# Technical issues regarding the implementation of Directive 2009/125/EC EuP for boilers

## 1) Primary energy factor

**Issue**: The primary energy factor, expressed in gross calorific value in the mathematical model developed in Lot 1, is given a default value of 2,5.

This value of 2,5 does not represent the current average of the European electricity power generation efficiency, according to common definitions and official data.

In addition, taking into account the future aspirations of the electricity producers to reduce losses through the primary energy factor, there is no incentive for manufacturers to improve the energy efficiency of their products.

**Proposal** : ***to set primary energy factor at 2,8 in the EuP Directive because :***

- → This value is based on the current official Eurostat data used to calculate properly the primary energy factor (see annex 1 of this document).
- → This value encourages manufacturers to reduce their product consumptions, regardless of the improvement of the future European electricity generation efficiency, in accordance with the EuP directive objectives.
- → This value is coherent with the current European legislation and provides a relevant comparison of the European legislation effects on the $CO_2$ emission reductions & energy savings.

  This factor will have to be reassessed at regular intervals to update the European electricity generation efficiency.

**To reduce properly the environmental impacts of the energy using products, the primary energy factor cannot be assessed on future estimated averages.**

Taking into account the estimated future efficiencies of power generation now will lead to an artificially picture of the efficiencies of high power consuming products. There will then be little incentive for manufacturers to improve the efficiency of their products as they will artificially be given a higher ranking than is the actual case.

To see the real effect of the EuP Directive on the $CO_2$ emission reduction & energy savings, a reliable and accurate value of the primary energy factor has to be taken, based on the current European electricity generation.

The estimate of the current European electricity generation efficiency based on the official Eurostat data provides ***a primary energy factor of 2,8*** (2008 Eurostat data, see annex 1 of this document).

Thus, to fix the primary energy factor at 2,8 will give a true picture of the efficiency at the time of marketing and further encourage manufacturers, independently of the efforts of the electricity producers, in accordance with the EuP Directive objectives.

**To compare properly the effect of each European Directive on $CO_2$ emission reduction & energy savings, coherent and homogeneous reference values shall be used.**

The 2,8 primary energy factor is expressed in gross calorific value (GCV), according to the Eco-boiler math model methodology.

The value of 2,8 in GCV is aligned with the Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services (the primary energy factor is equal to 2,5 in **NCV** ≈ 2,8 in GCV).

To be consistent, homogeneous reference values between Directives shall be taken in order to provide a fair and reliable comparison of the European Legislation effects on the $CO_2$ emission reduction & energy savings.

## 2) NOx emissions of Gas Heat Pumps

**Issue**: The NOx limit proposed for Gas Heat Pump (GHP) is 50 mg/kWh. This limit is not suitable for Internal Combustion Engine (ICE) technologies. If this limit is adopted it will exclude ICE gas heat pumps from the European market whereas those technologies are 20% to 30% more efficient than condensing boilers and as efficient as the best available technologies for electrical heat pumps.

**Proposal**: ***to set a NOx emission level more suited to ICE Gas Heat Pumps***. Based on the existing experience of the mini cogeneration units using also ICE technology of the same output, this threshold value should be around 350 mg / KWh.

This new threshold will then encourage the growth of GHP on the European market as GHP provides high energy and $CO_2$ emission savings in buildings compared with other technologies.

**With current Industry knowledge and development, solutions to reduce NOx emissions of ICE gas heat pumps to a 50 mg/kWh threshold are not available.**

Gas Heat Pumps provide high efficient solutions for buildings. There are two main technologies for GHP: absorption technologies (chemical compression) and internal combustion engine technologies (based on a mechanical compression).

These technologies are different especially on NOx emission levels. Whereas gas absorption heat pumps can reach the proposed threshold, as they use conventional burner technology, internal combustion engine technologies cannot go down to that level.

ICE GHP is based on lean burn internal combustion engine technology. There is no adapted catalytic solution available today to reduce NOx emissions to the 50 mg/kWh level for lean burn ICEs. Solutions currently developed in the automotive industry are not suitable since they are designed for stochiometric engine technology.

Up to now, GHP manufacturers have worked with gas ICE engine offering the highest energy efficiency and consequently the lowest $CO_2$ emissions. Reducing NOx emissions will also lead to a reduction of the engine efficiency and the challenge is to find the best trade-off on these two parameters.

**ICE Gas Heat Pumps provide high energy and environmental savings in buildings**

The COP of a Gas Heat Pumps is close to 1,5 on primary energy. This is equivalent to the best available electrical HP technologies on the market.

The heat given off by the combustion engine is a real advantage because it can be used in different ways:

→ **An output power kept constant whatever the outside temperature.** The heat produced by the combustion engine is transferred to the heating system. Consequently, the output power of the GHP is kept constant whatever the outside conditions. This is a real advantage compared to electrical HP and many have to use an electrical resistance heater when the outside temperature decreases.

→ **No defrosting**. The combustion engine provides also energy to avoid defrosting and induced energy consumptions.

→ **Free production of sanitary hot water.** When the outside temperature is above 7°C, the heat given off by the combustion engine can be used to produce sanitary hot water. In this case, the overall energy efficiency of the system increases by 15%.

Thanks to those advantages, the annual overall energy efficiency of GHP is 20% to 30% more important than a condensing boiler and is equivalent to the best available technologies of electrical HP. The GHP is a credible solution to provide heating, cooling and sanitary hot water to the most efficient buildings.

**The GHP technology continuously growth in performance and in reliability.**

Manufacturers work actually on the development of GHP units capable of producing also electricity via a generator linked to the engine. The electricity produced by the GHP can then cover the electricity demand of buildings (lighting for instance).

**Electrical HP also emits NOx…**

The GHP can be easily compared to an electrical HP because it provides the same functions (heating and cooling). Compared to electrical heat pumps, GHP avoid consumptions of electricity produced at a very low efficiency level by centralised electricity power plants (overall efficiency of 40%).

To fairly compare technologies in terms of NOx emissions, the NOx emissions of the central electricity power plants have to be taken into account (for all electricity-using products).

*The calculations below present the NOx emissions of an electrical HP (annual average COP of 3) when NOx emissions of the electricity power plants are taken into account.*

- *NOx emissions of central electricity power plants = 991 mg/kWh (European electricity generation, from the official data base EcoInvent).*
- *Electricity distribution loss = 6 %*
- *Annual average COP of an electrical HP = 3 (1,2 in primary energy).*

→ *Estimation of the average electrical HP NOx emissions = 991 mg/kWh x (1+6%) / 3 =* ***350 mg/kWh of output power.***

The calculation shows that the NOx emissions of electrical HP are far above the threshold proposed for gas boilers (50 mg/kWh max).

**Conclusions: to fairly compare ICE Gas Heat Pumps to others energy using products, it is proposed to set the NOx threshold of ICE Gas Heat Pumps to a higher value around 350mg/kwh. This relevant threshold will be fixed in such a way that:**

- **It encourages further the ICE Gas Heat Pumps manufacturers to reduce NOx emissions (the threshold will correspond to the low NOx GHP technologies),**

- **It provides the best compromise between low NOx emissions and high energy efficiency of GHP (low $CO_2$ emissions).** Based on the experience of the mini cogeneration units using also ICE technology of the same output, this threshold value should be around 350 mg / KWh, which would lead to NOx emissions as low as those of the electric heat pumps**,**
- **It encourages the further development of GHP on the European market, as GHP provides high energy and $CO_2$ emission savings in buildings.**

## Annex 1: calculation of the European primary energy factor

The calculations below present the primary energy factor obtained with the Eurostat data base. The factor obtained is closed to 2,8 (2008 Eurostat data base).

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Primary energy consumptions | | | | | | | | | |
| Nuclear power plants | 2 834 430 GWh | 2 936 430 GWh | 2 970 058 GWh | 2 987 047 GWh | 3 024 767 GWh | 2 992 558 GWh | 2 969 093 GWh | 2 805 326 GWh | 2 811 198 GWh |
| All thermal power plants | 4 443 570 GWh | 4 545 233 GWh | 4 660 884 GWh | 4 907 302 GWh | 4 918 767 GWh | 4 928 814 GWh | 5 029 360 GWh | 5 061 500 GWh | 4 983 616 GWh |
| Production from non thermal renewable energy | 409 090 GWh | 433 833 GWh | 388 721 GWh | 388 564 GWh | 422 211 GWh | 419 084 GWh | 434 766 GWh | 458 116 GWh | 491 064 GWh |
| | | | | | | | | | |
| Heat production from co generation | | | | | | | | | |
| Thermal power plants | 328 070 GWh | 355 477 GWh | 346 163 GWh | 391 477 GWh | 409 058 GWh | 403 686 GWh | 409 407 GWh | 386 895 GWh | 391 047 GWh |
| Nuclear power plants | 31 907 GWh | 33 221 GWh | 37 733 GWh | 42 744 GWh | 74 105 GWh | 77 070 GWh | 79 442 GWh | 76 442 GWh | 69 500 GWh |
| | | | | | | | | | |
| Total electricity delivered to the final consumer (minus net imports) | | | | | | | | | |
| | 2 481 390 GWh | 2 576 355 GWh | 2 573 132 GWh | 2 656 885 GWh | 2 717 018 GWh | 2 737 096 GWh | 2 808 652 GWh | 2 821 076 GWh | 2 827 247 GWh |
| | | | | | | | | | |
| Gross calorific value correction factor (apply to the primary energy consumptions of the thermal power plants) | | | | | | | | | |
| | 1,04 | 1,04 | 1,04 | 1,04 | 1,04 | 1,03 | 1,03 | 1,03 | 1,03 |
| | | | | | | | | | |
| Primary energy factor | | | | | | | | | |
| | **3,01** | **2,98** | **3,03** | **3,02** | **2,96** | **2,93** | **2,89** | **2,84** | **2,82** |

$$\boldsymbol{Primary\ energy\ factor} = \frac{\boldsymbol{total\ primary\ energy\ consumptions\ of\ all\ thermal\ power\ plants\ expressed\ in\ PCS\ (1)}}{\boldsymbol{total\ electricity\ delivered\ to\ the\ final\ consumers\ minus\ net\ imports}}$$

$$\begin{aligned}(1) = {} & (primary\ energy\ consumptions\ of\ nuclear\ power\ plants - heat\ production\ from\ nuclear\ power\ plant\ co\ generation) \\ & + (primary\ energy\ consumptions\ of\ all\ thermal\ power\ plants - heat\ production\ from\ thermal\ power\ plant\ co\ generation) \\ & \times gross\ calorific\ value\ correction\ factor + primary\ energy\ consumptions\ from\ production\ from\ non\ thermal\ renewable\ energy\end{aligned}$$