EUROMOT

Revision of the Gothenburg Protocol - Consequences for Stationary Engines

(Including Executive Summary)

The Euromot Position (revised)

As of 02 December 2009

EUROMOT

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ENGINES IN SOCIETY

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EUROMOT is the European Association of Internal Combustion Engine Manufacturers. It is committed to promoting the central role of the IC engine in modern society, reflects the importance of advanced technologies to sustain economic growth without endangering the global environment and communicates the assets of ICE power to regulators worldwide. For almost 20 years it has supported its members, consisting of national associations and companies from all over Europe and abroad, by providing expertise and up-to-date information and by campaigning on their behalf for internationally aligned legislation.

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EXECUTIVE SUMMARY

EUROMOT represents the manufacturers of stationary internal combustion engines and power plants, which fall under the scope of the Gothenburg Protocol, part of the Convention on Long-Range Transboundary Air Pollution (LRTAP).

In this position paper, EUROMOT would like to make comments and recommendations regarding the Revision of the Gothenburg Protocol and especially regarding the three different options for emission limit values (ELVs) with flexibility options as were proposed by the Expert Group on Techno-Economic Issues (EGTEI) for the Technical Annexes.

In our opinion, the new Protocol should be based on an environmental quality need approach taking environmental and economical aspects into consideration in a balanced way. The parties to the Convention on LRTAP comprises a very heterogeneous group of countries with very different conditions and needs regarding their economical situation, ambient air quality and existing infrastructure – just to mention a few aspects. This makes it necessary to include certain flexibility measures and to make clever choices (e.g. a regional step-wise approach) regarding the emission options in order to make the Gothenburg Protocol more technically and economically feasible in comparison to the current Protocol.

Regarding the limits for Stationary Engines, this environmental quality need approach should be put into practice by applying the three ELV options as follows:

- The use of the strictest ELV 1, which is close to the lowest achievable emission rate and places high demands on the existing infrastructure as well as cost, should be restricted only to degraded air sheds.

- To reach the level of ELV 2, technically demanding solutions are needed. ELV 2 should be applied in polluted industrialized and urban areas with a good existing infrastructure.

- ELV 3, as supported by EUROMOT, should be the preferred option for countries in an economic transition, in general for areas with a restricted existing infrastructure (this is especially the case in remote areas or islands) and smaller/medium sized plants in rural air sheds.

Choosing the regional approach, would offer a cost-effective way of reducing emissions with great benefits to the environment while at the same time allowing more countries to implement the Gothenburg Protocol.

The following text gives you more detail on the different proposed emission & new flexibility options and EUROMOT's opinion on these.

BACKGROUND

The current Gothenburg Protocol which entered into force 17 May 2005 also contains NOx emission limits for new stationary engines in Annex V table 4. Over the years, the engine industry has shown in a number of position papers and publications that the current emission limits for new stationary engines go *" [..]* ***beyond BAT, not technically and economically sound*** *and* ***not improving energy efficiency & usage of renewable fuels*** *"* /1, 8/, etc.

UNECE consists of 56 member states that are located in North America, Europe and wide parts of Asia. Several countries have claimed about their disability to fulfil the current limits in the technical annexes of the Gothenburg Protocol and as of 2 September 2009 only 25 countries (about half of all UNECE member states) had fully ratified the Protocol. In the current Protocol (article 3) is inbuilt a flexible mechanism "different emission reduction strategy"; by fulfilling the emission ceilings in Annex 2 of the Protocol a Party can deviate from the limit values in Annexes IV, V and VI, but more flexibility options seem to be needed in the Protocol in order to make it feasible.

In article 3 of the Gothenburg Protocol is also stipulated that the updating of the Protocol should start "no later than two years after entry into force of the Protocol". In beginning of 2008, the stationary engine sub-group within EGTEI was founded for the updating work of the stationary engine NOx emission limits. EUROMOT participated actively in all sub-group meetings during 2008 and 2009 (see sub-group webpage at /2/). Some proposals of EUROMOT after the first meetings in order to increase flexibility of the Protocol are presented in document /7/.

End of May 2009, the "Guidance document for New Stationary Engines" was finalized by the sub-group and sent to the UNECE secretariat. This document issued by UNECE can be found at /3/. Emission options proposed based on the Guidance document can be found in the "Draft Revised Technical Annex V" /4/ on pages 7 - 8 and 11 - 16. In the "Draft Revised Technical Annex V" several emission options ELV1, ELV2, ELV3 and new flexibility options are proposed for the stationary engine plant in order to make more ratifications possible.

Stationary engines provide many advantages e.g. a sustainable & peak demand management (which starts to be a challenge in many countries around the world) i.e. an optimal power generation mix in the grid can be achieved. Usage of high efficiency/high flexibility/distributed stationary engine power technology in a generation mix together with base load power plants will lead to significant benefits on a national **level such as increase of energy efficiency and thus lower total CO2 emissions**, less transmission network investments and losses, etc.

EMISSION & FLEXIBILITY OPTIONS IN "DRAFT REVISED TECHNICAL ANNEX V"

Emission options ELV1, ELV2 and ELV 3 in Annex V are listed in ANNEX 1. Below the meaning of the different options ELV 1 – 3 and the new flexibility mechanisms proposed is briefly explained.

Emission Options

ELV 1

ELV1 is a demanding but technically feasible option (if fuel of sufficient good quality and needed reagent for SCR is available) with the objective of achieving a high level of NOx reduction. The

ELV1 is based on a value between the lower and upper BAT AEL from the EU LCP BREF /5/ (where it is available). Cost impact is not taken into consideration.

SCR aspects:

SCR (Selective Catalytic Reaction) is an efficient technology but has technical (e.g. infrastructural) and economical constraints (please see page 360 /5/). This option assumes that a good infrastructure exists (**availability of suitable fuels, reagents**, spare parts, etc.) and focuses on reducing one plant emission component only (namely NOx) other emission impacts (CO_2, CO, VOC; NOx) such as secondary emissions caused from reagent transportation by trucks and production are not considered.

Emission limits:

For all gas/liquid fired applications the only alternative to fulfil the set NOx-limits are usage of SCR with a high efficiency. The driving force for application of SCR is often the need to improve local air quality especially in severely degraded air-sheds to comply with the high reduction targets of NOx emissions.

Note for meeting this emission option (ELV1) the availability of good quality fuel is a pre-requisite, e.g. non natural gases are often not of a good quality! Part load performance of lean burn gas engines pose also a risk for destroyed/burned SCR catalysts.

Proposed emission limits of the spark ignited (SG) and dual fuel (DF) engines (> 1 MWth unit) in gas mode are close to the lower end of the EU LCP BREF BAT span (**note** made for big plants > 50 MWth!) /5/. **These limits are also significantly lower than the ELVs currently discussed for big (≥ 50 MWth) lean burn gas engine plants in the new EU Industrial Emissions Directive!** Only one EU Member State has chosen to take all possible reduction measures for different sectors (including stationary engines) in order to be able to comply with the NOx ceiling set in the National Emission Ceilings Directive (NECD, 2001/81/EC) and is expected to implement national emission limits close to ELV 1 in the near future.

For (CI) **diesel** and **liquid** mode DF engines no BAT spans were set in the EU LCP BREF document. Regarding liquid fired diesel engines the EU LCP BREF stated in paragraph 6.5.5.4 *"[..] as a result SCR is part of BAT, but no specific emission levels are associated with BAT in a general case .."* and in UNECE document /3/ *"A limitation for the applicability of SCR is given for diesel engines, which need to be operated in varying loads", "[SCR] cannot be seen as BAT for engines with a frequent load variation due to technical constraints [..]".* The proposed NOx limit for the DF engine is for a long time main operation in liquid mode. In case of the gas fired (CI) diesel engine a similar approach should be followed as for the DF engine. Proposed emission levels are close to very strict emission limits for diesel engines set in countries with existing good infrastructure such as Belgium, Netherlands, France (**NB** for > 100 MWth plant) and Germany.

Regarding the flexibility options for Technical Annex V: ELV1 contains flexibility options 1 and 2 presented later in this text. In below chapter "Others" sudden gas interruption derogation and efficiency bonus items are further explained. These proposed "new flexible options", sudden gas supply interruption derogation and efficiency bonus option are important mechanisms in order to make the emission limits more feasible. Nevertheless, option ELV1 remains very demanding. In order to be achievable, a good infrastructure has to exist and expensive, sophisticated secondary efficient abatement technique has to be installed. The cost impact of the abatement option is not taken into consideration.

For this reason, EUROMOT recommends to restrict the application of ELV1 only to degraded airsheds.

ELV 2

ELV2, while technically demanding, pays greater attention to the costs of the measures for achieving reduction. ELV2 is a value based on the upper BAT AEL from the EU LCP BREF /5/ (where it is available).

Emission limits:

Proposed emission limits of the spark ignited (SG) and dual fuel (DF) engines in gas mode are achievable with a primary abatement measure namely advanced lean burn. "Advanced lean burn" will lead to higher emissions of unburned gaseous components such as CO, HC, lower flue gas temperature (detrimental for Combined Heat and Power (CHP) applications) and an increased fuel consumption (as a consequence also higher CO_2 emissions), i.e. not according to the IPPC (Integrated Pollution Prevention Control principle). Certain gas compositions (e.g. bio gases) will also set limitations, if the stipulated NOx-level for the SG-type engine is achievable or not due to possible fluctuations of the gas composition and contaminations (creation of deposits) which might influence combustor chamber dramatically within only a few operation hours. For the gas fired lean burn spark ignited (SG) and dual fuel (DF) engine types (> 1 MWth unit size) the limits are a mix of the EU LCP BREF document (**note** made for big > 50 MWth plants !) BAT range and "split views" by the industry (see table 7.36 /5/). NOx emission limits when comparing to national legislation for spark ignited (SG) engine is 50 % of the German federal limit and for the dual fuel (DF) engine in gas mode equal to German federal NOx- emission limit (TA-LUFT 2002) (but 50 % of the French Arrêté Ministeriel 2910 emission limit for a < 100 MWth plant).

For the **(CI) diesel engines and liquid mode DF** the only option to fulfil the proposed NOx limits are to use SCR (moderate – high efficiency). Some of the emission limit options for the liquid fired (CI) diesel engines have two alternatives (options); this is due to the cost aspect. A second (higher) limit option (now missing) is also recommended for the gas fired/light fuel oil (CI) diesel engines in order to be able to take the cost aspect more efficiently into account. The proposed NOx limit for the DF engine is for a long time main operation in liquid mode. In case of the gas fired diesel engine (CI) a similar approach should be followed as for the DF engine. The operation and maintenance cost (O&M) of a SCR system is mainly dependent of the consumed reagent (costly good quality urea or ammonia), the control system will adjust the reagent flow to the SCR based on the pre-programmed parameters and the measured engine loading/NOx outlet concentration, i.e. a stricter NOx-limit leads to higher reagent consumption and a higher O&M cost.

Proposed emission levels for diesel engines (depending on option) are close to countries with strict emission limits and good existing infrastructure such as France, Italy and Germany.

Regarding the flexibility options for Technical Annex V: ELV2 contains flexibility options 1 and 2 presented later in this text. In below chapter "Others" sudden gas interruption derogation and efficiency bonus items are further explained. These proposed "new flexible options", sudden gas supply interruption derogation and efficiency bonus option are important mechanisms in order to make the emission limits more feasible. Nevertheless, option ELV2 remains demanding.

Euromot recommends to restrict the application of ELV2 (higher emission options) to polluted industrialized/urban areas with a good existing infrastructure.

ELV 3

ELV 3 represents current good practices based on the legislation of a number of parties to the Convention or OECD.

- Spark ignited (SG) lean burn gas engines:
  - The lean burn principle representing BAT is used to keep the NOx-level at 190 mg/Nm^3 (15 % O_2), similar to law (TA-LUFT 2002) requirement in Germany. This emission level is also according to the IPPC (Integrated Pollution Prevention Principle) principle (optimized conditions): low fuel consumption and unburned gaseous emissions (CO, VOC, etc.) and high flue gas temperature (relevant for CHP applications).

- Dual fuel (DF) engine in gas mode:
  - The lean burn principle representing BAT is used to keep the NOx-level at 380 mg/Nm^3 (15 % O_2), similar to emission law in France (< 100 MWth plant). The Portuguese NOx-limit is also close by /13/. This emission level is also according to the IPPC (Integrated Pollution Prevention Principle) principle (optimized conditions): low fuel consumption and unburned gaseous emissions (CO, VOC, etc.) and high flue gas temperature (relevant for CHP applications).

- Liquid fired DF and liquid/gas (CI) fired diesel engines:
  - DF-type (liquid):
    - Optimized low-NOx rated engine. NOx emission 2000 mg/Nm^3 (15 % O_2) at optimized fuel consumption, lower NOx-level of 1850 mg/Nm^3 can be reached by use of injection retard at a higher fuel consumption. Emission limit minimum requirement as used by OECD /6/. Many countries participating in the UNECE work do not have emission legislation for stationary engine plants and therefore the minimum requirement as used by OECD is chosen. Public development financial institutions such as OECD Export Credit Agencies and European Development Finance Institutions and leading banks worldwide have publicly referenced the use of the IFC performance standards in which EHS Guidelines /9/ and /10/ are integrated.
  - (CI) Diesel Engine:
    - (CI) diesel (Medium/Slow Speed), 5- 20 MW: NOx level of 1600 mg/Nm^3 (15 % O_2) can for medium speed four stroke engine types be fulfilled by a primary method as the latest design Low-NOx generation < 400 mm cylinder bore engine at optimized fuel consumption. For some other engine types a wet method with increased fuel consumption or SCR is the option. Emission limit minimum requirement as used by OECD /6/, for more information see above. In some EU countries like UK/11/, Portugal /13/ and Finland /12/ about similar NOx-limits are applied to plants < 50 MWth.

      A NOx-level of 1300 mg/Nm3 is a future option for some engine types, (NOx level measured in some first laboratory trials). **BUT further big development efforts which will take years are needed before commercial release is possible**.

- (CI) diesel (Medium/Slow Speed), > 20 MW: NOx level option of 1850 mg/Nm^3 (15 % O_2) can be fulfilled by a primary method as the current design Low-NOx tuned ≥ 400 mm cylinder bore engine by injection retard (for medium speed engines), for a two stroke engine some wet method both with an increased fuel consumption is an alternative. Future four stroke and two stroke engine generations are expected to reach NOx-level without an increased heat rate. Emission limit minimum requirement as used by OECD /6/, for more information see above.

  NOx-level option of 750 mg/Nm^3 can only be reached by using SCR (note infrastructure demand); this is a NOx-emission limit as per TA-LUFT 1986 for diesel engines which has been used by several countries when setting national standards (e. g. Italy).

- (CI) diesel (high speed) > 5 MW: NOx level of 900 mg/Nm^3 (15 % O_2) can be fulfilled by a primary method. NOx level corresponds to US Tier 2 requirements for which engines are optimized. Engine design modifications are needed in order to reach the NOx-level of 750 mg/Nm^3 with an increase in fuel consumption.

According to Euromot ELV 3 (HIGHER VALUE) represents the preferred way especially for smaller/medium size plants in rural, remote (islands, etc.) areas in EU and in general for countries in an economic transition.

<u>New proposed flexible mechanisms</u>

1. Existing infrastructure (for options ELV1 and ELV2)

For certain geographical areas such as remote islands/other areas where the existing infrastructure is poor (commercial availability of good fuel quality [e.g. no gas, no low sulphur liquid fuel, etc.], reagents, etc. restricted) or application of a secondary abatement technique (such as SCR) is not feasible due to peak-load operation and varying loads of engines, a time limited transition period during which the upper ELV 3 limits are applied is granted.

2. “Grid stability plants” (for options ELV1 and ELV2)

For engines operating 500 - 1500 hr/year the upper ELV 3 limits are applied. It is expected that these kinds of plants will be needed due to the large increase in renewable energy production (e.g. wind and solar power) in order to stabilize the electrical grid (to secure a sustainable & peak demand management). These power plants will typically have frequent start-up/shut-down periods and operate on varying loads (making usage of SCR infeasible).

Others (for all options)

- Sudden unforeseen gas supply interruption: for a limited time period **(NOT TO EXCEED 10 DAYS EXCEPT WHERE THERE IS AN OVERRIDING NEED TO MAINTAIN ENERGY SUPPLIES)** a derogation from emission limits when operating on back-up fuel.

- Emission NOx bonus: efficient engines consume less fuel and thus generate less CO_2 , and since higher efficiency of the engine can lead to higher temperatures and thus higher NOx concentrations in the flue gas, a bonus formula [ELV *actual efficiency/reference efficiency] could be justified *

CONCLUSION

The stationary engine plant contributes **according to EU statistics less than 0.26 % of the total NOx emissions in Europe (EU 15 area)** /8/. According to Annex IV of the IPPC Directive /14/: "*Considerations to be taken into account generally or in specific cases **when determining best available techniques**, as defined in Article 2 (11), bearing in mind the likely costs and benefits of a measure* and *… the consumption and nature of raw materials (including water) used in the process and their energy efficiency*".

Thus, we believe that **ELV 1** – which focuses solely on the reduction of a single pollutant namely NOx and does not consider the impact of other emissions and costs – does not represent BAT or the IPPC approaches. We consider this emission option to be closer to a "LAER" (Lowest Achievable Emission Rate) used in degraded air sheds ("nonattainment" in US).

Furthermore, we observe following: when comparing e.g. emission NOx-limits for > 1 MWth unit gas engines in the UNECE document /4/ to a **big gas turbine single > 50 MWth unit we note that gas engines from a very small size have a stricter NOx-limit of 35 mg/Nm^3 (15 % O_2) compared to the big gas turbine unit limit of 50 mg/Nm^3 (15 % O_2).** Note also that the EU proposed Industrial Emissions Directive for big plants (≥ 50 MWth) stipulates leaner NOx limits than what is proposed here for > 1 MWth engine units! **Liquid/gas fired boiler plants < 50 MWth are not regulated either but stationary engines already from a small (1 .. 5 MWth depending on engine type and fuel) unit size. Thus application of ELV 1 as universal limits would unjustifiable discriminate the stationary engine technology and lead to an unfair distortion in the competition with other technologies.**

ELV 2 takes cost of the emission abatement more into account, especially the higher limit options are closer to BAT (Best Available Technique) approach for polluted industrialized/urban areas with a good existing infrastructure.

ELV 3 is BAT especially for areas with a restricted existing infrastructure (such as remote areas or islands) and smaller/medium size plants in rural air sheds in EU and in general for economies in an economic transition. It should be noted that this option (higher values) is according to limits used by several EU countries today and to the OECD minimum approach.

EUROMOT supports an environmental quality driven approach which takes into account environmental, technical and economical aspects. In our opinion ELV 3 (HIGHER VALUE) represents the preferred way especially for smaller/medium size plants in rural, remote (islands, etc.) areas in EU and in general for countries in an economic transition. Polluted industrial/urban areas could apply the ELV 2 option (higher values) and by this be close to a BAT approach. In our

opinion, ELV 1 should only be applied in “special” areas with a degraded airshed where an overriding need to improve the air quality exists and the cost aspect is considered less important (similar to a “LAER approach” in non attainment areas in US).

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SOURCES

/1/ Euromot position: Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to abate Acidification, Eutrophication and Ground Level Ozone, April 2003, at http://www.euromot.org/alfresco/d/d/workspace/SpacesStore/b4ebe3ed-d1d5-410b-81ce-05a27985ff0e/UNECE%20CLRTAP%20ABC%20analysis%202003%2004.pdf

/2/ EGTEI Stationary Engines Sub-group webpage at http://www.citepa.org/forums/egtei/egtei_Stationary_engines.htm

/3/ New stationary Engines" Guidance document can be found at: http://www.unece.org/env/lrtap/WorkingGroups/wgs/docs45th%20session.htm, click on "Other and Informal Documents" button and then click on "Draft Guidance document on control techniques for emissions of Sulphur, NOx, VOCS, dust from stationary sources" and then go open document 7-42 and you will find it.

/4/ http://www.unece.org/env/documents/2009/EB/wg5/wgsr45/ece.eb.air.wg.5.2009.18.e.pdf

/5/ EU LCP BREF, July 2006 at ftp://ftp.jrc.es/pub/eippcb/doc/lcp_bref_0706.pdf

/6/ “Recommendation on Common Approaches on Environment and officially Supported Export Credits”, 2007.

/7/ Euromot Proposal for the proceedings in the revision process of the technical annexes in the Gothenburg Protocol, 2008 at http://www.euromot.org/alfresco/d/d/workspace/SpacesStore/6c02a43e-7266-4609-8aa3-97a4acf2a724/UNECE%20CLRTAP%202008%2006.pdf

/8/ Protocol to the 1979 Convention on Long-Range Transboundary, Air pollution to Abate Acidification, Eutrophication and ground Level Ozone – Alternative Reduction Strategy Need in Order to reach BAT, 2005 at http://www.euromot.org/alfresco/d/d/workspace/SpacesStore/d5f61e8f-49c0-402d-83a9-2431302e6ab5/UNECE%20CLRTAP%202005%2005.pdf

/9/ IFC General EHS Guidelines, 2007 at http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_GeneralEHS/$FILE/Final+-+General+EHS+Guidelines.pdf

/10/ IFC Thermal Power Plants EHS Guidelines, 2008 at http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_ThermalPower/$FILE/FINAL_Thermal+Power.pdf

/11/ UK “Environmental Protection Act 1990, part 1 (1995 revision), PG 1/5 (95): Secretary of state’s Guidance-compression Ignition Engines, 20-50 MW Net rated Thermal input

/12/ Best Available Techniques (BAT) in Small Applications 5 – 50 MW Combustion Plants in Finland at http://www.ymparisto.fi/download.asp?contentid=3708&lan=fi

/13/ Portugal: Order No 677/2009 dated June 23 2009

/14/ IPPC Directive 96/61/EC at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31996L0061:EN:HTML

ANNEX 1

Table 1:

Different NOx emission options for new stationary engines, NG=Natural Gas, HFO=Heavy Fuel Oil, LFO= Light Fuel Oil. Note derogation (e) has been added in the table to the diesel in NG mode!

Engine Type, Power, Fuel Specification	ELV1 (a),(b),(c) mg/Nm^3(dry 15 % O_2)	ELV 2 (a),(b),(c) mg/Nm^3(dry 15 % O_2)	ELV 3 (a) mg/Nm^3(dry 15 % O_2)
Gas engines>1 MWth Spark-ignited, all gaseous fuels	35	95	190
Dual fuel engines > 1 MWth			
All gaseous fuels	35 (e)	190 (e)	380 (e)
All liquid fuels			
1 – 20 MWth	225	750	[1850] [2000]
> 20 MWth	225	450	[1850] [2000]
Diesel engines >5 MWth Slow (< 300 rpm) / Medium (300-1200 rpm) speed			
5 – 20 MWth			
HFO & bio-oils	225	[450] [750]	[1300] (d) [1600]
LFO & NG	150 **(e)**	190 **(e)**	[1300] (d) [1600] **(e)**
> 20 MWth			
HFO & bio-oils	190	[225] [450]	[750] [1850]
LFO & NG	150 **(e)**	190 **(e)**	[750] [1850] **(e)**
High speed(> 1200 rpm)	[130] [150]	190	[750] [900]

(a) These values do not apply to engines running less than 500 hours a year

(b) Where SCR cannot currently be applied [certain geographical areas, like remote islands] or the unavailability of good fuel or raw material quality not guaranteed, a transition period of [x] yrs can be granted. During this transition period upper value of ELV 3 can be applied.

(c) A flexibility option for engines running between 500 to 1500 operational hours per year is to apply [the upper value of ELV 3] [achievable with primary measures]

(d) Limit of primary measures under development (Currently only first laboratory tests done on some engine type)

(e) A derogation from the obligation to comply with the emission limit values can be granted to combustion plants using gaseous fuel which have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be

equipped with a waste gas purification facility. The exception time period shall not exceed 10 days except there is an overriding need to maintain energy supplies.

[Since engines running with higher energy efficiency consume less fuel and emit these for less CO_2 and since a higher efficiency of the engines can lead to higher temperatures and therefore to higher NOx concentrations in the flue gases, a NOx bonus using the formula [ELV * actual efficiency / reference efficiency] could be justified[*]]

[*] See e.g. UK "Environmental Protection Act 1990, part 1 (1995 revision), PG 1/5 (95): Secretary of state's Guidance-compression Ignition Engines, 20-50 MW Net rated Thermal input /11/ (prescribes efficiency correction from 40 %)