Euromot proposal for the proceeding in the revision process of the technical annexes in the Gothenburg Protocol

The Euromot Final Position

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EUROMOT

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ENGINES IN SOCIETY

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1 Background

By December 2009 the subgroup “Stationary Engines” that works under the umbrella of EGTEI (Expert Group on Techno-Economic Issues) and WGSR (Working Group on Strategies and Review) of the UNECE (United Nations Economic Commission for Europe) shall evaluate and make a proposal for revised emission limit values (ELV) for new stationary internal reciprocating engines.

UNECE consist of 56 member states that are located in North America, Europe and wide parts of Asia. The Gothenburg Protocol is one of eight protocols under CLRTAP (Convention on Long-Range Transboundary Air Pollution) and is the only Protocol under United Nations that deals with emission from stationary engines.

Several member states have claimed about their disability to fulfil the current limits in the technical annexes of the Gothenburg Protocol. At the moment **only 26 member states** (and thus less than 50% of all UNECE member states) have fully ratified the Gothenburg Protocol.

Euromot unifies the knowledge and technical expertise of the worldwide stationary engine industry. The following text shows and summarises different political options based on technical possibilities, market conditions, infrastructural conditions and the information exchange in the subgroup stationary engines within EGTEI.

The aim of this paper is to support the political members within WGSR and EB (Executive Body) and give a neutral view of possible options for the revision of the technical annexes of the Gothenburg Protocol.

2 Outcomes of first subgroup meeting in Frankfurt on 27 February 2008

During the meeting on 27 February 2008 the engine industry discussed with several representatives of European UNECE member states about the current status of the engine technology and about possible ELV:s for the revised annexes of the Gothenburg Protocol. The outcomes were:

- Engine industry (Euromot) highlighted that different engine types, boundary conditions such as different operation modes, available fuel types & qualities, existing infrastructure for reagents (such as urea/ammonia, etc. needed for emission reduction) and availability of educated service/operator personnel and spare parts have a big impact on the achievable emission levels of stationary engine plants.

- Engine industry presented emission levels achievable with primary and secondary abtement techniques at “best case conditions”. It was highlighted that the engines are often operated under severe (far from optimum) conditions due to local conditions such as varying existing infrastructures. As a consequence foulings on internal surfaces of the engines and on secondary abatement equipment might occur. Furthermore possible impurities in the fuels might also deactivate the catalysts used for emission abatement. These boundary conditions need to be considered when setting emission limits.

- Euromot showed that the whole group of renewable fuels (gaseous and liquid) and different efficient stationary engine plant configurations such as CHP (**C**ombined **H**eat and **P**ower), etc. are not covered with appropriate ELV that are based on cost-effective and practicable conditions.

- The current ELV (**E**mision **L**imit **V**alues) table in annex V of the Gothenburg Protocol is not appropriate for many different member states of UNECE based on the available financial and infrastructural conditions. The set ELVs are thus beyond BAT (**B**est **A**vailable **T**echniques).

3 Main concerns and assessement of the current ELV

Low NOx emission limit values (like proposed in general in the UNECE Gothenburg Protocol for the stationary diesel and gas engines) would result in drastically increased power plant investment and electrical energy production costs e.g for the diesel engines secondary exhaust gas cleaning, such as a SCR (**S**elective **C**atalytic **R**eduction) catalysts will be necessary. Bigger stationary engines are usually operated on economic fuels such as heavy fuel oils, fuel emulsions or refinery vacuum residuals. Additionally, a higher fuel price can be expected if fuel options are reduced or refined appropriately. If the consequence will be that, heavy fuel oil is taken out as one fuel option (only one from a lot of fuel options within the area of UNECE) this will be contra productive to fuel diversification which is the only tool to combat fuel price volatility and energy security. Furthermore, political stability might be threatened with the rebirth of government subsidies to cover the higher electricity prices.

Stationary engine plants have a good efficiency at part loads, a fast load response (a typical load application rate is 12.5 % of MCR (**M**aximum **C**ontinuous **R**ating) per minute compared to 5 % MCR/minute for an oil/coal fired boiler plant) and consist usually of several engine units. A stationary enine plant has therefore an optimal matching at a high efficiency of different loading demands. In some western countries such as in USA stationary engine plants has thus become popular for grid stability applications during the high energy need hours of the week days and thus costly investments in transmission lines can be avoided or postponed.

Generally speaking, the smaller the power plant, the higher the additional costs for emissions control will also be. The current ELV might postpone or even cancel needed investments in new efficient and reliable power plants and old, inefficient, unreliable power plants, producing high amounts of emissions will thus be operated longer than forecasted. As a consequence more frequent energy black-outs in the electrical grid due to shortage of capacity at peak hours might start to occure creating difficulties for the economical and social development of the society.

Alternative technologies might be gas fuel based boiler or gas turbine thermal plants, hydropower or big coal power plants. However, these fuels are not abundant or not available in all regions e.g. in remote areas and islands in the different countries. Fuel flexible high efficient stationary engines are however well suited for base power load production. Countries and/or areas that are not able to switch to such alternatives might have to suffer of higher energy production costs.

Coal power plants work on an efficiency level which is lower compared with stationary engines, that means more fuel is needed and thus more CO_2 is produced from a coal fired plant per produced electrical kilowatthour of energy. The contribution of the high efficiency of stationary engine power plants to reduce CO_2 green house gases is not honored by the current ELV in the annex of the Gothenburg Protocol. Only one emission namely NOx seems to be in focus without considering the whole picture. On the contrary engine tunings increasing the fuel consumption (and decreasing the efficiency with increased CO_2 emisions) will be needed for the lean burn spark ignited gas engine in order to comply with the set NOx-limit, all other engine types will have to be equipped with high cost SCRs. This is definitely **not** according to the **I**ntegrated **P**ollution **P**revention **C**ontrol (IPPC) principle (where amongst all: technical and economical feasibilities, energy efficiency, other emissions such as CO, HC, CO_2, etc. are aspects also to be considered). An efficiency bonus in general, including combined heat and power (CHP), other efficient and innovative systems could avoid jeopardizing and instead promote the efforts to reduce greenhouse gas emissions in the context of the Kyoto Protocol (see our proposal in annex 2).

Biofuels offer a good alternative to produce electric energy in a CO_2 neutral way and is a mean to increase local employment. Growing the own fuel will thus support the local economy and reduce the fossil fuel dependency and price volatility. In the actual annex of the Gothenburg Protocol no differentiation between standard fossil and bio fuels is made. To balance the higher NOx emissions, caused by the natural nitrogen and oxygen contents in such fuels, and to honor the positive impact on CO_2 emissions, NOx bonuses should be granted to biofuels (see proposal in annex 2).

Due to the fragile political, economical and ecological impacts the following suggestions are to be considered:

- Some of the western world countries have in the past reduced emissions consecutively by adding incentives to the power producers. For many of the countries in the UNECE area incentives will have to come from outside as some UNECE member states cannot otherwise afford to implement the limits.
- A distinction is to be made between the sizes of the power generation facilities !

  In the UNECE Gothenburgh Protocol only big (> 50 MWth) competing prime mover technologies such as boiler plants and single gas turbine units have emission limits, smaller sizes not. However relatively small gas (> 1 MWth) and diesel engine (> 5 MWth) units have strict NOx-limits, of which some seem to be identical to those in force for big stationary engine plants in France (> 100 MWth). According to the EU IPPC Directive, combustion plants > 50 MWth shall apply BAT. Distributed energy, cannot afford excessive strict emission limits with a relatively high cost on emissions control; large remote boiler, etc. power plants alone might result in destabilized grids at peak hours. In order to support highly efficient and clean energy we suggest taking the total emissions into account. Utilizing the thermal energy of a power plant, the total efficiency can typically (dependent on the application) be doubled; thus, combined heat and power will decrease total emissions.
- Additionally, emissions trading within the local power community; offers incentives to reduce emissions by installing conventional units and green power (wind, bio, etc) in parallel. In order to conserve energy it will be allowed to produce the conventional and green power where it is most efficient; not necessarily at the same site.

4 Recommendations

- Many of the countries in the UNECE area do not still report their total emissions or even emissions from different sectors. It is often unknown what kind of emission legislation(s) (ground level concentration (GLC) in focus only and not stack emissions ?) exists in these UNECE countries, we therefore assume that (based on the assessment in chapter 3) in many cases old inefficient technologies are still operated in order to produce the needed energy. Probably a lot of old coal, HFO (**H**eavy **F**uel **O**il) and natural gas operated boilers are still used to produce this energy.
- As far above assumption is not disproved by the means that are described in the Gothenburg Protocol (regular emission reporting in order to overtake the data in the unilateral modelling work) we recommend to set minimum requirements as proposed by OECD ("Recommendation on Common Approaches on Environment and Officially Supported Export Credits", 2007), i.e. a benchmarking against host country and World Bank/IFC standards should be made and **the more stringent standard should be applied** (see IFC Guideline values /1/ in table 1 below). It might be assumpted that currently in many UNECE member states higher emissions are emitted than should be if the OECD recommendation was adopted. UNECE member states that have already more stringent emission legislations should maintain their standards.
- UNECE member states that would "start" with "OECD ELVs" should be supported during a special timeframe in which emission levels should be reported regularly. When the surrounding infrastructural and economic conditions have been improved and if the reports show that more stringent ELVs are needed ("hot spots occur"), these new ELVs could be implemented with allowance of the EB and/or the WGSR. This act should be based on the reports of the single UNECE member states and on the results of the modelling work within the CLRTAP. An environmental ruling shall be based on the cost-effective environmental quality need driven approach and not on an available technology driven approach

regardless of costs, which seems unfortunately to be the case with current set limits for the stationary engine plant. **Note:** for certain fuels such as bio fuels (gaseous, liquid) there is no viable (proven) secondary NOx-emission abatement technology on the market at the moment, also with liquid residual fuels big problems to achieve the set emission limits might occure.

- Some UNECE member states seem to be keen to support especially “inactive” countries that obviously have the biggest problems to meet the current ELVs in the annexes of the Gothenburg Protocol. We propose to centralise this support in order to reach a fast and visible success (improve the situation of availability of educated service/operator personnel that is qualified to operate power plant equipment in an optimized mode, able to adapt and utilize new technical innovations, improve the economic frame of fuel purchase and energy prices, etc.). International cooperation in the energy sector will become more and more important as the worldwide energy demand is steadily growing, but greenhouse gases on the other hand are to be decreased. A varying (flexible) environmental related emission legislation has to be adapted due to the different “economical, infrastructural and technical statuses” of each UNECE member state.
- Euromot therefore proposes to distinguish in following geographic areas:
  - North America (Canada and USA)
  - EU 15
  - Rest of EU
  - EECCA and rest of UNECE member states
- According to OECD recommendations we propose to differentiate between high populated and rural areas.
- Furthermore engine power plants that are highly efficient (and maybe relatively more benefitful from the total IPPC point of view e.g. due to the low specific water consumption, etc. e.g. in a desert area) shall be give an efficiency bonus after an environmental assessment.

Table 1: Proposed ELVs based on OECD (IFC/Worldbank /1/) environmental recommendations. Note 1 “special area” limits in below table are Euromot proposals (“Rural area” levels are from source /1/), in source /1/ is mentioned that higher performance levels should be applicable to facilities in degraded air-sheds. Note 2: the dual fuel liquid-value for rural areas is proposed by Euromot, (DF is optimized to be able to operate in two fuel modes (gasous/liquid), therefore emissions in liquid mode differ from those of a diesel engine).

	NO_x mg/Nm^3 (at 15% O_2)	
Technology	Special area (e.g. city)	Rural area
Oil fired diesel engine (CI)		
< 400 mm bore	750	1600
>= 400 mm bore	750	1850
Spark Ignition 4-stroke natural gas lean burn engine	200	200
High Pressure gas diesel engine natural gas mode	750	1600
Low pressure Dual fuel engine - natural gas mode	400	400
Dual fuel engine - liquid mode	750	2000

- IFC/World Bank Guideline values are used in big parts of the world (outside the UNECE area). Therefore the overtaking of these ELVs would mean a minimum harmonisation of the emission legislation worldwide. The stationary engine industry could then optimize and focus the R&D capacities instead of a fragmented development of “special engines” for “special

regions". The "released" R&D capacities could then be used to accelerate the development process for cleaner engine technologies. The environment can only be saved using high efficient, clean and low fuel consuming technologies, in the "Kyoto Protocol spirit", the stationary engine is one such a technology. Therefore the political frame is necessary to help to implement stepwise emission limit values that also take into account the big need to decrease the greenhouse gas emissions. **Euromot supports the political will to implement lower NOx limit values in logical and fair steps according to the IPPC approach.** These steps can only be done if several surrounding conditions are given due to the political work within the UNECE.

5 Sources

/1/ IFC: Environmental, Health and Safety (EHS) Guidelines, General EHS Guidelines, April 30 2007. Available at http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_GeneralEHS/$FILE/Final+-+General+EHS+Guidelines.pdf

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Vaasa - Frankfurt/M, 2008/07/14

Johan Boij
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ANNEX 1

Different engine types:

The main engine types are diesel dual fuel and spark ignited engines. Below the main principles are shown in figures 1A, B and C. In the diesel process (GD) fuel and air are injected separately (not mixed) into the cylinder: air is injected and compressed by the piston and then in the end of the compression stroke the fuel is injected and ignited by the hot air. The lean-burn gas engine is functioning according to the otto principle (fuel and burning air are premixed before injection to the cylinder). The spark ignited lean burn engine (SG) is a "pure" gas engine and the gas fuel is ignited by e.g. a spark plug. The dual fuel engine (DF) is in liquid mode operating according the diesel process. In gas mode the dual engine (DF) functions according to the otto process, ignition of the gaseous fuel is done in the end of the compression stroke by injecting a small amount pilot liquid fuel (typically 1-2% fuel of total heat input, when main fuel is natural gas) .

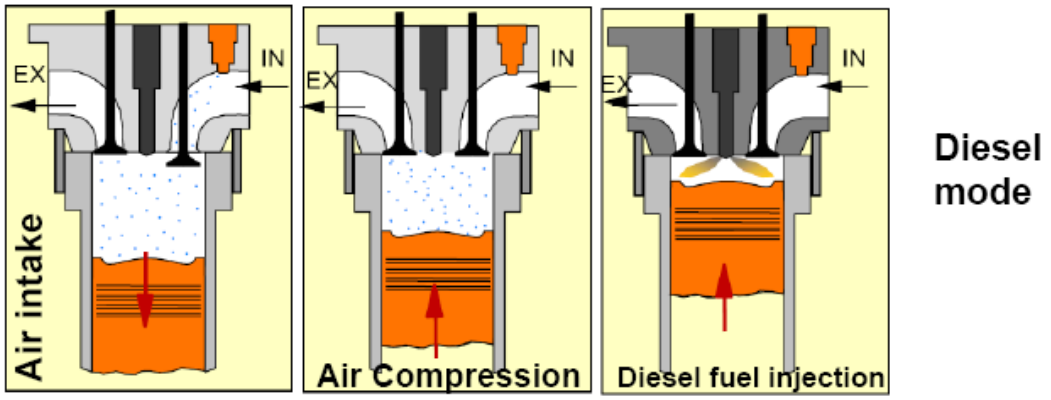

Figure 1A: Diesel Process (e.g. DF in liquid mode and GD) (source Wärtsilä)

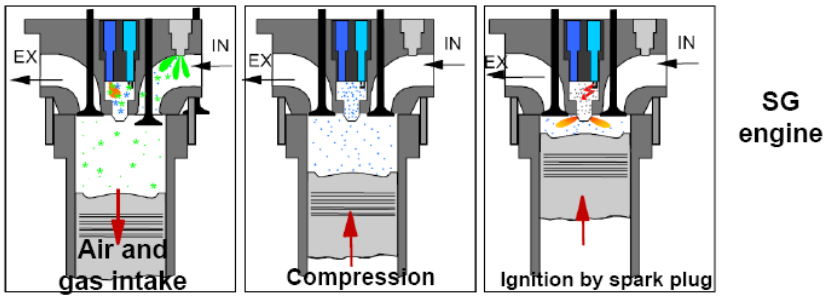

Figure 1B. Spark ignition (by a spark plug) engine (SG) (source Wärtsilä)

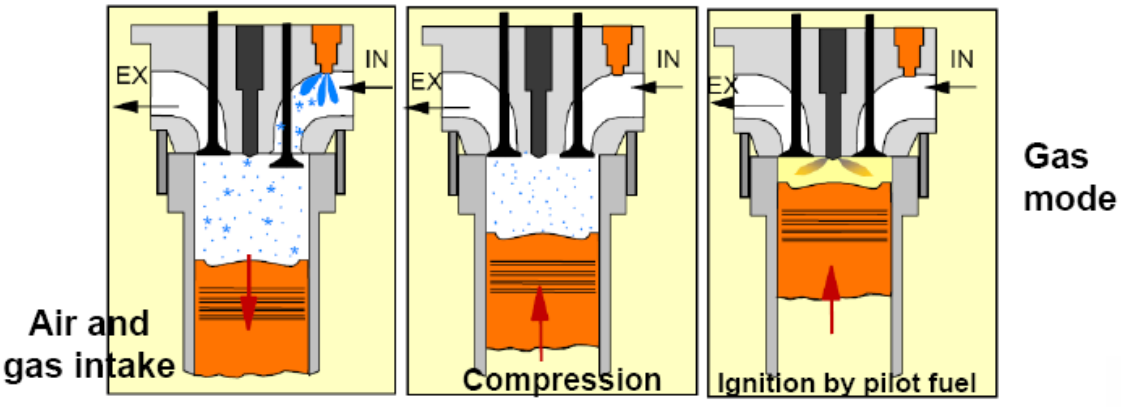

Figure 1C. Dual fuel engine (DF in gas mode), (source Wärtsilä).

ANNEX 2

Efficiency bonuses

To promote high fuel efficiency and low CO_2 emissions emission bonuses on all emissions (NOx, CO, etc.) should be introduced.

Engines in mechanical drive applications are often loaded differently from stationary applications, often mechanical drives are used at varying loadings and engine speeds (rpm:s).(“harsh conditions”).

- High efficient single cycle diesel and gas engines:
  - Corrected emission limit [mg/Nm^3] = emission limit [mg/Nm^3]*engine shaft efficiency/reference efficiency
    - Engine shaft efficiency calculation according to ISO 3046-1:2002 (E)
    - Reference efficiency is 35 % for engines < 5 MWth and 40 % for bigger units

- Combined cycle processes:
  - Corrected emission limit [mg/Nm^3] = emission limit [mg/Nm^3]*combined cycle process efficiency/45
    - Combined cycle process efficiency = engine + steam turbine shaft/alternator gross outputs

- High efficient combined heat and power systems (CHP):
  - Total CHP efficiency = (electricity MWe, gross) + 2/3 heat recovery (MWheat, gross)/C > 65 %
    - C = primary energy consumed (input) calculated on the lower heat value of the fuel
  - Corrected emission limit [mg/Nm^3] = emission limit [mg/Nm^3]*1.3

- Sustainable fuels (biofuels):
  - Corrected emission limit [mg/Nm^3] = emission limit [mg/Nm^3]*1.3

- Engine driven plants in mechanical drive applications:
  - Corrected emission limit [mg/Nm^3] = emission limit [mg/Nm^3]*1.3