Environmental effect	BAT
Natural gas	Fugitive emissions	∞ using fuel gas leak detection systems and alarms.
	Efficient use of natural resources	∞ using expansion turbines to recover the energy content of the pressurised fuel gases ∞ preheating the fuel gas by using waste heat from the boiler or gas turbine
Pure liquified ammonia (if used)	Health and safety risk according to ammonia	∞ for handling and storage of pure liquified ammonia, pressure reservoirs for pure liquified ammonia >100 m^3 should be constructed as double wall and should be located subterraneously; reservoirs of 100 m^3 and smaller should be manufactured including annealling process ∞ from a safety point of view, the use of an ammonia-water solution is less risky than the storage and handling of pure liquefied ammonia.

Table 7.34: BAT for the supply and handling of gaseous fuels

Figure 23:

Plant type	Electrical efficiency (%)		Fuel utilisation (%)	Remarks
	New plants	Existing plants	New and existing plants	
Gas turbine				
Gas turbine	36 – 40	32 – 35	-	
Gas engine				
Gas engine	38 – 45		-	
Gas engine with HRSG in CHP mode	>38	>35	75 – 85	The wide range of energy efficiency in CHP plants is very much dependent upon the specific situation and the local demand of electricity and heat
Gas–fired boiler				
Gas–fired boiler	40 – 42	38 – 40		
CCGT				
Combined cycle with or without supplementary firing (HRSG) for electricity generation only	54 – 58	50 – 54	-	
Combined cycle without supplementary firing (HRSG) in CHP mode	<38	<35	75 – 85	The wide range of the electrical and energy efficiency of CHP plants very much depends on the specific local demand for electricity and heat. By operating the CCGT in the CHP mode, the energy efficiency includes the amount of the electrical efficiency and should always be seen together to achieve the best overall exergetic efficiency.
Combined cycle with supplementary firing in CHP mode	<40	<35	75 – 85	

Table 7.35: Efficiency of gas-fired combustion plants associated to the use of BAT (based on ISO conditions)

Figure 24:

Plant type	Emission level associated with BAT (mg/Nm³)		O_2 level (%)	BAT options to reach these levels	Monitoring
	NO_x	CO			
Gas–fired boilers					
New gas–fired boilers	50 – 100[1]	30 – 100	3	Low-NO_x burners or SCR or SNCR	Continuous
Existing gas–fired boiler	50 – 100[2]	30 – 100	3	Low-NO_x burners or SCR or SNCR	Continuous
CCGT					
New CCGT without supplementary firing (HRSG)	20 – 50	5 – 100	15	Dry low-NO_x premix burners or SCR	Continuous
Existing CCGT without supplementary firing (HRSG)	20 – 90[3]	5 – 100[5]	15	Dry low-NO_x premix burners or water and steam injection or SCR if the required space has already been forseen in the HRSG	Continuous
New CCGT with supplementary firing	20 - 50	30 – 100	Plant spec.	Dry low-NO_x premix burners and low-NO_x burners for the boiler part or SCR or SNCR	Continuous
Existing CCGT with supplementary firing	20 – 90[4]	30 – 100 [5	Plant spec.	Dry low-NO_x premix burners or water and steam injection and low-NO_x burners for the boiler part or SCR if the required space has already been foreseen in the HRSG or SNCR	Continuous

	Industry claimed that the ranges need to be changed to:
1,2	upper end to 120 mg/Nm^3
3	80 – 120 mg/Nm^3
	because gas fired boilers depend on the firing temperature, the type of burners, the size of the boiler, the heating surfaces, the air temperature and the load factor of the power plant. In case the boiler is equipped with flue-gas recycling it is possible to decrease the NO_x emission to a level of 100 mg/Nm^3. However, retrofitting an existing boiler with flue-gas recycling will require high (not cost effective) investment costs.
2	One Member State proposed that for existing gas fired boilers, which have been converted recently from heavy fuel oil to burn natural gas, after full modification with primary measures to reduce NO_X (flue-gas recirculation, fuel and air staging), the BAT achievable emission levels should be modified to 10 – 150 mg/Nm^3.
4	Industry mentioned that due to the large wall burners which are used for supplementary firing of the HRSG the NO_x emission of the gas turbine may increase in 10 – 20 mg/Nm^3. This increase is caused by local high temperatures of these duct burners. Therefore, the level associated with BAT in the case of supplementary firing should be 80 – 140 mg/Nm^3.
3,4	One Member State claimed that the upper BAT levels for CCGT plants >50 MW cannot be over 80 mg/Nm^3 and for plants over 200 MW the upper BAT level should be below 35 mg/Nm^3 because these levels have already been fixed as ELVs in the Member State in question.
5	One Member State claimed that the upper levels of CO for CCGT plants >50 MW cannot be over 35 mg/Nm^3 because this level has already been fixed as ELV in the Member State in question.

Table 7.37: BAT for the reduction of NO_X and CO emissions from some gas-fired combustion plants

Figure 25:

Plant type	Emission level associated with BAT (mg/Nm^3)		O_2 level (%)	BAT options to reach these levels	Monitoring
	NO_x	CO			
Gas turbines					
New gas turbines	20 - 50	5 – 100	15	Dry low-NO_x premix burners (standard equipment for new gas turbines) or SCR	Continuous
DLN for existing gas turbines	20 - 75	5 - 100	15	Dry low-NO_x premix burners as retrofitting packages if available	Continuous
Existing gas turbines	50 – 90 (1)	30 - 100	15	Water and steam injection or SCR	Continuous
Gas engines					
New gas engines	20 – 75 (2)	30 – 100 (3)	15	Lean burn concept low-NO_x tuned and oxidation catalyst for CO or SCR and oxidation catalyst for CO	Continuous (4)
New gas engine with HRSG in CHP mode	20 – 75 (2)	30 – 100 (3)	15	Lean burn concept low-NO_x tuned and oxidation catalyst for CO or SCR and oxidation catalyst for CO	Continuous (4)
Existing gas engines	20 – 100 (2)	30 – 100 (3)	15	Low-NO_x tuned	Continuous (4)

1	Industry and one Member State claimed that the amount of water or steam that can be injected in an existing gas turbine is limited. Injection high amounts of water or steam may lead to damage of gas turbine components. Therefore, they claimed that the range needs to be substituted by 80 – 120 mg/Nm^3.
2	Industry claimed that these ranges are not according the BAT approach. The reason given was that the range given as BAT is the same as the one given by the American LAER approach (lowest achievable emission rate). Industry proposed an environmental quality driven approach taking the surrounding (urban/other areas) into account. That means that small plants situated in rural areas shall have leaner BAT levels than large plants in city areas. Industry claimed that levels of 190 mg/Nm^3 (15 % O_2) in gas mode represented the overall emission optimum considering the lowest possible fuel consumption and unburned gaseous emission of CO, VOC etc. for spark-ignited (SG) and dual fuel engines (DF) in gas mode.
3	Industry mentioned that due to technical reasons (fuel composition impact), CO should be at a level of 110 – 380 mg/Nm^3 (15 % O_2) in order to represent BAT.
	Another Industry representative claimed that the ranges should be changed to:
2	90 – 190 mg/Nm^3
3	100 mg/Nm^3 because the emission levels associated with BAT for gas engines are only applicable for burning natural gas and not for renewable gases like landfill gas, biogas or purification gas. Moreover, they claimed that such levels would create disadvantages for competitiveness in the market for such gases.
4	One Industry representative proposed charging to discontinuous monitoring because continuous engine emission monitoring is not common practice for stationary internal combustion engines.

Table 7.36: BAT for the reduction of NO_X and CO emissions from some gas-fired combustion plants

Part 5. Co-combustion of waste and recovered fuel
Not applicable for the proposed expansion project.