ANNEX D – OVERVIEW SUMMARY OF ECODESIGN-RELATED IMPROVEMENT POTENTIALS ON A SECTORAL BASIS (Reproduced from ENTR Lot 4 Preparatory Study, Task 5)

The improvement potential for industrial and laboratory furnaces and ovens varies considerably. A summary of estimates is as follows (more detailed data is given in applicable sections of the ENTR Lot 4 Preparatory Study report):

Sector / size	Improvement potential	Comments
Steel production, lime and cement (very large size)	Negligible using current processes	Very high energy cost has already resulted in new furnaces being as energy efficient as possible**Error! Reference source not found.** although replacing existing inefficient furnaces depends on availability of capital investment.
New steel processes	CO2 emissions could be significantly reduced by adoption of CCS or by an electrochemical process if electricity generated without fossil fuels is used. Overall, however, energy consumption will increase.	
New cement process	CO2 emissions can be reduced by CCS (increased energy consumption) or by changing to magnesium-based cements.	
Large steel re-heating	c.10%	However, this depends on availability of uses for waste heat (stakeholders have suggested that c.10% may be achievable).
Glass melting and processing	10% – 20%	Heat loss from glass melting is significant and improvement appears to be technically possible, but significant technical issues need to be resolved.
Ceramics – large size	c.10% – 20%	Lower estimate from ceramics furnace manufacture but further energy reductions possible at higher cost.
Metal melting / foundries / scrap refining	20% – 40%	Large-scale processes (smelting and melting) are energy efficient but smaller-scale have large heat losses if no heat recovery is used. Recuperative and regenerative burners can reduce energy consumption by 20% – 40%

Sector / size	Improvement potential	Comments
Bread and bakery	Small	Research has shown that further energy savings are not currently possible and more research is needed.
Medium-size furnaces and ovens – electric	c.10%	The majority of medium-sized furnaces and ovens are electric, but higher energy consumers tend to be gas/ oil. Heat losses from electric heated are mainly due to quality of insulation and presence of leaks. Much larger savings (up to 80%) are feasible for those processes where infrared or microwave heating are viable.
Medium-size furnaces and ovens – gas / oil	20% – 40%	Heat losses large from hot combustion gases as heat recovery and use of recuperative and regenerative burners are still not common.
Laboratory ovens and furnaces	c.10%-30%	Estimate from manufacturers. Most are electric, so most heat losses are through insulation and due to leaks, but large losses can also occur if ventilation is poorly controlled.

There are many technology developments that can reduce energy consumption. Some can benefit most types of furnace and ovens, such as improved insulation performance, whereas others are specific to certain types of process only. These technologies are described in Tasks 4 and 5, and are summarised in the table below. Note that each option is applicable only to certain processes and estimated values are based on current average designs.

Summary of improvement potential of eco-design options of laboratory, medium-size and large industrial furnaces and ovens

Design option	Improvement potential (energy use reduction)	Comments
Laboratory		
Improved insulation	Ovens 10% Furnaces 5%	Stakeholders' estimates. Either thicker layer (unattractive to users) or lower thermal conductivity (more expensive)
Improved ventilation control	Estimated c.20%	User-dependent and suitable mainly applicable for drying processes.
Microwave assist	Varies depending on process, can be 20% – 90% (average c.50%)	Only for certain processes such as dental zirconia.

Design option	Improvement potential (energy use reduction)	Comments
Additional door glass and infrared coating	2% – 3% (where glass doors are used)	Only some ovens have glass doors (from DG ENER Lot 22 Prep. Study)
Temperature control / timers	Estimated c. 20%	Small energy reduction by preventing too high temperature being used. Bigger benefit by automatically switching off when not in use.
Infrared heating for drying ovens	10% – 20%	For drying only.
Medium size industrial		
Improved insulation	Estimates: Ovens 15% Furnaces 10%	Improvement by increased thickness and in some furnaces by use of lower thermal conductivity types. Already used in some furnaces but not suitable for all types.
Improved process control	Estimated at c.10% but very variable	Process-dependent.
Heat exchangers for ventilation air or gas burner air	c.16% heat recovery	These are used in commercial catering ovens (information from DG ENER Lot 22 study)
Self-recuperative burners	20% – 30%	Already available with some metal melting furnaces.
Self-regenerative burners	c.40%	Rare in medium-sized but are used in large furnaces.
Others	Similar to large (below) but not all feasible	
Large size industrial		
Improved thermal insulation	c. 3% – 5%	Large furnace insulation tends to be better than that used in smaller designs and may be specified by user. Lower thermal conductivity insulation may half insulation losses (c.3% energy saving) but suitable only for some types.
Hot air for gas burners	Up to 20%	Depends on hot air temperature.
Recuperative burners	20% – >50%	Based on change from cold air burners.
Regenerative burners	40% – 50%	Based on change from cold air burners. Change from recuperative burners reduces gas consumption by c.20%.

Design option	Improvement potential (energy use reduction)	Comments
Oxy-fuel burners	30% – 40% (plus reduced NOx emissions)	NB Considerable energy is also required for oxygen production via air separation.
Gas / air ratio control	Up to 18% fuel saving	Claim from DoE publication for furnace at 1100°C
Flameless combustion	10% – 30% (plus reduced NOx emissions)	
Microwave assist	Varies depending on process, can be 20% – 90% (ave. c.50%	Improvement possible only for certain processes, potential varies, can be as much as 90%.
Infrared heaters (gas)	25% (less gas)	Reduces gas consumption and increases throughput rate.
Preheating (glass melting furnaces)	Estimated at c.10% – 20%	Pre-heating uncommon for glass melting and more research is needed. Pre-heating is more common in other sectors.
Ceramics drier design to use hotter drying air	c.20%	Uses hot air from kiln, changes needed to use hotter air without cooling by dilution.
Batch to continuous process	Up to 50%	Requires larger throughput of materials so often not practical. This advantage exists with certain process types, is impractical with some and a few batch processes are more efficient than similar continuous versions.
Reduce kiln car density (and mass), also bread baking tins	6%	Applicable mainly to ceramics.
DC electric arc for steel melting	0.32 GJ electricity / tonne steel melted	Compared to AC electric arc.
Leak prevention	2.5%	Preventive maintenance, **not** eco-design per se.
Production control	Up to 9%	**Not** an eco-design option per se.
Increased size of production	Up to 50%	Applicable to many sectors but this is not always achievable as depends on market size for product. However there is a trend to build smaller furnaces to reduce size of investment[1]

[1] IPPC BREG (glass) - applicable to glass melting (very large furnaces can use the most efficient end-fired regenerative), also occurs with steel re-heating furnaces (information from stakeholder)

Design option	Improvement potential (energy use reduction)	Comments
Produce magnesium-based cement instead of standard clinker	40% reduction in fossil fuel energy, 40% increase in electricity consumption and more or less eliminates lifetime CO_2 emissions	Novacem – more research required.