EFFECTIVE POLICIES AND MEASURES IN ENERGY EFFICIENCY IN END-USE EQUIPMENT AND INDUSTRIALPROCESSES

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Abstract*: The paper gives an overview of: the energy saving policies for end-use equipment and industrial processes adopted by the European Union during the past ten years; the results achieved compared to the expected savings identified in the technical-economic analysis; the planned new policies, as described in the Commission Action Plan for Energy Efficiency and in the European Climate Change Programme (ECCP); and the expected results. Since the launch of the PACE (1989) and SAVE (1992) programmes a great effort has been made to transform the end-use equipment market and improve energy efficiency in industrial processes. For end-use equipment a framework Directive for the labelling of domestic appliances was introduced in 1992, the majority of domestic appliances have been labelled. Moreover in 1996 the first minimum efficiency standard for refrigerator was adopted, this entered into force in 1999. In addition starting in 1996 a number of voluntary agreements have been concluded with manufacturers for TVs and VCRs, washing machines, dishwashers, electric storage, water heaters, and audio equipment. The paper will present the first comprehensive analysis of the market transformation resulting from the implementation of EU policies in this area, in particular labelling and mandatory or voluntary standards. For industrial processes, the main policy area explored was the used of Long Term Agreements (LTAs), these agreement so far have been concluded also at national level. The paper gives an overview of: the energy saving policies for end-use equipment and industrial processes adopted by the European Union during the past ten years; the results achieved compared to the expected savings identified in the technical-economic analysis; the planned new policies, as described in the Commission Action Plan for Energy Efficiency and in the European Climate Change Programme (ECCP); and the expected results.*

1. END-USE EQUIPMENT

The European Commission under the SAVE and PACE programmes has pursued several actions to improve energy efficiency of equipment in the domestic, commercial and industrial sectors. These actions include labelling and classification schemes, minimum efficiency standards and negotiated agreements, and technology procurement. It is widely accepted that to enhance the average efficiency of equipment present on the market today, a range of different actions is needed in order to exploit the full energy efficiency potentials of the available technology. Market transformation in terms of energy performance is the goal of any energy efficiency action for appliances. The various instruments (minimum efficiency standards, labelling, incentives, procurement etc.) are intended to interact and influence the market, which in the case of energy efficiency does not function well enough on its own, because of the well known barriers to energy efficiency. Consumer/user information is effective in shifting the whole

energy efficiency distribution curve: however the effectiveness of energy labelling schemes is more difficult to evaluate than for other policy measures, because labelling relies heavily on consumer/user behaviour. Labelling actions focus customers' attention on operating costs and other environmental aspects of the equipment, thus enlarging the market share of efficient equipment. To eliminate the "bad" equipment from the market minimum efficiency standards, setting the lowest acceptable performance level, are a well known and tried method. As it is described in this paper, negotiated agreements have also been used in the EU as an alternative to MEPS established through legislation. Technology procurement (i.e. the process of aggregating purchase power in order to specify new high efficiency equipment) acts on the higher end of the market by accelerating and expanding the penetration of new and more efficient products into the market place. Technology procurement might also include incentives aimed at both customers and/or manufacturers. The European Commission under the SAVE programme has implemented a proposed combination of these policy instruments to transform the market for equipment in the domestic, commercial and industrial sectors.

1.1 Domestic appliances

Cold appliances consumed about 118.4 TWh/year in 1995. In 1994 the Commission published the energy-labelling Directive (94/2/EC) of 21.1.94 which made the display of comparative energy information labels mandatory for cold appliances from 1.1.1995. Mandatory minimum energy efficiency requirements were announced in Directive (96/57/EC) of 3.9.1996 and came into force from 3.9.1999. There has been a pronounced improvement in the energy efficiency of new cold appliances offered for sale in the EU since 1990 to 1992. The average cold appliance offered for sale at the beginning of 1999 used about 27% less energy to perform the same task than one offered for sale in the period of 1990 to 1992. This represents an average annual energy efficiency improvement over the intervening period of about 4.3% per year. Since 1990 to 1992, there had been an average cold appliance efficiency improvement of two labelling classes by 1999, such that the greatest number of models were in the B and C classes as opposed to the D and E classes for the 1992 database. Furthermore the share of A class appliances had increased from 1.8% from 1990-92 to 15.6% in 1999. The strongest efficiency improvements appear to have occurred between 1992 and 1994, between 1997 and 1998 and again from 1998 to 1999. It can only be conjecture as to why these trends occurred as they have; however, it is possible that the improvement from 1992 to 1994 resulted from a general repositioning of the market in anticipation of the introduction of labelling and efficiency requirements while the increase in improvement from 1997 to 1999 was partly driven by the then pending minimum efficiency requirements and partly by the improving implementation and impact of the energy label. Figure 1 shows the distribution by labelling class in 1990 to 1992 and in 1999, but also shows the distribution by labelling class in 1999 if models which would have failed to satisfy the September 1999 minimum efficiency requirements are left out. Some 12.2% of models offered for sale in 1999 did not satisfy the minimum efficiency requirements compared to 72% in 1990-92.

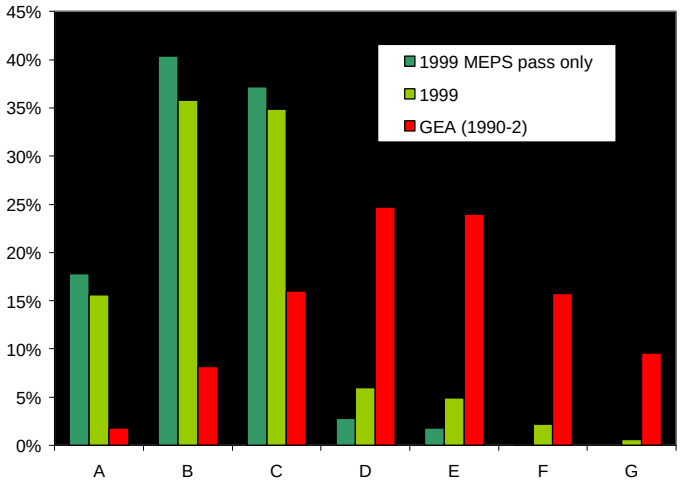

Figure 1 Share of EU cold appliance models by labelling class from 1990-92 to 1999.

A new SAVE study to provide technical guidance to the Commission to support the revision of the EU energy labelling and minimum energy efficiency standards regulations has been recently completed. The new analyses indicates the average LLCC EEI, i.e. the Energy Efficiency Index of the model at Least Life Cycle Cost, is about 46.8% of the consumption of the average model of the 1992 GEA I analysis. This implies that cold appliance energy efficiency could still be improved by an average of 36% in relative terms before there is any net disadvantage for EU consumers. Cold appliances with an EEI of 20% are technically possible but the exact values depend on the category and the other constraints imposed. The highest efficiency models on the market in 1999 had EEI of about 29%. The new policies planned are the revision of the refrigeration appliance label and a new set of efficiency levels. The revision of the energy label is particularly urgent since there are only three classes left on the market and there are not incentives for manufacturers to improve refrigeration appliances beyond the A class level. The study recommend to place to new A class at the 30% energy efficiency index, the new label should be introduced sometime during 2003. The new minimum efficiency requirement shall be placed at an energy efficiency index of 55%, and should be introduced in 2005. As a temporary solution the SAVE sponsored project Energy Plus has launched a European wide procurement for combined refrigerators/freezers with an energy efficiency index of 0.42. This will stimulate in the short term the production of cold appliances with energy index of around 40%.

Washing machines consumed about 33.4 TWh/year in 1995. In 1995 the Commission published the energy-labelling Directive (95/12/EC) of 23.5.95 which made the display of comparative energy information labels mandatory for washing machines from 30.9.1996. A negotiated agreement to impose minimum requirements on washing machine energy efficiency and a fleet target was reached between the European association of household appliance manufacturers, CECED, and the Commission on 24.7.1997 and is applicable from 22.10.1997 to 31.12.2001. Under the terms of the agreement CECED signatories agreed to discontinue production and importation of E, F and G energy class washing machines, excluding those with a load a capacity below 3 kg and vertical axis machines, after 31.12.1997; and of D energy class washing machines, excluding those with a load a capacity below 3 kg and with a maximum spin speed lower than 600 rpm, after 31.12.1999. The agreed fleet target was to reach a production-weighted target for year 2000 of 0.24 kWh/Kg.

The average energy efficiency of new washing machines available for sale in the EU had improved by an estimated 25% from pre-labelling in 1993-1994 to 1999.

Table 1 Washing machine sales-weighted annual average specific energy (kWh/cycle/kg):

1994	1996	1997	1998	1999	2000
0.286	0.260	0.242	0.234	0.228	0.219

The new policies planned are the revision of the washing machines labelling Directive and a new voluntary agreement. The new Washing Machine technical-economic analysis indicates that the best appliance on the market can reach a specific energy consumption of 0.17 kWh/kg. This would suggest a new A-class border at 0.17 kWh/kg (at present: 0.19 kWh/kg). The second planned policy action is to update the production weighted specific energy consumption target to 0.20 kWh/kg in 2003.

Dishwashers consumed about 14.1 TWh/year in 1995. In 1997 the Commission published the energy-labelling Directive (97/17/EC) of 16.4.97 which made the display of comparative energy information labels mandatory for dishwashers from 31.12.1998. In fact most Member States didn't implement this legislation until 1999. A negotiated agreement to impose minimum requirements on dishwashers was reached between the European major household appliances association, CECED, and the Commission on 19.9.2000. Under the terms of the agreement CECED signatories agreed to discontinue production and importation of E, F and G energy class dishwashers, for those models with a place settings bigger or equal 10, and of E and F energy class for those models with a place settings below 10 after 31.12.2000; after 31.12.2004 an additional energy class will be phased out. The agreed fleet target is to reach a production weighted target reduction by 20% of energy consumption by year 2002 compared to the base case. A recent stock model analysis carried out in the context of the European Climate Change Programme, has estimated an increase penetration of dishwasher from 37% in year 2000 to 46 % in year 2010. Even with the introduction of ambitious policy measurers the consumption in year 2010 would be higher then in 1990 by 3 TWh, however if there where no policy measures the consumption would be 5 TWh higher.

Dryers consumed about 10.6 TWh/year in 1995. In 1995 the Commission published the energy labelling Directive (95/13/EC) of 23.5.95 which made the display of comparative energy information labels mandatory for clothes-dryers from 30.9.1996. There are no European voluntary agreements or mandatory minimum efficiency standards applying to this product. The average energy efficiency of new clothes-dryers available for sale in the EU has improved by a very small degree since the introduction of energy labelling. At the outset of energy labelling almost all clothes-dryers on the market were either class C or D and there were no A or B class appliances on the market. Since that time most D rated clothes-dryers have been upgraded to C class appliances, but it is not possible to make significant further improvements in efficiency without adopting fundamentally different technologies such as using a heat pump. The label has been successful in stimulating the market for class A clothes-dryers and there are now at least 3 heat pump dryers on the market. The only new policy option envisaged is to establish a voluntary market share target for class A dryers. Ownership of clothes-dryers has risen from 22% of households in the EU in 1995 to 27% in 2000. Ownership levels are much higher in northern European countries, such as the UK, than in southern Europe. The vast majority of clothes-dryers sold in the EU are electric but some

gas models exist. Nonetheless, there is a considerable primary energy, and hence CO_2, saving achievable in Europe by fuel switching from electric to gas clothes-dryers. As indicated for dishwashers the recent stock model analysis carried out in the context of the ECCP, has included an increase penetration of dryers from 27% in year 2000 to 35 % in year 2010. Even with the introduction of ambitious policy measurers the consumption in year 2010 would be higher then in 1990 by 3 TWh, however if there where no policy measures the consumption would be 6 TWh higher.

Domestic and offices room air-conditioners consumed about 11 TWh/year in 1996.There are currently no energy efficiency regulations nor voluntary agreements in place for room air conditioners in the EU. The EERAC study recommended the introduction of mandatory comparative energy labelling for room air conditioners (RACs). A draft proposal is currently under discussion at the labelling committee. The study also recommended that either a set of minimum energy efficiency standards be imposed or that a voluntary agreement should be reached with industry (Eurovent and CECED) having at least the same energy saving impact. Forecast RAC energy consumption under a business-as-usual scenario is projected to increase from 11.0 TWh in 1996 to 30 TWh/year by 2010. Increasing the average EER in line with the study's policy recommendations would save up to 3 TWh per year by 2010, about 10% of the business-as-usual scenario.

Domestic electric storage water heaters consumed 68 TWh in 1995 and are thus the second most important group of domestic appliances in energy terms behind cold appliances. Standing losses accounted for 22% or 19 TWh of this total, which is roughly the total electricity consumption of Ireland. The market average thresholds were recommended by the study as appropriate levels for mandatory minimum efficiency standards, but have since been adopted as the production weighted targets for 2002 under the terms of the negotiated agreement. The negotiated agreement to impose minimum energy performance requirements on DESWHs was reached between the European household appliances association, CECED, and the European Commission on 19.3.2000. Under the terms of the agreement the CECED members who manufacture DESWHs have agreed to stop producing or importing into the EU market DESWH products with standing losses above some thresholds after 31.12.2000 and to have attained production weighted average DESWH standing losses of no more than the thresholds defined in table 4 by the beginning of 2002 (except for UK manufacturers who have until the end of 2002 to reach the targets). In addition to agreeing to meet these targets CECED manufacturers have committed themselves to displaying the standing loss performance of their appliances as soon as a labelling or information Directive is agreed (i.e. in advance of its implementation at Member State level). The draft labelling Directive proposal has already been submitted to the labelling committee. Thus far DESWH efficiency in the EU has been defined purely in terms of the standing losses. Standing losses typically only account for 22% of DESWH energy consumption, but as the efficiency of the electric water heating process is close to 100% there is little to be gained in raising the efficiency of the water heating process unless a heat pump or alternative energy source were to be considered. Moving from a business as usual (BAU) to a least life cycle cost scenario is forecast to lead to a reduction in annual standing losses equivalent to 34% of the BAU standing losses by 2020. This would amount to an annual saving of 5.3 TWh by 2020. The thresholds in the current voluntary agreement fall someway short of the estimated LLCC standing loss levels.

Electric ovens consumed 16.2 TWh in 1995 As yet there are no EU regulations or voluntary agreements applying to gas or electric oven energy efficiency. The oven study recommends the introduction of minimum energy efficiency requirements (MEES) or voluntary agreements with industry that result in removing from the market those electric ovens with worse performances than the current market average (1.2 kWh/cycle), to be followed some years later by a second-round threshold of either 0.8 or 0.9 kWh/cycle. For gas ovens the study recommends a first-round target of 1.5 kWh (or 5.4 MJ) per cycle and a second-round target of 1.25 kWh (4.5 MJ) per cycle. Overall, the maximum technical energy-saving potential from combined options is thought to be approximately 54% for electric ovens and 55% for gas ovens compared to the average oven of each type. The existence of electric ovens with brick test energy consumption of 0.6–0.7 kWh per cycle confirms that the combined maximum technical savings potentials are achievable at least in the case of electric ovens. A draft proposal for an energy efficiency label set the class A at this level. Introducing mandatory minimum energy efficiency standards or negotiated agreements in line with the SAVE study's policy recommendations would save up to 4.3 TWh of electricity and 2.3 PJ (6.4 TWh) of gas per year by 2020, about 23% of the business-as-usual totals. In terms of CO_2, this is forecast to avoid up to 1.85 million tonnes of annual emissions by 2020.

Consumer electronics (TV, VCR, audio equipment, IRDs) consumed 44 TWh in 1995. The European Commission has reached a negotiated agreement with European industry regarding TVs and VCRs standby power consumption. The agreed target are: televisions and video recorders with stand-by consumption greater than 10 W will not be commercialised after 1 January 2000; each manufacturers has individually to reach a sales-weighted average (per company) of 6 W by year 2000. Manufacturers agreed that the company sales-weighted average would be progressively reduced towards 3 Watts by year 2009. The 2000 average stand-by consumption reached by the companies participating in the voluntary agreement was 3.77 W for TVs and 3.87 W for VCRs. The best company for TVs in having an average of 1.18 W and the worse having an average of 6.72 W. The results (sales based) of the negotiated agreement are shown if figure 2.

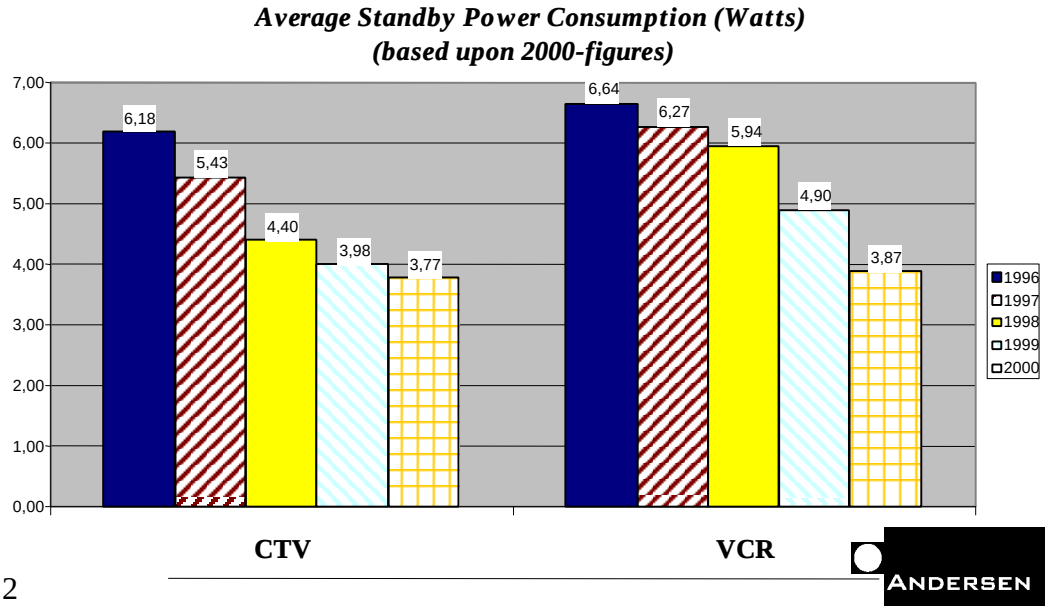

Fig.2

An additional agreement for audio equipment has been reached during year 2000. The targets for this agreement are as follows: maximum allowed stand-by consumption of 5 W for all equipment marketed after 1/1/2001; maximum allowed stand-by consumption of 3 W for all equipment marketed after 1/1/2004; maximum allowed stand-by consumption of 1 W for all equipment marketed after 1/1/2007. There are no regulations or agreements regarding on-mode power consumption. The TV on mode study recommended the introduction of mandatory comparative energy labelling for TVs. To this end the European Commission has already made a proposal to the labelling Committee for introducing a Directive for labelling TV. The study proposal was based on a technical and statistical analysis of TVs on the market which suggested that the efficiency classifications would be appropriate. The proposed labelling scheme uses the principle that the lower boundary of the 'D' category corresponds to the market average, the boundary for the 'A' category to the best technology, and the boundary for the 'G' category to the least-efficient technology.
The above projections take no account of potentially radical shifts in preferred technology. The popularisation of digital pay-TV is poised to have a large impact on overall TV energy consumption as additional, integrated receiver decoder (IRD) equipment is required to receive and decode the signal. There are signs that IRD use is about to increase dramatically as a result of huge market stimuli such as the decision by major TV service companies in the UK to give away IRD set-top boxes in order to build the long-term market for subscription TV. Owing to the absence of a standby passive mode, IRDs currently use an average of 21.5 W continuously and hence would add an extra consumption of 188 kWh/year per participating household. If IRD ownership were to rise to 50% of EU households by 2010, a not unrealistic prospect, and were IRDs to continue not to have a standby passive mode or even a normal on/off switch, total TV-related energy demand could increase by an additional 15.3 TWh/year. To limit this large energy consumption the Commission has proposed to all concerned parties to sign a Code of Conduct, which would introduce power management for this equipment together with targets for the consumption in standby.

1.2 Lighting

Energy consumption of lighting amounted in the EU in 1995 to 270 TWh per year. Large electricity savings of the order of 80 TWh per year can be achieved with the use of more energy efficient equipment. To achieve these savings, it is essential to promote high efficiency equipment and systems and to phase out low efficiency units. Experts indicated that the most effective policy instrument to achieve market transformation in terms of energy efficiency is to introduce minimum efficiency requirements. A Directive (2000/55/EC) for minimum efficiency standards was introduced in September 2000. To minimise the impact on manufactures, a phased approach has been proposed, associated with long transition periods before the entry into force of each level of minimum efficiency standards. The first level of the proposal will phase out "high-loss" ballasts and come into force one year after the adoption of the Directive. After three years a second efficiency step will come into force, by which the "conventional" ballasts will be phased out. These ballasts represent about 75% of the current market. A third phase to phase out magnetic ballasts will be evaluated in four years time.

Market research has indicated that to achieve durable market transformation and increase the use of CFLs in the residential sector, it is essential to develop and market attractive and well designed CFL dedicated lighting fixtures. To this end a major European design competition

for designers, students and fixture manufacturers have been launched at the beginning of 1999 and 2001 for Dedicated CFL Fixture. The main challenge for competition participants is to produce innovative and attractive design solutions aimed at the residential market for lighting fixtures dedicated to pin-based CFLs. The key technical design feature is that fixtures embody the ballast for the CFLs, thus making the retrofit of an incandescent lamp impossible. One of the main expected results of the competition is to boost the market for pin-based CFLs, nowadays almost not present at points of sale for residential customer, because there are almost no domestic fixtures able to take them.

To reduce lighting energy consumption in the non-residential sector, the Commission decided to launch the **GreenLight Programme** at the beginning of year 2000. The programme participants (public or private companies) commit themselves to installing energy-efficient lighting technologies in their facilities wherever (1) it is profitable, and (2) lighting quality gets maintained or improved. The Programme invites top-managers to register with the European Commission and commit to fulfil the programme Guidelines. The programme requirements, i.e. to undertake profitable lighting upgrades within a given time period, and the benefits for programme participant companies are described in the Guidelines. The GreenLight Programme has been established by the European Commission with a strong support from National Energy Agencies. The agencies would help to tailor and market the programme at national level. National Energy Agencies will also provide national partners with a customised technical support.

1.3 Electric motors

The motor load in the European Union was in 1992 548 TWh in the industrial sector and 170 TWh in the tertiary sector, i.e. the about 38 % of the total Union electricity consumption. CEMEP and the European Commission have agreed a new system of efficiency classification. This system has been designed for a product range of three phase A.C. squirrel cage induction motors in the power range of 1.1 to 90 kW, with 2- or 4-poles, in standard design. These motors are according to various studies the most important power ranges, which have to be improved in their efficiency in order to reduce electrical energy consumption. This power range has been subdivided into three bands of efficiency. The lowest band is called eff3 and covers round about two thirds of the motors currently sold in the EU, therefore eff3 represents the current standard efficiency. The next class is called eff 2 and represents almost a third of the motors currently sold and finally the class eff1, which represents motors with high efficiency. This class of motors has a current market share of 2 percent. The efficiency class of all the motors covered by this agreement has to be designated on the nameplates and in the catalogues. Additionally the efficiency at full load and at three-quarter load will be quoted in the catalogue. By this, efficiency will become an easy to handle quality criterion and OEMs will have the chance to use the different classes of motors for a cost effective efficiency optimisation of their applications.. They may decide whether an eff2 motor is sufficient or whether an eff1 motor is the cost and energy efficient solution. Moreover the market share of class eff 3 motors has to be reduced by 50 percent till the year 2003, the annual motor energy consumption will be reduced by 3 TWh. Each percentage point in favour of eff1 would in the beginning enable an additional reduction of additionally 400 GWh annually. The estimate is that the total energy saving by the promotion in favour of eff2 and eff1 will in the long run result in energy savings of at least 6 TWh annually. For other motor systems end use equipment (fans, pumps, compressors) technical-economic analyses are under way and possible policy actions under assessment. For pumps a

classification scheme will soon be proposed. Soon the MotorChallenge programme will be launched, this will address the system savings and will have a structure similar to the GreenLight programme.

1.4 Conclusion for end-use equipment

For most of the policy actions implemented for end-use equipment the full effects will be felt only when the equipment stock will be completely replaced by equipment more efficient meeting to the targets of the policy actions. For cold appliances and washing machines savings in excess of about 20% have already been achieved, together will a great decline of stand-by consumption for TVs and VCRs. For dishwasher, electric storage water, electric motors and audio equipment the effect will only be visible by 2010.
Energy savings potentials realisable by new policy actions from substituting more efficient equipment for each end-use are indicated in the Tables in Annex I, this include assumption for ownership levels. Many end-use equipment such as cold appliances, washing machines, ovens and water heaters have had relatively slow evolutions in ownership and sales volumes. Others such as clothes-dryers, dishwashers, air conditioners and satellite decoders are anticipated to have quite steady or rapid rises in penetration rates. Periodically entire new classes of appliances enter the market which have the potential to become significant energy consumers such as satellite decoder set top boxes, home PCs and other office equipment, and flat screen TVs. The energy savings potentials have been calculated assuming that the existing stock of appliances is gradually replaced by those whose efficiency would correspond or be close to the least life cycle product cost for the consumer. This would be the result of ambitious EU policies including minimum efficiency requirements and challenging energy labelling. To achieve these targets it would also require some changes in consumer behaviour and other components (e.g. detergents).
The analysis of energy saving potential indicates that the scope for energy savings lies mainly in the following equipment sectors :

- **electric motor systems**, by addressing the efficiency and design of the entire motor system and in particular through the accelerated introduction of Variable Speed Drives (VSD), and actions on compress air systems [saving potential 38,80 MtCO2];
- **office equipment** in both the domestic and tertiary sectors [saving potential 33.75 MtCO2];
- **lighting** in both the domestic and tertiary sectors [saving potential 24 MtCO2]
- **consumer electronics** (reduction of stand by losses, especially for STB, and on-mode of TV) [saving potential 14 MtCO2];
- **electric heating equipment**: e.g. substitution of electric heating with heat pumps [saving potential 11,25 MtCO2];
- **commercial HVAC systems** [saving potential 8,28 MtCO2];
- **domestic refrigeration appliances** [saving potential 6,90 MtCO2].
- **domestic appliances**, through early replacement programmes [saving potential at least 5 MtCO2]
- **training and education programmes** for consumers/end-users targeting consumer behaviour [saving potential at least 10 MtCO2]

Based on its consideration of the analysis and the ongoing activities in labelling and energy efficiency the ECCP has identified the following priorities for Community level policy action.

- The adoption of a new *Framework Directive for Efficiency Requirement of Electrical and Electronic End-use Equipment* to facilitate and accelerate the achievement of ambitious energy efficiency targets.
- The *revision of the Energy Labelling Directive 92/75/EC* to provide for additional and effective consumer information.
- The introduction of the *Motor Challenge Programme* to achieve system optimisation in motor driven processes and accelerate the penetration of Variable Speed Drives
- The conclusion of an *agreement with the lamp manufacturers* to substantially increase the sales of CFLs by 2005 and 2010
- The promotion of the *GreenLight Programme* ;
- The effective implementation of the *Energy Star Programme and of the Code of Conduct for Digital TV Services*;

2. INDUSTRIAL PROCESSES.

Energy efficiency in industrial *core-processes* of energy intensive sectors is generally difficult to improve because industry already perceives energy as a high cost factor. Moreover most of the efficiency improvements are linked to new investment for new plants. However, there is still a potential to update older (and lower efficient) production plants of energy intensive industries by accelerating the investments and making user that the best practice is followed in the design of new plants. Different categories of efficiency potentials can be defined: the theoretical potential, the technical potential, the economic and the market potential. The difference between the level of energy efficiency realised in practice (the market potential) and the level that is economic profitable is often described as the "efficiency gap". The exploitation of this gap, also described in terms of "no-regret" potentials, should be a policy priority. A practical approach to evaluate the efficiency potential in the industrial sector is to determine the average efficiency for a given type of process (or plant) and to compare it with the best existing practice (including new and most efficient technologies commercially available on the market).
It is also important to note that core processes consume on average about 50% of energy in the process industries. The saving potential compared to the BaU scenario, which is economic feasible is about 16 MToE (including electricity), or about 60 Mt CO2. Energy efficiency in *non-core areas* of energy intensive sectors of industry and in particular in less energy intensive industries as well as in SMEs represents a large potential that is estimated at 15-25 % of total consumption. The saving potential compared to the BaU scenario, which is economic feasible, is about 10 MToE (including electricity), or about 40 Mt Co2.
There is a strong interrelation among all the measures and programmes identified; moreover the contribution and feasibility of individual actions are strictly linked to other polices (e.g. Energy tax, tradable permits, environmental permits, etc). To overcome this “efficiency gap“ public authorities have implemented a set of policies and programmes such as price-based and fiscal instruments, regulation, information programmes, public aid for RTD, but also voluntary approaches. Given the great variety of voluntary approaches used in the Member States it is important to create a common framework. The internal market requires industry and commerce to be operating under similar conditions across the EU as far as practicable. The precise framing of measures to improve energy efficiency, however, will often need to take into

account differing national circumstances and opportunities and, where there is no overriding need for action at Community level, may be left to national competence, in line with the principle of subsidiarity.

The Commission has been working on the promotion of the LTA instrument and in the creation of a possible harmonised framework for the LTA approach. The Commission work is based on the checklist presented in the Commission Communication on Environmental Agreements (COM(96)561). It retains the essential elements of the above mentioned checklist: the objectives, the quantified targets, the monitoring and reporting mechanisms, and the obligations of the parties. It adds some new requirements specific to LTA such as the energy conservation plan and the communication plan. The most important attribute of LTA, which makes them particularly suited for "common" implementation in several Member States is their flexibility. They can be designed to follow a common framework and yet allow for specifics to differ according to national industrial situations. The proposed framework is designed to contribute to the creation of a level playing field among the same industrial sectors in different Member States, which are competitors in the internal market. In addition, the minimum requirements will help to assure that LTA are effective, transparent and open to public scrutiny. In the Commission's view, Member States could, in line with their own national programmes for the reduction of CO_2 and efficiency improvements, and within national legislative frameworks, use the "common" LTA approach to achieve their goals.

Given the complexity of the individual production processes, it could be difficult to have regulation flexible enough to adapt to the different and specific characteristic of each sector. By using an LTA approach there will be more degrees of freedom in adapting the targets and methodology to each industrial sector. By designing tailor-made solutions both for the specific industrial sector, for which collective targets are set, and for individual companies within the sector, LTA allow for a different timing of energy saving investments for individual companies.
Since industry itself has the best knowledge of their production processes, it is clear that co-operation between public authorities and industry can facilitate the establishment of ambitious energy efficiency targets, which are at the same time realistic and achievable. Thus, taking into account both the different circumstances and position of each sector and of each individual participating company in an LTA approach, industry can decide by itself how best to achieve the target. Industry would be, in partnership with public authorities, responsible for introducing feasible energy conservation measures based on an energy efficiency programme.
However, as it has been clearly indicated in the Communication on Environmental Agreements, there are also certain risks associated. In particular there is the risk that the negotiated energy efficiency targets reflect little more than "business as usual". To avoid this it is certainly helpful to set general targets by legislation. A high public awareness for CO_2 emissions reduction would also help as well as a negotiation process open to public scrutiny. Moreover the "risk of free-riding", i.e. a number of companies belonging to the sector and not committing themselves to make the efficiency improvements, increases the more demanding the targets are; this risk must be clearly assessed by public authorities when setting the target.

2.1 Recommended Priority Policy Actions for Industrial Processes

The ECCP concluded that the following policy actions essential to recover the CO2 emission reduction potentials in industrial processes.

- The implementation of **comprehensive energy audit and management scheme (**provisionally called **E2MAS as an energy section for the EMAS directive**) is the most important measure to foster energy efficiency in industry, in particular in non-energy intensive sector and SMEs. Therefore the establishment of an energy audit and management scheme is highly recommended as a priority. The scheme should particular focus on the non-core processes, which represent about half of energy consumption of industry. This programme shall also foster **training and education of energy managers and maintenance personnel**.
- **Long term agreements (**LTAs) are one of the most efficient instruments in energy intensive industry to improve energy efficiency and to reduce emissions. LTAs have been so far concluded at national level. However, it should be explored if European agreements could be concluded in order to avoid internal market distortions. If this would not be feasible, it is desirable that the Commission develops guidance on target setting, monitoring and reporting, etc. LTAs should aim at achieving the economic CO2 saving potentials in core processes of energy intensive sectors. LTAs shall also target at establishing energy management schemes in less energy intensive sectors and non core processes of process industries as well as at the application of energy-efficient equipment like motors, pumps, VSDs, furnaces, burners, etc.
- **Making better use of the existing IPPC Directive**. The Directive was not perceived originally for climate change. The Directive foresees already in Article 3 the obligation to use energy efficiently. BREFs should be improved on energy efficiency requirements for individual sectors. National authorities granting the permits shall ensure that energy efficiency requirements **are implemented.**

2.2 Conclusions for industrial processes

A common European LTA, constructed according to the guidelines proposed by the European Commission, may be a suitable instrument to improve the energy efficiency of industrial processes to meet at least the economic potential. In the industrial sector the LTA could be a cost-effective solution, where industry will gain considerable economic benefits and Member States could achieve substantial reductions of CO_2 emissions. Accordingly, Member States should consider the use of the LTA as a viable policy instrument to improve energy efficiency in the industry and evaluate its effectiveness in achieving the efficiency targets. To help SMEs the luanch of the E2MAS scheme is highly recommended.

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ANNEX I[1]

Table 1: Residential Electrical Equipment Consumption and Savings Potential

	Consumption 1990	Consumption 1995	Consumption 2010BaU/2010 policy scenario	Savings 1990/2010 policy scenario	Savings 2010BaU vs 2010 policy scenario	Policy Actions to deliver scenario[2]
Refrigerators and freezers	123.6	118.4	96.2/80.7	42.92	15.5	New Label and MEPS or NA
Washing machines	40.0	33.4	23.7/17.1	22.9	6.6	New Label and new NA
Dishwashers	12.8	14.1	17.6/15.6	-2.8	2.0	Implementation existing NA
Driers	8.2	10.6	14/11.4	-3.2	2.6	New NA (sale target for class A)
Room air-conditioners	1.6	2.5	7.5/6.7	-5.1	0.8	New Label and MEPS
Electric storage water heater	72	68	68/65.2	6.8	2.8	New label and MEPS or second NA
Electric ovens	15.1	16.2	16.5/16.1	-1.0	0.4	New label and MEPS or NA
Consumer electronics stand-by	15	20	26/4	11	22	Code of Conducts and new NAs
Lighting	80	89	112/84	-4.0	27.4	NA (sale target for class A)
Consumer electronics on mode	15	25	50/40	-25	10	New Label
Office equipment	2	10	65/32	-29	33	Implementation of Energy Star
Heat pump/domestic electric heating	150	150	150/125	25	25	New Label and promotion campaign
Miscellaneous	26.0	29	39/39	-13	0	
Central heating circulation pumps	30	32	37/30	0	7	New Label and MEPS
Total	591.3	618.2	722.5/566.8	24.5	155.7	

[1] All the figures in Annex I are in TWh

[2] Label: mandatory labelling under Directive 92/75

MEPS: Minimum Energy Performance Standards introduced through regulations

NA: negotiated agreements

Table 2: Commercial Electrical Equipment Consumption and Savings Potential

	Consumption 1990	Consumption 1995	Consumption 2010BaU/2010 policy scenario	Savings 1990/2010 policy scenario	Savings 2010BaU vs 2010 policy scenario	Ongoing measures
Commercial (Central) Air-Conditioning (HVAC) and ventilation	64,2	75,4	123/104,6	-40,4	18,4	New classification, and voluntary programme (GreenBuilding)
Commercial refrigeration equipment and display units	28	32,8	45,4/34,1	-6,1	11,3	new classification, and voluntary programme (Motor challenge)
Commercial lighting Including street lighting	130,2	152,7	197,6/169,9	-39,7	27,7	classification, GreenLight and MEPS
Office equipment	27,1	40,7	76,4/33,8	-6,7	42,6	Implementation of Energy Star
Conveyors	17,8	20,9	23,5/22,5	-4,7	1	
Cooking	24,4	28,6	36,9/33,2	-8,8	3,7	
Pumps	25,1	29,4	35/29,7	-4,6	5,3	Motor Challenge
Electric Space and water heating	88,7	97	111,90/101,10	-12,40	10,80	Promotion of Heat pumps
Miscellaneous	6	9	12,2/9	-3	3,2	
Total	411,5	486,5	661,9/537,9	-126,4	124	

Table 3: Industrial Motor Equipment Consumption and Savings Potential

	Consumption 1990	Consumption 1995	Consumption 2010BaU/2010 policy scenario	Savings 1990/2010 policy scenario	Savings 2010BaU vs 2010 policy scenario	Priority Policy Actions to deliver scenario
Electric Motors	535,3	562,5	645,5/627,2	-91,9	18,3	new MEPS
VSDs	294,4	312,5	373,7/ 306,8	-12,4	66,9	Promotion campaign and Motor challange
Pumps	115,3	122,4	146,4/143,1	-27,8	3,3	Classification and Motor challenge
Air Compressors	94,5	100,3	119,9/103,4	-9,0	16,5	Introduction of Motor challenge
Fans	84,3	89,5	107,1/103,9	-19,5	3,2	Introduction of Motor challenge
Additional system optimisation	-	-	-	58,2	58,2	Introduction of Motor challenge
Total	535,3	568,2	679,5/532,3	-3,9	147.2	