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Case Study 3: Appliance Energy Efficiency

Thomas Guéret, International Energy Agency

Organisation for Economic Co-operation and Development
International Energy Agency
Organisation de Coopération et de Développement Economiques
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FOREWORD

This document was prepared by the OECD and IEA Secretariats in March 2005 at the request of the Annex I Expert Group on the United Nations Framework Convention on Climate Change (UNFCCC). The Annex I Expert Group oversees development of analytical papers for the purpose of providing useful and timely input to the climate change negotiations. These papers may also be useful to national policy-makers and other decision-makers. In a collaborative effort, authors work with the Annex I Expert Group to develop these papers. However, the papers do not necessarily represent the views of the OECD or the IEA, nor are they intended to prejudge the views of countries participating in the Annex I Expert Group. Rather, they are Secretariat information papers intended to inform Member countries, as well as the UNFCCC audience.

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Questions and comments should be sent to:

Thomas Guéret
International Energy Agency
9, rue de la Fédération
75015 Paris, France
Email: Thomas.Gueret@iea.org
Fax: +33 (0)1 40 57 67 49

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Executive Summary

Energy efficiency improvements in appliances can bring significant GHG emission reductions at low or negative cost to society, by lowering overall energy use and expenditures for consumers without reducing the quality of service, and by decreasing overall energy investment needs.

A number of barriers stand in the way of implementing and diffusing technologies that bring more efficient energy use. Designing effective policies to promote less energy-intensive technologies for appliances has proved difficult, although a number of countries have now introduced successful policies in that domain. In addition to collaboration on technology development, sharing information and establishing collaboration on policy design is of particular relevance in this field, where cost-effective technology is usually available, but market barriers prevent its actual implementation.

This paper presents case studies touching both on best practices for technology collaboration and on policy collaboration.

The following lessons can be drawn:

- Successful examples of technology transfer relied on training and capacity building of the existing local industry, and not on the transfer of ready-made technologies developed in industrialised countries. Technology is crucial but the context for its transfer and proper implementation is even more important. Initiatives must adapt to the local context, in terms of both industrial environment and government's objectives and capacities.

- International collaboration on energy efficiency policies for appliances is not only useful in itself, namely providing improvement in the immediate energy efficiency of the given service; it also helps trigger synergies fostering technology improvements, through the removal of barriers to the deployment of better technologies in the market place.

- International collaboration for energy efficient appliances is one factor that can raise political interest in each country and gives new momentum to the design and implementation of national policies in this field.

- Convening power can provide a form of international coordination, whereby main stakeholders in the electric appliance sector could envisage moving towards certain technology improvements, including the introduction of standards viewed as compatible with available technologies. International collaboration on technologies and policies deserve a high level forum. The OECD/IEA has provided this in the past.

- The experience of restructuring in appliance industries indicates that collaboration to deploy energy efficient appliances has been most effective where local manufacturing capacity existed and know-how could be transferred. International collaboration on technology and energy efficiency policy can be an important driver to improve local industrial capacity and to facilitate the integration in the international market electrical appliances.

1. Introduction

1.1 Context and background

This section is a standard feature of the Annex I Expert Group's case studies on international technology collaboration. You may skip to section 1.2 if you have read other papers in this series.

Mitigating climate change and achieving stabilisation of greenhouse gas atmospheric concentrations – the objective of the United Nations Framework Convention on Climate Change (UNFCCC) – will require deep reductions in global energy-related carbon dioxide emissions. Developing and disseminating new or improved low-carbon energy technology will thus be needed. Besides R&D efforts, adequate policies, regulations, legislations and economic tools will also be required. Two previous AIXG papers have focused on possible drivers for such a profound technological change: *Technology Innovation, Development and Diffusion*, released in June 2003, and *International Energy Technology Collaboration and Climate Change Mitigation*, released in June 2004.

The first of these papers (Philibert 2003) assesses a broad range of technical options for reducing energy-related CO_2 emissions. It examines how technologies evolve and the role of research and development (R&D) efforts, alternative policies, and short-term investment decisions in making long-term options available. It considers various policy tools that may induce technological change, some very specific (e.g. R&D subsidies), and others with broader expected effects (e.g. taxes or cap-and-trade systems). Its overall conclusion is that policies specifically designed to promote technical change, or "technology push", could play a critical role in making available and affordable new energy technologies. But they would not be sufficient to achieve the Convention's objective. This is because there is a large potential for cuts that could be achieved in the short run with existing technologies; and second, the development of new technologies requires a market pull as much as a technology push.

The second paper (Philibert 2004) considers the potential advantages and disadvantages of international energy technology collaboration and transfer for promoting technological change. These advantages may consist of lowering R&D costs and stimulating other countries to invest in R&D; and disadvantages may include free-riding and the difficulty of reaching agreement between many actors. This paper provides further discussion on the role of international collaboration by describing the globalisation of the economy and current efforts of technology collaboration and transfer. Finally, it considers various ways to strengthen international energy technology collaboration.

This paper is one of several case-studies that seek to provide practical insights on the role international technology collaboration could play to achieve the objectives of the UNFCCC. They all consider the past achievements of international technology collaboration, and the role it could play in helping to develop and disseminate new technologies in the future: what worked, what did not work and why, and what lessons might be drawn from past experiences.

These case studies consider concentrating solar power technologies (Philibert 2004), high-yielding crop varieties (Gagnon-Lebrun 2004), energy efficient appliances (Guéret 2005), clean coal technologies (Philibert 2005) and wind power grid integration (Justus 2005).

1.2 A case study on appliance energy efficiency

The aim of this paper is to provide some insights about international technology collaboration in the field of energy efficiency. This case study is particularly relevant because of its global market varied issues ranging from refrigerators to standby consumption and upcoming new services (mainly in Information and Communication Technology – ICT).

This paper focuses on a set of end-uses, provides a general overview of energy efficiency policies and technology collaboration experience to date, and suggests possible avenues for future collaboration. Some estimations of related Greenhouse Gases (GHG) emissions abatement are given where possible.

Residential appliances

Residential appliances and equipment use 30% of all electricity generated in OECD countries, producing 12% of all energy-related carbon dioxide (CO_2) emissions. They are the second largest consumer of electricity and the third largest emitter of greenhouse gas emissions in OECD countries. Since 1973, primary energy demand in the residential sector in OECD countries has grown more than all other sectors apart from transport.

The potential for efficiency improvements is significant, as assessed in the IEA's "Cool Appliances" (IEA, 2002). Implementing best available technologies through policies leading to a Least Life-Cycle Cost for end-users would deliver up to 642 TWh of savings by 2010 (i.e. 24% of the total related electricity use to this date) and 1,110 TWh (i.e. 33%) by 2030, compared with current policies. Related CO_2 reductions would reach 322 $MtCO_2$ in 2010 and 572$MtCO_2$ in 2030.

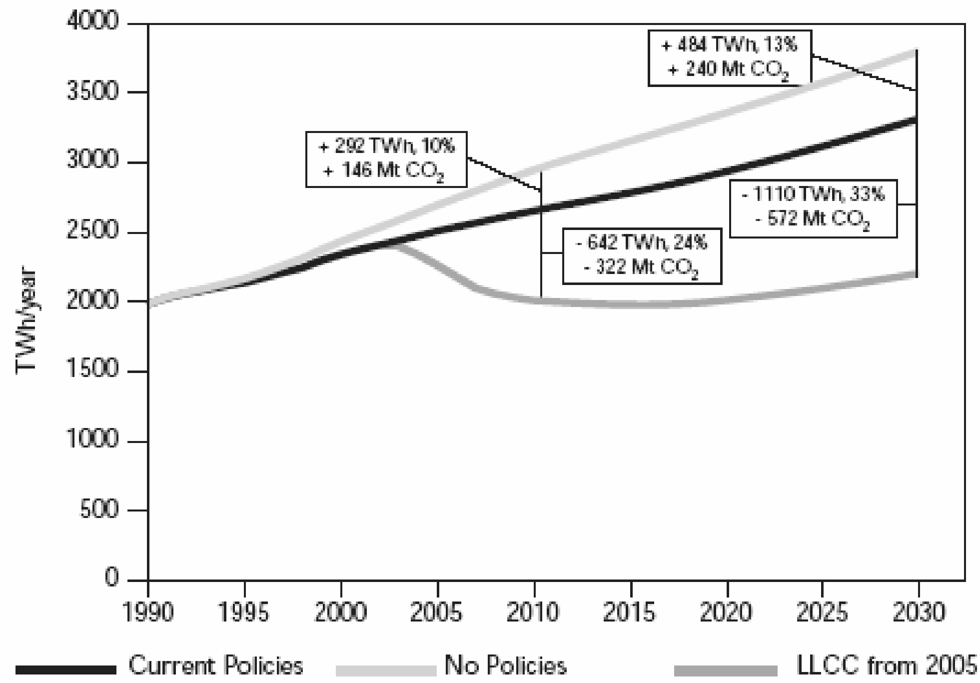
Furthermore, these savings can be achieved at a negative cost to society, the extra cost of improving appliance efficiency being more than offset by a saving in running costs over the appliance's life. Each tonne of CO_2 avoided this way would save consumers $65 in the US and €169 in Europe. As for the developing and Economies In Transition countries, comprehensive figures are not available, but some general statements are possible. The range of equipment and use is very wide among countries. In all cases, potential savings are expected to be high there too.

The contribution of residential appliances' uses to overall electricity consumption is usually less in developing than in OECD countries – as well as their absolute level per capita. Nevertheless, relative potential savings for domestic appliances in developing countries should be higher than in OECD countries at least in the short and medium term. This is because the average level of efficiency is lower there, both as a result of lower income and less developed markets, and few of these countries have implemented measures to improve appliance efficiency; also, the ownership rate of appliances is lower, but growing more rapidly than in IEA countries. The potential impact of new and more efficient appliances is higher because households still have to be equipped, whereas in OECD countries the markets are in a turnover phase. Furthermore, this impact would be felt even more in these countries, as they face problems installing generation capacity to keep up with growing demand.

Domestic appliances encompass a variety of uses and technical issues. For the purpose of this study, particular scope will be given to the following:

- Refrigerators and freezers (referred to as "cold appliances");
- Standby and off-mode consumption (which is also related to office equipment);
- Some new upcoming end-uses such as TV decoders or multiple purpose "set-top boxes" and other ICT (Information and Communication Technologies).

Figure 1: Residential electrical appliance electricity consumption under No Policy, Current Policy and Least Life-Cycle Cost 2005 scenarios in IEA countries, 1990 to 2030



Source: "Cool Appliances", IEA, Paris 2002.

Office equipment

The specific electricity use in commercial buildings is the fastest growing in electricity consumption in OECD countries. Specific electricity uses are those that cannot be supplied by other forms of energy; for instance lighting and computers are specific uses of electricity (and not heating, cooking and hot water).

Voluntary standards or energy-efficiency endorsement labels such as ENERGY STAR©[1] have proven to be very efficient in reducing office equipment electricity consumption. In the case of computers and monitors, the feature, when enabled, causes the equipment to enter a standby mode which reduces electricity consumption based on the Energy Star specification, when the equipment is not being used. Other office equipment employs various technologies to reduce energy use (e.g. copy and fax machines would reduce energy consumption by cooling down their toner while waiting for the next task). Provided these options are actually implemented, this label offers some energy saving.

However, one important issue is energy consumption in standby or off-mode. The requirements for standby and off-modes in the Energy Star requirements have long been too high to prevent some kind of negative side effect: owing to the longer time period in a year that offices are closed, computers and screens that would be left in standby instead of completely switched off (provided there is an off-mode and not a high off-mode consumption) would consume much more electricity in standby outside office opening hours

[1] ENERGY STAR® is a propriety of the US EPA (Environmental Protection Agency). It provides a labelling scheme to be used by manufacturers on a voluntary basis on a large number of appliances, including both office equipment and residential appliances.

than the electricity saved through its compliance to Energy Star. As per the U.S.-EU Agreement on ENERGY STAR, any changes to Energy Star specifications for products covered by the Agreement (i.e. office equipment) are made only when there is acceptance from both EPA and the European Commission. These changes are then put into force by both Parties simultaneously. The ENERGY STAR specification for screens (also known as computer monitors) was revised and is in effect in both the EU and the US as of January 2005. It has been improved to levels that address this problem[2].

This illustrates ongoing international technology collaboration: an agreement was signed in December 2000 between the US Government and the European Community to co-ordinate energy-efficient labelling programmes for office equipment through the common use of the Energy Star programme logo and specifications. The European Commission then established the European Community Energy Star Board that has some power to adapt these specifications to its own market.

By fixing the standby power issue, the full potential for energy saving through Energy Star specifications for office equipment is now addressed and should be realized progressively in the coming years, with the turn-over of existing computers. Savings of 50% can be expected from Energy Star's latest specification compared to less efficient PCs, hence a reduction of CO_2 emissions. As it is voluntary, the Energy Star scheme may not be able to realise its full potential of the market. However, it can contribute to a large extent, and in addition, minimum efficiency standards could be implemented in the future.

No global figures are available for office equipment electricity use. To assess an order of magnitude, the case of United States can be put forward. The electricity used by PCs accounts for 2% of national US electricity consumption, hence emissions of 46 $MteCO_2$. According to this, about 23 $MtCO_2$ could be saved[3]. The worldwide potential could be about 100 $MteCO_2$. Other office equipment uses about 3% of electricity in the US. Similar saving potentials could be highlighted there too.

<u>Global markets:</u>

In most cases, the markets for electrical appliances are at least regional and more often global. One example of the later is that of CFLs (Compact Fluorescent Lamps), together with global companies like e.g. General Electric, Philips, Osram, as well as Chinese suppliers that sell products worldwide.

However, this is not necessarily the case for other appliances. Some local or regional companies are stronger in the "cold appliances" market or for washing machines for example, as transport costs is a barrier to accessing other markets. In the US, vertical axis washers / dryers are widespread even though they are less energy efficient and require more detergent than horizontal axis machines.

Safety or quality standards can prevent importation of poor quality products. There can also be different kinds of protectionism, including custom duties. In some developing countries, social reasons, which may relate both to the provision of basic needs and a necessity to support local industrial activity, force appliances to be manufactured by state-owned or state-subsidised companies[4].

[2] Basically 4W in standby and 2W in off-mode for screens.
[3] Exclusive of indirect savings linked to reduced air conditioning electricity use cf. 2.2.
[4] For example, the case of central African countries (*inter alia* Mali, Niger, Tchad) is of interest: No cold appliances manufacturers exist there, and the importation of foreign products is difficult and costly as these countries have no access to maritime transportation and road transport is inefficient. As a result, the cost of a refrigerator, even of low quality and imported second-hand is higher than a new and efficient model in any other country. In addition, high outside temperatures and high electricity prices contribute to higher energy consumption and high cost. It is understandable that other countries strive to develop or preserve a domestic production of cold appliances in order to

The type and features of appliances vary markedly across countries, as do cultural habits and users' behaviour. There are also different technical specificities amongst regions (e.g. voltage, outlet type). These national circumstances must be taken into account when considering international collaboration on technology and policy.

1.3 The case for technology and policy collaboration

When considering the efficiency of appliances, international technology collaboration has to focus on both policies and technologies. Although other papers in this series also deal with the policy aspect, it is considered here more specifically.

Energy efficiency policies, be they standards, labels, incentives or mandatory Minimum Efficiency Performance Standards (known as MEPS), require a high technical and legal capacity to be implemented. The need for internationally harmonised standards and policies, beside their role for enhancing world trade, is particularly important here because one single country is generally unable to impact global manufacturers and markets. Without coordinated efforts, for example, one single country may be unable to introduce an identified cost effective technology onto the market if it is the only country to support it. In addition, even if several countries were supportive, the dispersion of thresholds, measurement methods or displaying modes could also introduce confusion.

Furthermore, energy efficiency is not only related to technology development itself – a number of very efficient technologies have been available for many years, sometimes decades, and are still not commonly used – but it also requires an effective implementation of efficient solutions, and this is far from being the case.

As explained in section 3 of this paper, a number of market barriers prevent the implementation of energy efficiency to its optimal level. There are complex reasons for this, for instance: the technology case of each appliance type and its potential improvement, given the particular national circumstances; legal difficulties of intervening in very competitive markets; diverse stakeholders and actors in the field; public information and behavioural change. These problems can only be solved with specific policies that necessitate high technical and legal skills. As a relatively new and still developing science, modern energy efficiency policies need international cooperation in a similar way that technology development does. The techniques themselves and the know-how can be compared to technologies. In short, there is a strong need for building capacity, training and exchange of ideas and experience. Even more than for other case studies, the need for international collaboration in policy techniques cannot be separated from the analysis of technology issues.

1.4 Industrial competitiveness

Another particular focus of the paper is related to competitiveness.

A number of events or trends are tending to raise the profile of energy efficiency on the political agenda worldwide, and should eventually impact appliances markets[5]. Examples of this are the recent rise in oil prices, hence the possible increase in electricity prices in most countries, concerns related to climate change and the recent entry into force of the Kyoto Protocol. Raising public awareness and the demand for

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prevent such problems. Technology collaboration would be an issue for these countries to develop an efficient domestic production.

[5] Some reasons why this does not yet happen are provided in section 3.1

stronger public participation and transparency is also likely to push for more efficiency as well as a general awareness that energy efficiency potentials are not achieved because of market barriers or failures.

Industries will progressively face stronger consumers' demand and public policies to improve the energy efficiency of energy-using products worldwide. Adapting to this new environment will be crucial for the competitiveness of each end-use equipment industry in the future. With such developments ahead, implementing safe and sound energy efficiency policies in a way that helps industry develop good technologies in a tight timeframe, will be a strong determinant for countries to keep or take new market shares worldwide[6].

1.5 Structure of this paper

Owing to these specificities, the structure of this paper has been adapted. In Part Two, technologies are addressed as in other case studies: namely it assesses the potential for energy efficiency improvements in electric appliances. Part Three is dedicated to the technical issues of energy efficiency policies as these represent a major element to foster market diffusion of more cost-effective and CO_2 friendly technologies. Part Four includes a set of examples of collaborations related to one or both of these two fields, then illustrates how they combine in the most comprehensive and efficient approaches. Part Five draws lessons from these case studies.

2. The Potential of Energy Efficient Technologies

2.1 Cold appliances

Almost 100% of domestic refrigeration appliances sold around the world use a vapour compression refrigeration cycle to cool stored food. A small market share exists for gas absorption cooled appliances, which are used almost exclusively for hotel mini-bars, and a very small niche market exists for thermo-electrically cooled appliances for camping and mobile home use.

A typical refrigerator or freezer has a single compressor and condenser and one or two evaporators operating in series in a single cooling circuit. About 95% of European appliances use natural convective cooling to transfer heat to the evaporator and from the condenser, while almost all North American, Australasian and Japanese appliances use forced convection (i.e. use electrically powered fans) often called "no frost systems".

Natural convective cooling is efficient, low cost and convenient for appliances with small to medium cooling capacities and which operate in low humidity conditions. In higher humidity, frosting on the evaporator is a problem for consumers and requires the use of a fan. Beyond a certain volume and height it is difficult to maintain appropriate internal temperature distribution without using a fan.

Whether the appliance is no-frost or cooled by natural convection, its efficiency is greatly influenced by the quality of insulation, the efficiency of the compressor and of the heat exchangers and the quality of the control system. All of these have improved significantly over recent years.

[6] This item does not only refer to the case of national manufacturers, but more widely to the general issue of industries on the national territory, including those that would be partially or totally owned by foreign or international groups.

Technology Focus: Efficiency techniques in cold appliances

Quality of insulation depends first on the conductivity of the foam or whatever other insulating material is used. It also depends on the reduction of "thermal bridges" caused by discontinuities in the insulating layer, either due to bad insulation installation (poor design or poor manufacturing operation) or where structural or functional parts of the appliance have to penetrate the insulation. The latter can be reduced by better design (e.g. reduction of required holes' surfaces, conductivity of the materials used). Vacuum panels are the latest development in insulation materials.

Efficiency of the compressor is related to efficient electric motors and pumps. Great deployment improvements have been made in recent years, but the most efficient models and technologies still have to penetrate the market.

The larger a refrigeration appliance, the easier it is to make it more "efficient" if efficiency is measured in terms of the inverse of the energy used per unit storage space at a given temperature. The reason for this is that the surface to volume ratio is lower for larger appliances thus the heat loss per unit volume is smaller, while the useful space available for insulation or cooling circuit components is larger, which has a bearing on their efficiency. Similarly, larger capacity compressors are inherently more effective than smaller capacity units and hence give an efficiency gain to appliances with inherently larger cooling capacities. However, this does not completely offset the additional energy use of bigger "cold" appliances, but the variations in energy use and volume are far from being proportional.

2.2 Standby power

Many appliances require a small level of electricity for standby functions – to power a built-in clock, respond to programming or respond to remote commands. In other devices, energy is simply wasted when the appliance is not doing anything at all, for example when there is not a general switch preventing the system from using some electricity.

As illustrated in section 1.2 (on office equipment), the standby or off-use consumptions of electrical equipment can contribute to much higher electricity use than actually needed. High standby or idle mode consumption can offset efficiency gains delivered by the newest technology developments. For most appliances, owing to the longer time period in a year that they are not used, if left in standby instead of completely switched off, this would consume much more electricity in standby mode than during actual use.

This standby and off-mode issue relates to both office equipment (e.g. computers, printers, fax machines, network facilities) and home equipment (e.g. hi-fi, TV and accessories, various wireless equipment). In both cases, the impact of standby and off-mode depends on the actual consumption and on the time spent in each mode.

However, some implications for office equipment are different to those for home equipment. Firstly the appliances are different of course, even if computers and other office equipment are often present in households too (although it is unlikely to see large copiers or fax machines, for example, in private homes). Secondly the equipment is used differently. Apart from fax machines and network facilities, the use of most office equipment is limited to business hours, which represents a maximum of about 3,000 hours a year (i.e. 35%) for collective equipment such as copiers or network printers; and 2,000 hours a year (i.e. 25%) for personal equipment such as individual computers or printers. On the other hand, the use of home appliances with standby or off-mode consumption is very different and more diverse. For example, VCRs or DVD players are only used for a few hours per week on average, whereas TVs and set-top boxes are more likely to be used 4 to 6 hours a day.

Finally, there is an increased reliance on air conditioning in commercial buildings. As the electricity spent in standby mode is converted into heat, additional energy is often required to maintain the temperature at a given level. Consequently, addressing the energy efficiency of office equipment may induce additional savings.

As for home equipment, most consumer electronics use more electricity in idle or standby mode than during their relatively brief operating time. This is true for VCRs, set-top boxes, most audio and hi-fi equipment and most office equipment. The standby and idle-mode electricity consumption of consumer electronics (excluding televisions) in IEA countries and of miscellaneous end-uses (excluding major uses such as lighting, cold appliances, clothes and dish washers, cookers…) is estimated to have been 61.1 TWh in 1990 and 120 TWh in 2000. If standby power consumption in all residential end-uses is aggregated, these figures are likely to be significantly higher. Nonetheless, these consumption levels alone amounted to 5.2% of IEA residential electricity demand in 2000, and represent emissions of about 250 $MtCO_2$. In a no policy scenario, this could double in 2010, resulting in a 250 $MtCO_2$ increase in GHG emissions, only for IEA countries. Technology collaboration could play a dramatic role in this regard: development and spreading of efficient technologies could avoid most of these additional emissions.

Some simple solutions exist to prevent such consumption levels. For TV and related equipment and for hi-fi, the consumer can use a multiple adapter with a general switch. Wall switches may also operate some outlets. However, this implies both technical problems (switching on and off may cause electrical shocks and damage equipment) and behavioural constraints (regularly programming the date and hours of equipment). Some products exist on the market that will automatically switch off the equipment while in standby. They detect the signal of the remote control and power the appliance again when operated. These devices consume very low electricity and may provide high savings while not altering the user's habits.

This technology can be inserted directly into the appliance instead of adding some external equipment to fix this problem. There are already TV sets on the market consuming less than 0.1 W in standby mode (against about 10W for existing appliances).

When more complicated services are required – such as signal amplifying or decoding, data processing, safeguarding memory etc. – major improvements are still possible as shown by the low energy requirement of cellular phones, personal organisers, etc. that provide service over several days from the little amount of energy available in a battery (typically a few Wh, equivalent to the energy used during one hour by a relatively efficient standby appliance).

2.3 New upcoming end-uses

Set-top boxes are new devices in the field of satellite and cable TV. They provide a multiple purpose service such as satellite signal amplifying and demodulating, data decoding, data storage, and access to a set of individual services. With a fast growing number of appliances and a low energy efficiency of existing products, they offer major potential savings. There were about 400 million set-top boxes in early 2004, consuming 6 to 12 W on average in standby mode. It is estimated that this figure will rise to one billion in 2010 and as much as 1.5 billion in 2015. Depending on technology development and the policies actually implemented, these boxes could consume from 4 to 25W in standby by these dates. It has significant energy demand implications. These new end-uses are therefore an obvious target for improvements in energy efficiency technology and policies that bring cost-effective and more efficient technologies to the market. In 2015, the global permanent use of electricity of set-top boxes could range from 6GW to 37GW. As much as 30 large power plants could be avoided by an efficient design of equipment.

There is also a boom in the number and overall electricity consumption of external power supplies, mostly used for new technologies (laptop computers, cellular phones, personal organisers, and other portable devices). Technological solutions exist to enhance the efficiency while in use, or to cut consumption when the device is turned off or disconnected.

Technology Focus: Power supply in electric appliances

Basically, a power supply is made of a transformer with one primary coil connected to the grid and a secondary coil providing induced power. The quality of the transformer depends on the nature of the wires and of the iron core, their shapes, and the number of spins in each coil. Provided the power is switched off upstream of the transformer, any off-mode consumption can be avoided. However, with external power supplies, it is more complicated. The switch is downstream of the transformer. Even with no load on the secondary circuit, the transformer would continue to use some electricity. Today's power supplies use a number of electronic parts adding to equipment features or quality, and can even partly or totally replace the coils themselves. Nevertheless, the no-load consumption often remains, in spite of easy electronic solutions that allow switching off automatically the upstream power connection when no load is detected.

The role of international collaboration in this field is addressed in the section 4.3 below.

3. Technical Aspects of Energy Efficiency Policies

3.1 Addressing market barriers

As stated in section 1.3, some impediments exist for energy efficiency to be implemented at a level that would minimise overall energy use and do so cost-effectively. Below is a list of the most commonly quoted market barriers or impediments [IEA/SLT(2004)27]:

- Information on energy consumption and possible savings held by more efficient appliances is often difficult to obtain. In addition, energy efficiency will be one of a number of features considered by a purchaser. Technical features, size, colour, purchasing price (as opposed to running costs) are other priorities of the customer and without a direct label on energy efficiency, the latter is unlikely to be a key factor in the consumer's choice.

- The market is more likely based on the purchase price of one appliance type than on the total service cost, i.e. including energy costs. To assess the latter, the consumer would need to integrate the purchasing price and the total price of energy use over the appliance's lifetime. Furthermore, with low visibility of the lifetime cost and high levels of competition, even informed manufacturers would find it difficult to introduce more efficient appliances on the market because of those already existing that are cheaper but of a lower quality.

- Even if information is available and the consumer is aware of the life cycle cost and is interested in obtaining the best available, the most efficient appliances may be somewhat more expensive. The consumer may not be able to afford the purchasing price of the optimal choice appliance. If many consumers are in this position, the market for efficient appliances would simply not develop, and their price would remain high.

- The investor may not pay the energy bill, as in the case of a rented apartment, and so may have little interest in purchasing a slightly more expensive appliance that would save the user huge amounts of energy.

- A similar issue arises in manufacturing. As long as energy efficiency and the running costs of appliances are not well known by users, there is no formulated demand for more efficient appliances. Manufacturers may use the cheapest components to save a few cents even if this induces much larger running costs for final consumers. Manufacturers have limited interest in improving the efficiency of their products since they do not bear the cost of the induced electricity consumption.

Of course, setting prices right, for example to reflect CO_2 emissions through an emissions trading scheme or energy taxes, could help promote more efficient technologies. However, it is now well researched and well known that alleviating existing market barriers would be even more effective in bringing best available and cost-effective technologies to the market place. Technical collaboration can contribute dramatically to the design and implementation of dedicated policies aiming at alleviating market barriers.

3.2 The policy package

OECD countries and a number of developing countries use a variety of policies to improve the energy efficiency of home appliances and office equipment and, increasingly, home entertainment electronics and lighting equipment. The most widely deployed policy measures are:

- Information and awareness raising programmes;

- Energy labelling;

- Mandatory minimum energy performance standards (MEPS);

- Voluntary efficiency agreements (VAs).

Other instruments, such as procurement programmes and financial incentives, are used less frequently and for limited duration. Labels, MEPS and VAs are typically implemented at national and regional levels, while financial incentives are mostly implemented by sub-national – state/provincial and local – authorities and by utilities and third-party consumer organisations.

Some explanation on energy labelling may be useful at this stage. In the above section (3.1), we have stated that the basic information on energy consumption of the energy end using products may either not be displayed at all, or is displayed in a way that is not easily accessible to the consumer. In addition, consumers have other parameters in mind when purchasing a new appliance. Unless energy labelling is easy to find and understand, it is unlikely that the customer would pay sufficient attention to energy consumption characteristics of the appliance.

The first thing to do to address this is to set consumption measurement standards, mandatory requirements to test the devices and have independent oversight so all the information is available. However, this is not sufficient because the consumer cannot cope directly with technical information. The Energy Label is designed for this. Through a very efficient design, it provides at first glance the relative efficiency of the appliance; for example, by the number of stars indicating its efficiency (Australia), by a cursor on a scale

(US), or by using an A to G type scale as in Europe. The energy label is mandatory on the appliances in retail outlets and must also be displayed in mail order catalogues. Ultimately, it will be mandatory in commercial advertising. For example, nearly all IEA countries, and many other countries, use labels for refrigerators and other major home appliances.

Many countries have also adopted minimum energy performance standards (MEPS) for refrigerators. For other home appliances, MEPS are also used in Canada, the United States and Korea for example. China is currently introducing a comprehensive set of MEPS. Other countries use such regulatory standards, or similarly-defined ones, more sporadically. Japan has fleet average targets for refrigerators and room air-conditioners (the ‘Top Runner’ program). Australia and New Zealand have recently introduced MEPS on some equipment such as refrigerators, freezers and air-conditioners. Switzerland has used voluntary targets for refrigerators, washing machines, clothes dryers, dishwashers and electric ovens. The European Union has voluntary targets for washing machines, dishwashers, water heaters, televisions, videocassette recorders, audio equipment, digital receiver decoders and external power supplies.

Endorsement labels are the most commonly employed policy instruments for office equipment and home electronics. Energy Star (US EPA and US Department of Energy) and the European Group for Energy Efficient Appliances (GEEA) labels are used for personal computers, monitors, printers, copiers and fax machines. With the exception of Japan’s standards for televisions, videocassette recorders, photocopiers, computers and magnetic hard-disk drives, MEPS are rarely used for such equipment. Voluntary targets, also called negotiated agreements, are more common measures used to improve these types of electronic equipment. The EU uses voluntary targets for TV and VCRs, audio, decoders, external power supplies (IEA 2003, pp. 62-63). Switzerland uses voluntary targets for all major types of office equipment.

International collaboration is a base for these policies. International standards are directly used or referred to in national standard and regulation schemes. Existing national policies have been adopted in other countries (Energy Star is used in Japan, and in Europe for office equipment; the European type energy label is now used in other countries such as China, Tunisia and Latin America).

The most successful countries have used a comprehensive set of policies including labels, MEPS and awareness campaigns. VAs can dramatically contribute to the process. They sometimes constitute the major policy tool. In the latter case, standards and labels can be used as second line of “defence” of the market’s efficiency against new entrants that may not agree to the commitments of existing producers.

Regardless to the exact choice of policy package, the process must be continually updated as technologies evolve. The efficiency of components improves; uses and needs evolve too. Policies need to be updated regularly in order to take into account technological improvements and deployment. Apart from consumers benefitting from obtaining useful information on their purchase, an up-to-date labelling scheme also facilitates: accurate implementation of MEPS, and the setting of VAs commitment levels and thresholds for possible financial incentives or procurement programs.

3.3 Capacity needs

The implementation of appropriate measures to foster development and deployment of energy efficient appliances – basically labels and MEPS – have the following features:

- The design or the adaptation of (existing) standards for measurement methods;
- Consumer research used to design the energy label in an appropriate way regarding local culture and consumers needs, in order to maximise the rate of understanding from purchasers;

- The establishment and accreditation of national test facilities;
- The energy performance certification, verification and compliance process;
- The development of appliance energy efficiency and labelling criteria;
- Public communications and outreach strategy;
- The assessment of the projected policy impacts and the monitoring of the successive phases of an iterative process.

Furthermore, a comprehensive policy should aim at undertaking this kind of work for a number of appliances – ultimately dozens of types in order to target and implement these most accurately. In order to implement each particular scheme as detailed above, one would have to rely on comprehensive and consistent data (e.g. energy consumption monitoring, both field measurements and nation-wide assessment, equipment ratios and market share analysis, consumer behaviour). All in all, a sound and sustainable legal and technical ability is required in order to implement measures progressively, ensure consistency, and update them when necessary.

3.4 Standards issues, international harmonisation

The use of well-established and renowned standards is of utmost importance in the matter of energy efficiency policies. First because the legal basis of policy implementation has to be as strong as possible: for measurement methods, for appliances definition as well as for efficiency threshold setting. Second because the technical issues are complex and must be handled at the highest level to get accurate and effective policies.

One particular country has rarely the capacity to design original standards that would address the whole complexity of the technical and legal stakes for each particular appliance type. Even if it were, it would not be very efficient to work out a scheme completely independent from existing ones. Beside the fact that the work would then have been done twice, the lack of harmonization amongst national or regional policy measurement methods and thresholds is likely to weaken the global combined effect.

An example for this is the European Union regulation for displaying CO2 emissions of new cars in retailing places and on commercials. The directive 1999/94/EC of 13 December 1999 introduced the mandatory display of the CO2 emissions data of new cars, both on commercials and with labelling on the retailing places. However, the Directive does not specify how labelling should be implemented, in contrast with what has been the practice for electric appliances for years. EU Member states have therefore implemented the Directive in different ways. Some used the frame of the EU energy label graded A to G, but based on different rating methods and thresholds. Most of them did not, so that very aware consumers can compare two models, but most will not get an immediate idea of the efficiency of one particular car compared to the range of possible fuel efficiencies and CO2 emissions. As a conclusion, this directive introduced some valuable information and service to the consumer, but would have been much more efficient with a higher level of detail and better harmonisation.

4. International Technology Collaboration

This section provides insights from different types of collaboration, from a technical approach on standby and set-top boxes to specific technology and policy collaboration with developing countries (Tunisia and China), as well as other approaches (the IEA Implementing Agreement on DSM).

4.1 RD&D, know-how and process up-grading

Technology collaboration for appliances is not usually about innovation, the complete development of a new technology that is not available elsewhere. In fact, experience shows that similar research and development projects are sometimes repeated in different places, simply because the information of existing techniques is not available, or not easily understood. Furthermore, up-grading appliance efficiency is the result of better design and manufacture. The latter is not always very advanced, especially in developing countries. Improvements do not always rely on complex technology. Knowledge in this field is often more a matter of training, understanding and adaptation rather than technology.

Technology collaboration should take this into account, both with a view to increase the level of information, and to improve policy design. This also implies that the avenues for technology collaboration should be diverse: enhanced research, technology exchange, but also training, learning by doing.

4.2 Upgrading of refrigerator manufacturing plants in Tunisia

This particular case study is described into more details in order to give a more in-depth analysis of one particular case, including background information and strategic thoughts.

Tunisia has a population of 9.8 million people with a 6.8% annual growth in electricity demand since 1980, of which 25% is consumed in the residential sector. Refrigerators consume as much as 40% of the latter. Owing to the rapid increase in equipment, this consumption could almost quadruple (+260%) by the year 2030 with no additional policies. In contrast, implementing energy efficiency standards that would deliver least life cycle costs for consumers would lead to a stabilisation some 15% above current consumption level.

There are as many as twelve plants manufacturing refrigerators in Tunisia. Most of them are simply assembling kits delivered by foreign countries' manufacturers, but a number of them produce original appliances with their own design using diverse components available on the world market (e.g. compressors, heat exchangers, chemicals for the insulating foam, etc.).

<u>Preliminary technical visits from CETIM and ADEME</u>

Back in 1998-1999, expert visits in some Tunisian plants have been funded by the French for the environment and energy efficiency (ADEME) and organised jointly with CETIM (Centre d'études techniques des industries mécaniques, a French official industrial technical centre) in relation with a Tunisian counterpart (CETIME) and the ANME (the Tunisian energy efficiency agency)[7]. Useful information was directly delivered to the producers to help them improving the design and manufacture of their products.

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[7] Such visits were also organised in other North African countries and in Syria. A total of 15 plants benefitted from this direct basic exchange of knowledge.

It appeared that only a few of the twelve plants have the capacity to manufacture efficient appliances in Tunisia. The reported collaboration has provided all visited plants with some basic improvements, but most of them would lack the technical capacity to implement sufficient further improvements. The way forward obviously required further technical collaboration, but also other collaboration related to policies, standards and enforcement capacities. This has been undertaken by the ANME-GEF project described below.

Labelling scheme and related policies enforcement

Tunisia has recently implemented a standard and labelling programme for household appliances and other energy using equipment. This US$1.4 Mn programme, which is the result of six years of work co financed by the Global Environmental Facility (GEF) and executed by ANME with some consultancy support, led to the introduction of energy labelling and MEPS regulations for refrigerators in 2004.

The very comprehensive set of tools used (basically all those described in section 3.3) and the attention given to design and implementation of the programme, not only serves as a role model for how such programmes can be conducted in developing countries, but also matches or exceeds the design and implementation of similar programmes in developed countries. Some key features of this programme are explained below.

First, building on the recent contacts undertaken by CETIM, further and more in-depth technical visits were implemented in all Tunisian plants. With the help of a former technology expert from French industry recently hired by CETIM, more detailed in-field analysis and training was provided on the following issues:

- The choice and combination of diverse components available on the world market with a view to improving energy consumption;

- How to avoid thermal bridges in the design and assembly process;

- The conditions for manufacturing and how to deal with them. For example, cool temperatures occur in winter in the Mediterranean region. The processing of chemicals for insulating foam requires temperatures over 20°C (optimum is 28°C). The thermal quality of the foam is much lower in colder temperatures. However simple action can take this into account, by gently warming the chemicals before operating and processing in a warm room or near a heating source.

Furthermore, some of the Tunisian manufacturers were greatly interested in further contacts and exchange of views regarding obtaining licenses and learning how to use specialised software for the design of energy efficient cold appliances. They first benefitted from the software collaboration described below. However the direct use of the software by the Tunisian manufacturers would represent the next step. Actual licensing and training are still pending.

Recently, **work on label design** in China has clearly demonstrated that designs that are effective in one community may be highly ineffective when transposed to another, and that the causes of these failures are not always foreseeable (Waide et al, 2004). As a result, policymakers should aim to test label designs with key stakeholders (consumers, retailers and manufacturers) before taking a decision on whether to adopt them or not. The budget to implement label design research in Tunisia was limited and thus it was decided to test a small number of adapted versions of the EU energy label, which has been highly effective in transforming the EU market. Radically different designs would only be considered if the modified EU labels were found to be ineffective.

The adopted label which received consumer appreciation is both in French (from the left margin of the label) and in Arabic (from the right margin). The A to G scale has been changed to a 1 to 8 scale which has proved to be more efficient in Tunisia. It is displayed both in the original form with arrows pointing from left to right on the French part of the label, and in an inverted form with arrows pointing from right to left in the Arabic part.

Development of a suitable energy performance test procedure and efficiency metrics has also been a key element in the strategy for energy labelling in Tunisia. The work was based on ISO and European EN 153 norms: a specific norm 'NT 81.70' was issued by the Tunisian INNORPI in 2001.

Establishing suitable testing facilities was also very important to ensure fair assessment and fair competition. Energy performance testing capacity is essential to underpin any standards and labelling program and the need to establish an independent government sponsored laboratory was recognised as a priority in designing the project. The French testing agency, LCIE (Laboratoire central des industries électriques), was contracted to design and specify the construction of a new test laboratory and to train local personnel from the national test agency, CETIME, to do this work. The laboratory was completed in early 2003 and CETIME staff, who had undergone refrigerator testing training in France, undertook a series of cross tests to ensure that their test results were consistent with those produced in LCIE. Local manufacturers were then invited to submit their appliances for free testing with CETIME throughout a year-long grace period and this enabled a large majority of models on the market to be tested and classified.

The techno-economic potential assessment has been realised through an intensive use of dedicated software. Thomson Corporation has developed a programme, Simarm, simulating the energy requirement of the products depending on their dimensions, the assembling process, the insulation used, the type, capacity, brand and model of the heat exchangers and of the compressor. Its principal feature is an up-to-date database referencing almost every single component available on the market and modelling the efficiency of their assemblage. The consultants worked very closely with key manufacturers to determine explicit technical characteristics of a set of typical base case appliances, which were chosen as characteristic of each of the main types of refrigerator found on the Tunisian market. The subsequent analysis explored the impacts of making successive design improvements applied in the order of the shortest payback time to the consumer.

As a result it is projected that by 2030 the programme will have saved 3.4 Mt of CO_2 at a cost to the GEF of just US cents 20/tonne. The cost of saved electricity for Tunisian consumers is projected to be less than USc1/kWh, which compares very favourably with the current tariff of USc7.4/kWh.

As the software was used with the actual design of the existing Tunisian products and helped identify possible improvements, valuable information could be forwarded to the manufacturers regarding the efficiency of their appliances.

To conclude, the globalisation and lowering duties worldwide should also lead to consideration for the future. In particular, Tunisia has an agreement for free trade with Europe coming into force in 2008. This process will probably initiate major changes in the sector. Only one or two plants will be able to face the competition and continue their activity over the long term. Tunisia's recent improvement in energy efficiency of its cold appliances market has benefitted consumers and enhanced the industry's competitiveness. This is still an on going process.

4.3 Standby and set-top box experiences

The rise of the "leaking electricity" issue dates from the mid-1990s with Alan Meier's work at Lawrence Berkeley National Laboratory, US (Meier 1999, Rainer 1996), with H. Nakagami in Japan (Nakagami, 1997) and with the first household electricity infield measurement campaigns run in Europe by Olivier Sidler's Enertech on behalf of the French ADEME and the EU energy efficiency programs (Sidler 2000).

The latter has international technology collaboration aspects, as it was part of the EU R&D programme aimed at fostering energy efficiency collaboration between Member States (SAVE programme). The 'simple' assessment of the actual infield energy uses in the residential and commercial sectors turns out to be more complicated: international collaboration is still needed to develop and dispatch sound measurement and data storage devices, to process data, to exchange results and draw possible policy avenues.

As for the latter, several workshops were organised by the IEA to address the problem of standby power first, and then the particular issue of set-top boxes. The IEA convened officials from its Member countries, world specialists in this field, and industry representatives to foster collaboration on monitoring and exchange views on the policy design.

The IEA released a publication "Things that go blip in the night" (2001) that addressed the general standby power issue. The recommendations of the IEA have now been implemented in several countries, either on a regulatory or a voluntary basis. Others countries have adopted other thresholds or used other policies options. All in all, the identified issues have now already been partly addressed. More needs to be done because most of the countries still have to implement sets of policies to this regard, because of the growing number of appliances and devices using standby power and finally because all potential technology improvements are not yet implemented.

Efficient solutions for external power supply have been highlighted during the IEA Workshops dealing with standby consumption. Some have been introduced on the market afterward. The government-led initiatives have received support from companies. Some companies are involved in the development of efficient solutions for power conversion. They some contributed to the IEA Workshops and continuously strive to improve efficiency and foster implementation of technical solutions. They contribute voluntarily to the different existing policies dealing with the standby issue. The website for one particular company provides a comprehensive list of the existing policies in various countries and highlights the contributions of the company, as well as providing information on their developments and the way companies can improve their energy efficiency and brand it (see section 8 for useful websites).

Different country and region level initiatives have been implemented for set-top boxes, including:

- Voluntary negotiated agreements as the European Code of Conduct for set-top boxes (part of the EU Stand-by Initiative, see section 8),
- Mandatory efficiency CEC standard (California Energy Commission),
- Voluntary endorsement labels like Energy star (under revision) or the Korean KEMCO label (which is also used for preferential government purchasing and may anticipate a MEPS).

The success is largely due to IEA's capacity to gather a critical mass of stakeholders and create a common understanding of the issue, its importance for energy consumption, and its technical solutions.

The set-top boxes issue was addressed in an IEA Workshop in June 2004. The subject is complex because of the number of possible services involved in set-top boxes. Nevertheless, industry representatives participated in an active and constructive manner; and some improvements in design have already been implemented to date. Further work is required to fully address this up-coming issue.

4.4 China as an example of comprehensive approach

China is currently relying on international expertise and experience to implement energy labelling and minimum energy efficiency performance standards (MEPS) for an impressive number of appliances. They even plan MEPS for passenger cars which would eliminate many inefficient vehicles.

The Chinese government aims to curb energy demand through these new policy instruments, and Chinese industry will probably increase its international competitiveness as a result of these national requirements.

A number of international collaboration initiatives have taken place or are still underway, involving a lot of foreign countries, international organisations, NGOs, companies, etc. Some key elements are common with previously detailed example of Tunisia.

From endorsement label to mandatory label

The China Center for Energy Conservation Product (CECP) is a voluntary program aimed at saving energy and reducing emissions by stimulating manufacturers to produce more efficient products and helping consumers to make more sustainable purchase decisions. In 1998, CECP began an energy conservation certification program for residential refrigerators. This soon expanded to more than ninety product categories covering home appliances, lighting, electronics, office equipment, industrial products, but also water saving products and other environmental-friendly products.

It reports collaboration with a wide range of organisations in this regard:

- United Nations Development Programme (UNDP);
- United Nations Department of Economic and Social Affairs (UNDESA);
- International Energy Agency (IEA);
- International Finance Corporation (IFC);
- International Institute for Energy Conservation (IIEC);
- United States Environmental Protection Agency (US EPA);
- Energy Foundation (EF);
- National Resource Defense Council (NRDC);
- Lawrence Berkley National Laboratory (LBNL)
- ICF Consulting;
- Collaborative Labelling and Appliance Standards Program (CLASP).

The basic work of CECP has been on voluntary endorsement label programmes, including energy efficiency, water conservation, and environmental protection. In 2005, China launched a new mandatory energy information label, which loosely resembles the European model but with five classes ranging from 1 to 5 instead of seven, initially to be used on refrigerators and air conditioners. On these two products, the labelling schemes overlap, but the energy information label is unlikely to be extended to all other voluntarily labelled products.

MEPS are getting more demanding

Back in 1999, China had already implemented a MEPS for eight product types, including room air conditioners, TVs, radios, refrigerators, clothes washers, rice cookers. CNIS (China national institute for standards) is responsible for these standards.

International collaboration had a dramatic impact on this policy too:

- Most of the existing requirements have been upgraded, sometimes several times, to adapt to technology and deployment improvements;
- Since then, new appliances have been added (e.g. lamps) or are under development (standby).

Industrial restructuring and market background

The experience and process for the appliance manufacturing sector and other industrial sectors have been very different in China. Early on the appliance sector went through a process of "privatisation" and ceased to be government owned or operated. The transformation of the sector in the 1990s to the present day has been based primarily on market responses – increased competition, quality issues, consumer preferences, pricing, scale of production, international technology partnerships, exporting, etc. – rather than on normative national policy to reshape the sector. From time to time the government has urged consolidation, and has at times (in the 1990s) prohibited further expansion due to oversupply. It has also always supported the development of "national champions" in each sector, but these have been secondary to market responses based on the drive to export and expand market share. In all cases, the result has been a dramatic concentration of manufacturers. Small poor quality manufacturers have merged into bigger companies that have been able to upgrade quality and gain ultimately international market shares. Joint ventures are frequent in this process, which has allowed the Chinese to obtain sound technology through collaboration with companies from other countries.

5. Lessons Learned

5.1 Lesson 1: Transferring technologies and know-how into national context

Successful technology transfer relied on training and capacity building of existing local industry, and not on the transfer of ready-made technologies developed in industrialised countries. The availability of technology is critical but the context for its transfer and proper implementation is even more important.

It is necessary to build on existing industrial and government capacities to ensure success. Additional capacities are to be developed in a consistent and constructive way.

In addition, capacity building would ideally cover both technical centres – be they public or private – and industry. This encourages technology development, energy efficiency policy implementation, and constitutes the necessary basis for further collaboration.

5.2 Lesson 2: Action must target technology and markets

A combination of technological R&D and strong support for market penetration is particularly important for appliances efficiency. Policy instruments may sometimes have to help overcome consumers' or investor's financial constraints, but they have mostly to address market failures. Their success does not only depend on the cost effectiveness of existing technological solutions, but also on organisation, capacity building, awareness of stakeholders and accurate information.

International collaboration contributes therefore to market improvements for energy efficient appliances by adapting the best existing standards and policies to more countries; updating requirements and covering new appliances; fostering a consistent worldwide demand; and triggering an upgrade on the supply side.

Furthermore, as technology continues to evolve, standard and labelling schemes need to be regularly upgraded. This is again an issue where international collaboration is essential.

5.3 Lesson 3: Similarities and complementarities

To a large extent, collaboration on standards and policies can follow the steps of technology collaboration, because technical and legal aspects can be best solved through information sharing and exchange of views, training and capacity building, as is the case for technology improvements.

Furthermore, technology and market policies are synergetic. Energy efficiency policies move demand towards more efficient appliances, themselves promoted by technology cooperation. Capacity building amongst countries leads to a better understanding of the technology and its potentials, which helps set adequate targets for energy efficiency improvements.

Technology activities trigger also potential market improvements. The wider the gap between energy savings potential and actual deployment, the more pressure there is to introduce and enforce energy efficiency policies.

Finally, if correctly implemented, capacity building would cover both technical centres – be they public or private – and industry. This is useful for technology development, energy efficiency policy implementation and provides a base for further collaboration initiatives.

5.4 Lesson 4: International initiative to foster political will and momentum for action

Political will is fundamental in achieving major improvements in this field, as the implementation of such policies requires capacity building, clear political orientation and facing up to opposition to required changes. A clear understanding of local industry conditions (as seen in section 4.4 on China), market opportunities and how local and global competitors can contribute is essential.

It must be emphasised that government's capacity to assess market needs and potential improvements is crucial in putting energy efficiency policy on the agenda of policy-makers. However, capacity building is a necessary first step if the potential provided by energy efficiency improvements is to be realised. International collaboration may be a solution to raise interest in countries and to give momentum to domestic policy-makers' initiatives.

5.5 Lesson 5: A venue for international collaboration

Convening power can provide a form of international coordination, whereby main stakeholders in the electric appliances sector could envisage moving towards certain technology improvements, including the introduction of standards that are viewed as compatible with available technologies.

The IEA provides an international venue for the exchange of up-to-date information and experience, as indicated by past workshops on standby power and set-top boxes. The rising demand of its Member countries and the higher profile of energy efficiency in the context of high energy prices and climate change policy are likely to create momentum for further activities of this kind.

5.6 Lesson 6: Industrial context is a key issue

The particular industrial history of each country is a key factor for successful energy efficiency and industrial policy. China is an example, although other cases exist. China has moved from a closed centrally planned economy to a more competitive market; Cuba implemented an upgrading of its refrigerators' plant with the help of GEF without changing the broader context; Tunisia provides a good example of successful energy efficiency and industrial policy in the refrigerator manufacturing sector.

Technology collaboration for energy efficient appliances has been most effective where local manufacturing capacity existed and know-how could be transferred via changes in manufacturing processes, as opposed to opening borders to more efficient appliances, which would have been difficult to accept for social reasons. The improvement of local manufactures can be achieved through a number of possibilities involving international contributions, e.g. training, but also license agreement and joint ventures.

The experience of restructuring in appliance industries indicates that energy efficiency needs capacity and techniques that are not likely to be developed in small local companies. Merging and fostering R&D is also crucial for domestic industry facing international competition.

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Some Useful Websites

STANDBY AND SET-TOP BOXES:

A particular company much involved in efficient power supplies (see section 5.3): http://www.powerint.com

SemiconTimes news website reports on the development of new power components for set top boxes:
http://www.semicontimes.com/content/archived-news.asp?smonth=11&syear=2004&recid=6552&type=1

EU Stanby Initiative :
http://energyefficiency.jrc.cec.eu.int/html/standby_initiative.htm

California Energy Commission:
http://www.energy.ca.gov/
http://standby.lbl.gov/

POWER SUPPLIES

http://www.efficientpowersupplies.org/

STANDARDS AND LABELLING

http://www.clasponline.org/

ENERGY STAR©:

http://www.energystar.gov

http://www.eu-energystar.org/

CHINA:

http://www.cecp.org.cn/englishhtml/

IEA DSM IMPLEMENTING AGREEMENT

http://dsm.iea.org/ (see Annex 7: International Collaboration on Market Transformation, Annex 10: Performance Contracting, Annex 11: Energy Use, Metering and Pricing for Demand Management Delivery and Annex 12: Co-operation on Energy Standards)