Energy Efficiency Policies and Indicators:

WEC Report 2001

Annex 1

Case Studies on Energy Efficiency Policy Measures

Table of content

Case studies on labelling programmes and efficiency standards for household electrical appliances: Brazil, China, Japan, Thailand, UK, USA 123

Case studies on energy audits: Australia, Finland, Korea, Thailand, USA 141

Case studies on economic and fiscal incentives: China, Japan, Thailand, Philippines, Brazil, USA, UK, Greece.. 157

Case studies fiscal measures on cars: Austria, Denmark, France, The Netherlands, UK........... 166

Case studies on energy efficiency regulation for new buildings: Australia, California, China, European Union, Germany, Hong Kong, Japan, Poland, Slovakia, Thailand 176

Case studies on labelling programmes and efficiency standards for household electrical appliances: Brazil, China, Japan, Thailand, UK, USA

Brazil: National Electricity Conservation Programme (PROCEL)

- **Objective of the programme**

PROCEL was established by the government in December 1985. Its objective is to promote energy efficiency. The programme works on both increasing end-use efficiency and reducing losses in electricity generation, transmission and distribution system. PROCEL funds or co-funds conservation projects that are carried out by state and local utilities, universities, state agencies, private companies, etc. The programme has focused mainly on energy efficiency improvements in refrigerator/freezers, air-conditioners and lighting sectors.

- **Main characteristics of the programme**

Actions taken by PROCEL in the field of cold appliances, in close cooperation with manufacturers, include the adoption of a standard test procedure for measuring electricity consumption of refrigerators/freezers (mid-1980s), initiation of a testing and labelling programme (1986), setting of voluntary energy efficiency standards (1994), recognition and awards for the top-rated models (1995-98), rebate programmes for the top-rated models (1996-97), revision of the test procedure and labels, and new voluntary agreement with manufacturers in 1998.

At the end of 1999, the following equipment was labelled: refrigerators (one door, two doors, frost-free, compact), freezers (vertical, horizontal), air conditioners (residential), electric showers, electric motors (1 HP- 150 HP). Labelling of washing machines is ongoing.

Brazil has voluntary efficiency standards for refrigerators. In the early nineties, PROCEL and the appliance manufacturers negotiated an agreement concerning efficiency standards, which applied to new one-door refrigerators starting in 1995, and to new two-door refrigerator-freezers and freezers starting in 1996. In 1998, a new voluntary agreement was signed that calls for a 10% improvement in the average efficiency of new refrigerators, freezers and air conditioners sold in Brazil by 2000 and a new 20% by 2002.This agreement included changes in the labelling system.

- **Impact / evaluation**

  - Market transformation

Early introduction (for a developing country) of standardized test procedures and labelling programme in mid-80s is considered to have greatly increased energy efficiency of cold appliances. At that time, typical one-door refrigerators consumed 525 kWh/yr and two-door models consumed 800 kWh/yr, resulting in a national average consumption of 600 kWh/yr for cold appliances). According to Brazilian appliance manufacturers, the average savings per refrigerator and freezer model reached 90 kWh/yr by 1993 and 135 kWh in 1996, respectively 15 and 23% reduction from the baseline consumption for new models in 1985. PROCEL estimates that the average savings increased to 170 kWh/yr by 1998 due mainly to the introduction and growing market share for high efficient models.

In 1994, as a result of PROCEL efforts on labelling, one major manufacturer introduced a new refrigerator-freezer consuming less than half as much electricity as previous models produced and sold in Brazil. But the influence of this introduction on market transformation is not known.

- Energy savings

Based on discussions with manufacturers and different experts, PROCEL is taking credit for 50% of the over mentioned energy savings which represents 1 600 GWh/yr of electricity savings in 1998 as a result of efficiency improvements made during the period 1986-98.

PROCEL estimates that its overall efforts resulted in 5 300 GWh savings in 1998 taking into account cumulated activity of the programme on refrigerators/freezers but also on lighting, metering, motors, etc. These savings and additional generation resulting power plants improvements enabled utilities to avoid constructing 1600 MW of new capacity meaning approx. $3.1 billion of avoided investments.

- Public costs

In the first years, PROCEL spent a total of approximately $25 million. This budget has been greatly reduced between 1990-92 and then progressively increased up to 20 $million per year by 1997/98 A specific loan fund is also available for efficiency projects (approx. $140 million in 1998).

- Problems / difficulties / adaptations

The existing energy efficiency law in Brazil does not authorize to introduce mandatory efficiency standards. As a consequence, the results of the agreement with manufacturers on efficiency standards are mixed. Manufacturers have only partially complied with these voluntary standards, replacing some inefficient models but maintaining production of others beyond the agreed upon deadline. A draft law is being discussed which would authorize the setting of mandatory minimum efficiency standards for appliances, lighting and other equipment.

In 1997, new energy labels have been introduced in Brazil, which are based on the European concept but still voluntary in nature.

- **Accompanying measures**

In 1994, PROCEL introduced a "seal of approval" for the top-rated models in the marketplace in order to stimulate the dissemination of more energy efficient models. This programme is still effective, and should reinforce the effectiveness of the new labelling scheme. Accordingly, a (regional) pilot project has been launched in 1996 to stimulate greater purchase of top rated models through rebates and advertising.

- **Main references**

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Geller, H., Almeida M., Lima M., Pimentel, G., and Pinhel A., Update on Brazil's national electricity conservation program (PROCEL), ACEEE, June 1999.

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China

- **Introduction**

China first enacted minimum energy performance standards in 1989 for eight residential products including, refrigerators, clothes washers, and air-conditioners as well as less energy-consuming appliances such as fans, rice cookers, televisions, radio receivers and recorders, and irons.

A first revision of existing standards has been undertaken at the end of the 90s. First to be revised was refrigerators standards, which went into effect on 1 January 2000. On 1 June 2000, new mandatory standards will be effective for electronic ballast, followed by air conditioners in the first quarter of 2001 and fluorescent lamps in mid 2001.

Until 1999, there was no labelling system in China. A voluntary endorsement-type energy efficiency labelling has been introduced in China in August 1999, which first applied to refrigerators. There is a project underway to develop a mandatory labelling system based on the European energy label.

- **Objective of the programme**

The new Law on Energy Conservation aims to slow down the very rapid growth of residential electricity demand (270% over the period 1985-92 compared to 31% for the overall electricity consumption) by stimulating manufacture and purchase of energy efficient appliances. As refrigerators, lighting and air conditioners are among the fastest growing end-uses for electricity in China, the process of setting minimum efficiency standards is centered on these appliances.

- **Main characteristics of the programme**

First standards established in 1989 were derived through a consensus process with manufacturers without performing engineering or statistical analyses. The technical committee issued draft standards and then solicited comments. According to our information the new refrigerator standards were prepared using the same consulting process. Although these minimum efficiency standards were not very high, it is not clear whether or not they were mandatory.

- **Impact / evaluation**

According to our information, no evaluation of the standards has been done. Even the State Bureau of Quality and Technical Supervision responsible for energy standards has never evaluated the market impact of existing standards. Impact of the revised standards implemented under the new Law on Energy Conservation is of course unknown for the time being. Accordingly the impact of the endorsement label on refrigerator market transformation is impossible to assess given the limited period of implementation.

- Market transformation

Refrigerator production in China jumped from 1.4 million units in 1985 to almost 11 million in 1998 and China's refrigerator industry is now the largest in the world. First standards have apparently not been very effective for market transformation because they were too weak: about 95% of the equipment already met the standard at the time of the promulgation. On average Chinese appliances are less efficient than those produced in developed countries; the standard Chinese refrigerator uses 2.5 kilowatt-hours per litre of volume per year which has to be compared to 1.5 kWh/l for European refrigerators.

Following the European-type label, efficiency of Chinese refrigerators on the market is as follows: 3% of models belongs to category A, 25% to category B and 60% to category C or D. The new standards could disqualify 5 to 10% of models on the market. A small but growing market for highly efficient appliances seems to appear in China. Some Chinese appliance manufacturers have found that energy efficiency has high marketing value.

- Energy savings

As the impact of the programme has not been evaluated yet, the energy savings are not known. The objective of the new market transformation programme implemented in 1999 with GEF support is to avoid 100 million tons of CO_2 over the lifetime of the refrigerators produced between 2002 and 2012 (the programme includes standards and labelling actions and other market transformation activities). A study on the impact of new standards for air-conditioners estimates that 20 million tons of CO_2 would be avoided on the same period.

- Public costs

The budget allowed to the Technical Committee for the preparation of new standards is estimated to be approximately US$ 1 000.

- Problems / difficulties / adaptations

First standards were not very effective because most products already met the standards and enforcement has not been really strict. The process chosen and the budget allowed to the preparation of new standards does not permit to rely on precise market data and detailed analysis of Chinese appliances real energy efficiency. As a consequence, the market transformation effect of the programme is probably less important than it could be. An attempt to introduce an Energy Star-type label for refrigerators has finally been abandoned because not enough models available on the Chinese market could receive the label.

- **Accompanying measures**

In 1989, the US EPA has launched the "US-China CFC-Free, Energy-efficiency refrigerator project" to transform refrigerator production in China. The project, which includes labelling and standards activities, is now supported by the GEF.

- **Main references**

Egan, K., and Du Pont, P., Asia's New Standard for Success: energy efficiency standards and labelling programs in 12 Asian countries, IIEC report, July 1998, Washington

Sinton J., Levins M., Fridley D., Yang F., and Lin J., Status report on Energy Efficiency Policy and Programs in China, Lawrence Berkeley National Laboratory, Energy Analysis Dpt, Dec. 1999.

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Japan: MEPS and Top-Runner

- **Introduction**

Appliance energy-efficiency standards were first introduced in Japan, in 1979, under the Energy Conservation Law as a reaction to the oil shocks. Refrigerators and household air-conditioners were the two appliances chosen for the first energy performance standards. Standards for refrigerators were removed in 1984 since all manufacturers have already exceeded efficiency targets. In 1994, new appliances were added to the list including fluorescent lamps, televisions, heat pumps, copiers and computers.

The Energy Conservation Law has been revised in June 1998 to reinforce previous standards. It established the Top-Runner Programme in which the energy performances of the most efficient products supplied domestically are used to set up the next efficiency standards. Products included in the Top Runner Programme are passenger cars and trucks, air conditioners, fluorescent lights, refrigerators, TV, VCRs, photocopiers, computers and hard-disk drives.

- **Objective of the programme**

First energy-efficiency standards were easily reached by the manufacturers using existing technology at little or no incremental cost. With the new standards based on the Top Runner approach, the objective is to stimulate technology development. The new standards will dramatically improve energy efficiency of appliances by setting targets values according to the current highest efficiency levels for each category of products.

- **Main characteristics of the programme**

Japan's energy efficiency standards programme differs from similar programmes in most other countries because it does not impose minimum energy performance standards for individual appliances. Japanese standards set a lower limit for the average efficiency of each manufacturer's shipments, when each appliance has to meet the standard with the European or US system.

With the new Top-Runner Programme, the standards are set according to the efficiency level of the most efficient product available in given category. For each manufacturer, the weighted average efficiency of all units shipped within a category must meet the standards for that category. Imported goods are also concerned.

Another important characteristic of the Top-Runner Programme is also the consideration of stand-by power loss of equipment such as televisions, video recorders and computers. As stand-by mode may represent up to 85% of annual energy consumption (for VCRs), stand-by consumption is included in the calculation of the energy-efficiency index for these appliances.

It is not clear whether Japanese standards are mandatory or voluntary. According to the Law, standards are voluntary for manufacturers and retailers but none manufacturer would risk negative publicity because it fails to achieve the standards. So, the standards are considered as mandatory even if legal sanctions in the Law are weak.

- **Impact / evaluation**

Very few evaluations of the existing standards and labelling programmes in Asia have been conducted and, surprisingly, reference to the impacts of Japanese energy performance programme is also very limited in the literature.

- Market transformation

First energy efficiency standards for refrigerators and air-conditioners resulted in significant efficiency improvements; between 1978 and 1983 (first standards target year), energy consumption decreased by 50% for refrigerators and 25% for air-conditioners. The impact of performance standards may be seen through the increase in unit energy consumption after 1983 when standards for refrigerators were removed.

- Energy savings

Expected energy savings effects of revised standards using Top Runner Programme are huge: 63% reduction in weighted-average energy consumption for heat-pumps, 17% for fluorescent lights, 16% for TVs, 59% for video recorders, 30% for refrigerators, etc. (different target years between 2003 and 2010).

For TVs, if 40% of the stock meets the new standards, 3 000 GWh of electricity will be saved in 2000. For copiers, if 66% of the stock meets the standards, then 13 GWh will be saved and average efficiency of copiers will increase by 3%.

The Top Runner Programme as a whole is expected to save approximately 10 $MtCO_2$ compared to the objective of 60 $MtCO_2$ that Japan must realize in order to stabilize its emissions to the 1990 level.

- Public costs

There is no information available on the global cost of the programme but the administrative cost of preparation is likely to be limited given the very short time needed for setting up new standards. Conversely, verifying compliance may necessitate higher costs than in other similar programmes (cf. infra).

- Problems / difficulties / adaptations

Improvements required by the energy efficiency standards set up in 1994 was too small to significantly stimulate technical change and produce large energy savings. These "weak" targets may result from the non-mandatory nature of the Japanese energy-efficiency standards and labelling policy, and the importance attached to the negotiation process with the different stakeholders. With the Top Runner Programme the strategy has changed, the objective being to introduce the best available technology in all the products and induce dramatic changes in energy-efficiency.

In Japan, standards are based on the sales-weighted average efficiency of each manufacturer's shipment. The advantage of this approach is its flexibility. It leaves more freedom to the manufacturer to adapt to the new regulation: they are free to keep energy consuming equipment on the market but they have to stimulate purchase of more energy-efficient equipment in order to meet the sales-weighted average efficiency target. The drawback of this approach is in the higher cost of the control process.

- **Accompanying measures**

Voluntary labelling is expected to be introduced in summer 2000 for different appliances.

- **Main references**

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Energy Efficient Strategies, Test Standards in APEC Member Economies, Main Report, Nov. 1999.
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Thailand: labelling programme

- **Introduction**

In 1991, Thailand launched a large national DSM plan managed by the national utility, the Electricity Generating Authority (EGAT). In 1992, the Energy Conservation Promotion Act was passed which authorized authorities to issue regulations establishing mandatory minimum efficiency standards and energy labels for energy-consuming products. EGAT initiated the refrigerator labelling programme in 1994 (programme was launched on September 1994 and refrigerators have been labelled since February 1995) and a similar programme for air conditioners in 1996 (programme on September 1995 and products labelled in February 1996).

In 1999, no minimum efficiency standards had been set but the National Energy Policy Office has commissioned a major study, which should make recommendations to the government for a comprehensive set of standards for some appliances. Refrigerators, air conditioners, electric motors, fluorescent lamps, and ballast are likely to be considered for minimum efficiency performance standards.

- **Objective of the programme**

The purpose of the DSM programme is to reduce peak energy demand while maintaining system quality and to develop energy-efficiency-oriented attitude within Thai consumers. The idea is to stimulate local manufacturers and importers to disseminate more efficient appliances on the market and to provide consumers with information in order to adopt energy saving appliances. Refrigerators and air conditioners have been chosen for initiating the labelling programme because there are the two largest and fastest growing end-uses in the residential sector.

- **Main characteristics of the programme**

Appliance labelling in Thailand differs from other similar programmes in that it is operated by the electricity utility (EGAT) and it has been a voluntary programme at the beginning. It is based on an agreement by the five leaders in the Thai refrigerators market for a voluntary testing and labelling programme for the largest category of domestic refrigerator (150 to 200 litres). Refrigerator labels have become mandatory in March 1999 for each model on the market including refrigerator-freezers (expected in 2000 for air-conditioners).

Initial cooperation of the manufacturers has been obtained easier than expected for the refrigerators because they believed that their products could compete more effectively if cheap, low quality products were prevented from being sold.

The overall approach to DSM has been to supplement voluntary programmes with nationwide campaigns and interest-free loans to customers; a very large media campaign has been organized to educate the public about the label system and the benefits of more efficient appliances. Direct consumer incentives were not judged necessary because the price differentials between the standard and more efficient refrigerators were limited.

- **Impact / evaluation**

  - Ex-post evaluation

No comprehensive study had evaluated the impact of the labelling programmes at the end of 1997 but limited results are available which indicated that the programme is successful. More detailed ex-post evaluation studies may be available in the future as part of the budget of the DSM programme comes from the Global Environment Fund.

  - Market transformation

According to different sources, labelling of refrigerators has incited manufacturers to increase their production of high-efficient models and to modify existing models in order to make them energy-efficient.

The efficiency scale on the label for each programme is one to five, with five being the most efficient. At the beginning of the programme (Fe. 1995), only one model was rated at five; by the end of 1996, the number of participating models had more than doubled and 70% of refrigerators were rated at five.

A comparison of Thai and US energy labelling initiatives indicates that this programme is having a significantly greater impact on the consumer appliance market than the older US programme: when 60% of Thai consumers ask about or look at the label, just 20% of American consumers do the same. Thai's programme may have a greater impact because its objective is clearly to persuade consumers to buy more efficient appliances when US programme only provides consumers with information.

  - Energy savings

Savings seem to be greater than expected. Average energy use of single-door refrigerators participating in the programme has decreased from 435 kWh/yr in 1995 to 389 kWh/yr in 1998. Total saving goal of the programme was 311 MW, with specific goal for refrigerators of 27 MW and 22 MW for air-conditioners. According to EGAT's estimates, savings had exceeded targets in October 1997, with a peak demand reduction of 39 MW and 297 GWh of energy saved for refrigerators, (respectively 13 MW and 297 GWh for air-conditioners). Corresponding $C0_2$ reductions are 177 000 t and 102 000 t respectively.

  - Public costs

The budget to implement the refrigerator programme is about 7,8 millions $ but it is not clear if all costs related to the programme administration expenses, advertising, etc.) are included or not.

  - Problems / difficulties / adaptations

Efficiency improvements made by the refrigerator manufacturers have been mainly incremental and achieved through improving the efficiency of compressors. Only one manufacturer has fundamentally changed the design by increasing insulation thickness.

Because the labelling system refers to the average energy consumption of Thai models, highest efficiency refrigerators may be less efficient than models in other countries (in

Thailand labelled models consume 485 kWh on average and between 340 to 450 kWh/yr for similar models in India).
Since the labelling programmes were voluntary, none of the manufacturers have chosen to label the products which are less efficient than average. There are no products rated 1 or 2 and very few rated 3.

The very large advertising campaign has produced positive results on Thai consumers inducing more energy-efficient purchases. But paradoxically, advertising has also lead to an increase of energy consumption because it has stimulated the purchase of air-conditioning equipment.

- **Accompanying measures**

The mandatory labelling programmes for refrigerators and air-conditioners will be soon complemented with minimum efficiency performance standards. Similar voluntary labelling programmes are effective for fluorescent tubes, electric motors, CFLs and ballast.

- **Main references**

Egan, K., Energy efficiency standards for electrical appliances: regulatory and voluntary approaches in the Philippines and Thailand, Compendium on Energy Conservation Legislation in Countries of the Asia and Pacific Region, United Nations ESCAP, 1999.
World Bank, Thailand - Promotion of electricity energy efficiency – GEF grant mid term review, East Asia and Pacific Regional Office, Sept. 1996.
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EU label and MEPS: case of United Kingdom

- **Introduction**

The energy-labelling framework Directive has been issued by the European Commission in 1992. The Energy Label became mandatory for cold appliances first for the Members States in 1995 (effective introduction in European countries depends upon national legislation). In UK, the display of energy label is compulsory for all cold and wet (washing machines, dryers) appliances in UK, and under consideration for different appliances.

Following the Label, minimum energy efficiency standards have been implemented throughout Europe in September 1999.

- **Objective of the programme**

The aim of the labelling programme is to facilitate the comparison of energy consumption between different appliances in the European Member countries. It is supposed to stimulate purchase, and as a consequence, manufacturing and retailing, of more energy-efficient appliances. Energy Label is also aimed at removing energy consuming models out of the market and as such to facilitate the implementation of minimum energy efficiency standards at the European level.

- **Main characteristics of the programme**

The Energy Label is the same throughout Europe. Energy efficiency is expressed on a scale from G (low efficiency) to A (high efficiency) with a corresponding colour code (from red to green). Colour and energy classes are supposed to facilitate the comparison between different appliances and the identification of the best available models. Absolute performance is also available through the annual energy consumption of the appliance.

Manufacturers are responsible for measuring energy consumption of appliances and for providing retailers with completed labels. Retailers are responsible for displaying the Label on each appliance.

With minimum energy efficiency standards, manufacturers, importers and retailers were not allowed to sell cold appliances belonging to energy classes G, F, E and D, from September 1999.

- **Impact / evaluation**

The evolution of EU cold appliance sales by energy class has been monitored from 1994 to 1996 in order to estimate the impact of the labelling programme on market transformation. It shows a significant shift of sales toward more efficient appliances since several years, which results from technical progress, evolution of consumer preferences, and introduction of energy labelling and efficiency standards.

- Market transformation

Average electricity consumption of new appliances has been decreasing since 30 years in European countries, and particularly in UK from 710 kWh/yr in 1975 to 645 kWh/yr in 1995 and 523 kWh/yr expected in 2010 for fridge-freezers.

The introduction of the Energy Label has favoured this evolution with a progressive shift of sales from low efficient to efficient classes: F and G from 20% to 15% between 1995 and 98, D and E from 57% to 50%, and B and C from 23% to 35%, respectively. Even if the Energy Label is not responsible for all this change in purchase, the average consumer was buying a more efficient machine at the end of 1996 than was being bought at the beginning of 1995; the new purchase used 20% less electricity than the old machine it replaced.

- Energy savings

Modelling analyses forecast a decrease of the total electricity consumption of cold appliances without any policies (ref. case) between 1990 and 2020 as a result of the decreasing unit energy consumption and the forthcoming saturation of ownership level: consumption is expected to decrease from 17,4 TWh in 2000 to 16,0 TWh in 2010 and 14,6 TWh in 2020. The introduction of label and 1999 efficiency standards may induce a further reduction in electricity consumption between 12 and 13.5 TWh. But if Energy Labels are revised taking account of regular technical progress and first standards are reinforced, energy savings could reach 8 TWh in 2020 (very optimistic assumptions).

- Problems / difficulties / adaptations

Purchase of efficient cold appliance was in UK very limited compared to some other European countries (Germany, Netherlands for example) before the introduction of the Energy Label. Energy labelling has somewhat modified consumption patterns but the evolution of preferences is slow and the proportion of highly efficient models in sales is still limited.

Independent analyses have revealed a tendency for some manufacturers to overestimate the energy efficiency of their products (not specific to UK) leading to a false classification of some appliances according to the energy classes. In the first years of the legislation, it has also been noticed that a significant proportion of models were not or improperly labelled because the manufacturers did not provide the labels or because the retailers were reluctant to display the label on low efficient models.

The influence of retail staff on the effectiveness of the energy label has been observed in several countries. A limited number of purchasers can make use of the information on the label without explanations from the retail staff. Motivated salespersons may induce purchase of more energy efficient appliances. But, at the opposite, insufficiently trained staff will minimize the interest of the new legislation if it does not fit with own criteria of quality.

- **Accompanying measures**

Discounts have been granted to A-C rated appliances in the framework of a programme launched by Scottish Hydro Electric. Energy saving Trust is also providing discounted efficient cold appliances to low income households to accelerate replacement of old, inefficient stock.

Negotiated agreements have been signed between the European Commission and the manufacturers for washing machines, televisions and videocassette recorders, which are very similar but allow more flexibility than minimum energy efficiency standards.

Following an agreement with US EPA, Energy Star labelling scheme will be adopted for office equipment in European countries. The European Commission estimates that office equipment consumes about 50 TWh of electricity in Europe each year. The proposed Energy Star programme is expected to help reduce this consumption figure by about 10 TWh/yr by 2015 (equiv. to about 5 million tons of carbon per year)

- **Main references**

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Waide, P., Monitoring of energy efficiency trends of European domestic refrigeration appliances, Final Report, SAVE contract, 1999.
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United States of America

- **Introduction**

Mandatory energy labelling of appliances was authorized by the Energy Policy and Conservation Act (EPCA) in 1975; the related Energy-Guide programme took effect in May 1980. Labels were required on refrigerators, freezers, dishwashers, water heaters, room air conditioners, clothes washers and furnaces. Later on labels have been required on fluorescent lamp ballast, fluorescent lamps, compact fluorescent lamps (CFLs), general service incandescent lamps.

The National Appliance Energy Conservation Act (NAECA) set efficiency standards and established schedules for mandatory review in 1987. Standards came into force for most major types of residential energy equipment really during the 90s. Residential products covered under NAECA were almost similar to the labelled appliances. Some standards set minimum energy efficiency levels while others were prescriptive.

First significant national appliance standards took effect under NAECA in 1990. These were for refrigerators, freezers, water heaters and room air conditioners. They were updated effective in 1993. New standards for refrigerators and freezers will be effective in July 2001.

- **Objective of the programme**

The idea of labelling programmes is to provide consumers with information on a product's relative energy use, operating cost, or efficiency. The philosophy behind comparison labelling is that if consumers have easy access to reliable energy performance comparisons they will make better-informed decisions and select more energy efficient products.

Efficiency standards are a complementary instrument to energy labelling. By setting a minimum efficiency level, standards remove inefficient products from the market and ensure that efficiency improvements are incorporated into all new products.

Both energy labelling and standards are supposed to stimulate technological change. With standards, manufacturers are obliged to increase products' efficiency in order to conform to legislation. Energy labelling may also stimulate innovation, some manufacturers seeking to differentiate from competitors on energy efficiency attribute.

- **Impact / evaluation**

  - Ex-post evaluation

Department of Energy (DOE) periodically reviews and updates the efficiency standards according to the transformation of the market. With the new process rules for standards setting (cf. infra), market analysis, national benefit analysis, analysis of impacts on consumers, utilities and manufacturers will be carried more systematically.

- Market transformation

Refrigerators and freezers are the appliances for which standards have been the most successful. The average rated electricity use of new refrigerators declined from about 1725 kWh/yr in 1972 to about 653 in 1994, and is expected to reach 475 kWh/yr in 2001. This large decline in electricity use was accompanied by a 10% increase in average refrigerator size and a greater penetration of feature such as automatic defrost. It is estimated that minimum efficiency standards have played a critical role in stimulating these efficiency improvements.

The 1990 standards required a 10% improvement in efficiency; many models available in 1989 already met this standard but they forced the least efficient models out of the marketplace. However, the 1993 standards were set at a level (30% improvement) that no products available in 1989 could meet. Manufacturers had to introduce an entire generation of new products in order to meet the 1993 standards.

This improvement in energy efficiency did not lead to an increase of prices. Consumer Price Index for refrigerators and freezers only increased 1.4 % per year between 1982/84 and 1993 (1.25% when taking into account increases in size), while the overall CPI for all goods increased 40 % and previously observed increases in current prices of refrigerators was 1.1% between 1948 and 1983.

- Energy savings

Impacts of energy labelling on market transformation cannot be isolated from the impacts resulting from the introduction of efficiency standards. As the results of energy labelling are generally considered mixed, direct energy savings are supposed to be limited compared to general impact of efficiency standards.

Existing appliance efficiency standards and updates are expected to save about 88 TWh/yr in 2000 and 245 TWh/yr in 2015 (respectively 2.7% and 6.0 % of projected electricity use). Corresponding peak capacity saved will be respectively 21 GW and 62 GW. According to LBL, existing standards will prevent 29 MtC emissions in 2000, and 65 MtC in 2010.

New standards to be adopted in the next few years (on clothes washers, central air conditioners, transformers, furnaces and boilers, fluorescent ballast, water heaters, etc.) could produce primary energy savings of 0.8 EJ in 2010 (approx. 3% of the projected residential energy consumption in 2004). This would eliminate the need for almost 32 GW of summer peak capacity in 2010 and 91 GW in 2020. Corresponding carbon emission savings are 13 MtC in 2010. Emission savings from efficiency standards would represent 15% of the US target for 2010.

Existing standards should save consumers about $130-160 billion net (i.e. energy costs savings minus the increased first cost-US$1996) over the lifetime of the products purchased by 2030. This implies an average benefit-cost ratio of 3.2 for consumers for standards already adopted.

- Public costs

Public costs related to standards are generally considered as low but the problems encountered by the US Department of Energy for reinforcing existing standards have shown that budgetary question was not insignificant. Limited existing information on public costs suggests a Federal government's programme expenditure of 200 million USD.

- Problems / difficulties / adaptations

Until 1994, the label (EnergyGuide) focused primarily on energy costs (in US $). The labels showed the products' estimated annual energy costs and the range of energy costs of similar models. Given the different energy prices in different States, the label also showed the operating cost of the appliance that could be expected under various energy rates. As a consequence, it was not easily understandable for consumers.

In 1994, the labels were revised to improve their readability and usefulness to consumers. New labels emphasize energy use in physical units (kWh). The intent was to make the labels easier to read and more useful to consumers in comparing the energy efficiency of the appliances. But this gain may have come at the expense of replacing a highly visible, easily understood and perhaps more salient number, dollar operating cost, with a "technical" term such as kWh.

DOE encountered serious organizational, budgetary and analytical problems in reviewing and updating of standards in the early 90s. Responding to manufacturers concerns, the Congress issued a one-year moratorium in 1996 on proposing or issuing energy conservation standards. DOE subsequently reformed the standards setting process by making the decision making process more open and understandable but as a consequence; the programme has fallen terribly behind schedule.

- **Accompanying measures**

Apart from standards, several programmes seek to accelerate the adoption of more energy efficient appliances, Green Lights (energy efficient lighting equipment) and Energy Star (computers, office equipment,) for example.

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Case studies on energy audits:
Australia, Finland, Korea, Thailand, USA

Australia: Enterprise Energy Audit Programme (EEAP)

- **Objective of the programme**

There was concern in the Australian Commonwealth government that not all economic opportunities to improve energy efficiency were being tapped by firms. The EEAP was designed to provide information to firms about these opportunities, being the lack of information one of the reasons that could explain the efficiency gap. The EEAP operated between 1991 and 1997.

Additionally, there was a need to understand the behaviour of firms when they make energy-related investments, so as to better formulate policies to improve the efficiency of energy use. For this purpose, the EEAP considered an initial follow-up survey, and later an extensive assessment.

- **Main characteristics of the programme**

The programme was applicable to industrial and service (commercial) facilities. The Department of Primary Industries funded the programme, which paid 50 percent of the audit cost up to a maximum of AUS$5,000 (approximately US$3,700).

Audits were performed by an energy-auditing organisation accredited by the Institution of Engineers, Australia. The programme considered a mandatory follow-up questionnaire within 12 months of the audit.

- **Impact / evaluation**

  - Market transformation

Approximately 1,200 firms participated during the seven years of the programme. The average firm spent about AUS$400,000 per year on energy, which represented about four percent of its operating costs. On average, 5.8 recommendations were made per firm and 4.7 (81 percent) of these measures were actually installed. Improvements to lighting systems were recommended in almost three out of every four audits and were the most common measure. The next most popular measures were air conditioning (45 percent), water heating (35 percent) and industrial equipment (34 percent). Implementation rates were fairly consistent across the different suggested measures, although the more expensive measures were implemented less often.

The audits led to increased energy efficiency awareness, being the springboards for other energy investigations.

- Energy savings

Energy savings amounted to 8 percent of original energy bills on average for each firm. The net present value of the EEAP to the population of firms that took part in it was US$140.3 million, considering an 8 percent discount rate and a 5-year investment life. The following table summarizes the results.

Table 1 Estimated Summary of Australia's Audit Programme 1991 – 1997

Cost Effective Energy Efficient Measures	**Number of Measures per Firm**	**Investment (Million US$)**	**Annual Savings (Million US$/yr)**	**Simple Payback (years)**
Recommended	5.8	108	73	1.5
Implemented	4.7	78	60	1.3

Source Harris *et al*, 1998

- Public costs

The programme demanded nearly 4 million US dollars of public funds, divided between 735 thousand US dollars for administration and half of the 6.5 million US dollars that were spent in audits.

- Problems / difficulties / adaptations

The initial mandatory follow-up survey was poorly designed, so the actual impact of the audits was unclear. Another problem that arose was that some firms expressed that audit recommendations were considered unsuitable or impractical, due to the lack of understanding of auditors with respect to the specific production processes of the firm.

In terms of coverage, the programme attracted larger firms, missing the small ones.

Though the overall programme was considered to be very successful, evaluators did not think that EEAP should be reinstated. Evaluators felt that the programme had achieved its stated purpose and had demonstrated that the auditing process was viable. Moreover, since audits were shown to be cost effective, government subsidies were not necessary. The evaluators thought that if such a policy was to be pursued, it should focus on a firm's entire operations rather than a single facility. Another major recommendation was to promote the use of more sophisticated economic tools than simple payback period, such as net present value. In addition, the use of more sophisticated tools might encourage firms to implement more expensive measures.

- **Accompanying measures**

Due to the poor results of the initial assessment, the Australian Bureau of Agricultural Economics (ABARE) was commissioned to undertake an extensive analysis of the programme. Special attention was given to the firm's attitudes to risk and environment, the rules used in decision-making, and the types of audit recommendations made and whether they were implemented. The results showed that 58 percent of firms were conservative or very conservative when considering investment in energy efficiency measures. The average required rate of return was around 20 percent, though data was limited and the numbers collected varied widely. To assess the measures suggested, 80 percent of firms used the simple payback method; only 30 percent used net present value.

- **Main references**

Harris, J., Anderson, J. and Shafron, W. (1998). Energy Efficiency Investment in Australia. ABARE Research Report 98.2. May 1998. Canberra.

Finland: Energy Audit Programme (EAP)

- **Objectives of the programme**

The main objectives of the programme is to conduct energy audits to identify energy saving opportunities. The EAP started in 1992, and has been managed by Motiva (Finland's energy conservation office) since 1993.

The goal is to have 80 percent of the total building stock of industrial and tertiary sectors audited by the year 2010.

- **Main characteristics of the programme**

The audit programme is very structured with well-planned management procedures, detailed guidelines, auditor training and authorisation scheme, monitoring system and active information dissemination. The process includes the use of various sophisticated models to assess the cost effectiveness of all aspects of the business operation. The main elements include the thorough evaluation of the current energy consumption including end uses and fuel choices, the identification of energy saving opportunities, and the reporting of the audits and implementation of the suggested measures.

Energy audits are conducted on all kinds of buildings and sectors except for residential buildings and government buildings. These buildings are addressed through other programmes rather than the EAP.

Audit legislation is the key driver behind a heavy subsidized programme, paying for 40 to 50 percent of the cost of the audits. This ensures continuity of funds and greater success of implementation of suggested measures.

The development of an automated monitoring system has been a key process that has received significant attention. Although this system has been expensive to develop and has burden associated with its use, it is believed this will allow for the adequate evaluation of the EAP when it is expanded significantly. Also, better data will be available which should lead to more conservation measures being suggested and the need for research in key areas.

- **Impact/Evaluation**

Audits in Finland have been very successful with 4,316 buildings being audited from 1992 through 2000. Currently, the rate of audits is low to achieve the goal of 80 percent of the buildings being audited by 2010. Annual audits need to be conducted on a volume of 50 million m^3 of building space to achieve the goal, but the average rate per year from 1992 through 1998 has been only about 18.5 million m^3. Furthermore, the annual rate has actually been declining in the later years.

- Market transformation

Although that the EAP has been successful, it is hard to see any market transformation taking place. Significant savings have been realised, but if the programme were stopped and/or all funding withheld, it is likely that very few audits would continue. The EAP does have plans to pursue an Energy Service Company (ESCO) activity to increase the number of audits to reach its goal. This activity will hopefully lead to permanent changes in the market and foster private sector activity.

- Energy savings

Table 2 highlights the results for the industrial sector representing 316 buildings with 23 million cubic meters of space. Savings are presented in three main categories: heat, electricity, and water. Although this is not noted in the savings, the water saving also results in additional energy savings from reduced pumping and treatment processes.

Table 2 Summary of Finland's Energy Saving Potential of Industrial Audits

	Energy/Water Savings Potential	Economic Savings Potential	Energy/ Water Percent Savings	Total Investment	Simple Payback (years)
Heat	426.9 GWh/yr	7.94 (M Euro/yr) 7.29 (M US $/yr)	19.8%	19.74 (M Euro) 18.11 (M US $)	2.48
Electricity	80.2 GWh/yr	4.04 (M Euro/yr) 3.71 (M US $/yr)	6.3%	7.09 (M Euro) 6.50 (M US $)	1.75
Water	1642.5 m^3/yr	1.52 (M Euro/yr) 1.40 (M US $/yr)	12.9%	2.73 (M Euro) 2.50 (M US $)	1.79
Total	507.1 GWh/yr and 164.5 m^3/yr (water)	13.51 (M Euro/yr) 12.39 (M US $/yr)		29.55 (M Euro) 27.11 (M US $)	2.19

Source: Adapted from Motiva, 2001. (US$ estimated at 1US$ = 1.09 Euro)

Table 3 represents the overall average savings potential for 2,644 reported energy audits. The rate of implementation is estimated to be approximately two-thirds of the suggested measures being installed within two to three years of the audit. Also, if one compares the two tables, it can be seen that the industrial audits have a greater percent of savings potential with a payback period that is slightly higher. This shows that more savings can be realised if a longer investment period is acceptable to the specific firm.

Table 3 Summary of the EAP Energy Saving Potential for all Types of Audits

	Energy/Water Savings Potential	**Economic Savings Potential**	**Energy/ Water Percent Savings**	**Total Investment**	**Simple Payback (years)**
Heat	893 GWh/yr	19 (M Euro/yr) 17.4 (M US $/yr)	17.3%	44 (M Euro) 40.4 (M US $)	2.32
Electricity	187 GWh/yr	12 (M Euro/yr) 11.0 (M US $/yr)	6.4%	19 (M Euro) 17.4 (M US $)	1.58
Water	2.5 M m^3/yr	3 (M Euro/yr) 2.8 (M US $/yr)	11.2%	5 (M Euro) 4.6 (M US $)	1.67
Total	1,080 GWh/yr and 164.5 m^3/yr (water)	34 (M Euro/yr) 31.2 (M US $/yr)		68 (M Euro) 62.4 (M US $)	2.0

Source: Adapted from SAVE, 2001. (US$ estimated at 1US$ = 1.09 Euro)

- Public costs

The full cost of programme administration is not fully clear. However, annually 1.7 M Euro (~1.6 M US$) is funded for subsidizing the audits.

- Problems / difficulties / adaptations

The immediate problem is the recent decrease in audit activity, although the EAP has a comprehensive plan to address this problem. The primary driver behind this problem is that in the early to mid 90s, Finland's construction sector was not that active so entities looked for areas to increase their business, such as conducting audits. However, recently the construction sector is rather active so interest in audits has declined.

Another significant problem has been the lack of attention or analysis regarding actual installations of suggested measures. Information available suggested that approximately two-thirds of the measures are installed in about two to three years after the audit. This appears to be fairly successful, but no analysis regarding the actual energy savings from direct energy monitoring has been conducted which is rather critical for assessing a programme.

- **Accompanying measures**

There are Voluntary Cooperation Agreements on the Promotion of Energy Conservation that help support the implementation of energy audit suggestions. Recent agreements cover 75 percent of the end use energy in the industrial sector, and 30 percent of the municipal sector. The level for private real estate and construction business enterprises is much lower with only five percent.

There also is a separate programme to conduct condition assessments in residential buildings. The housing authorities manage the overall activity, although evaluation results are not well documented. The fundamental approach is to apply systematic maintenance and repair practices with the development of plans for future building improvements. It is not exactly clear to what extent the focus is on energy conservation.

- **Main References**

SAVE, 2001. "The Guidebook for Energy Audits, Programme Schemes and Administration Procedures." SAVE – Project Final Report.
Motiva, 2001. "Energy Audits in Finland." BMU, Berlin, February 2, 2001.

Korea: Korea Energy Management Corporation (KEMCO) Energy Audit Programme

- **Objective of the programme**

The objective of the programme was to promote the efficient use of energy in every sector of the economy. The audit programme was implemented in 1995.

- **Main characteristics of the programme**

KEMCO funds and conducts audits for service buildings (commercial) and industrial facilities. Any enterprise can apply to KEMCO for energy auditing. In order to encourage the participation of small- and medium-sized enterprises (that is, which use less than 5,000 toe/year or 20,000 MWh/year), the audits for these firms are free. Free audits represented about 82 percent of the total.

KEMCO conducts mainly three types of audits, a Thermal Energy Audit, Electric Energy Audit, and Thermal Video System Audit. The Thermal Energy Audit deals mostly with fuel supplies, combustion processes, waste heat recovery, distribution, and several other areas such as process improvement. The Electric Energy Audit involves the inspection of the electrical supply system, electric service "quality" (power factor), load rates, heat source substitution, waste heat recovery, and overall process improvement. The Thermal Video System Audit uses heat-imaging equipment that measures the surface temperature within an accuracy of 0.1 degree Celsius. This type of audit covers the same areas as the other audits, but is more thorough and accurate.

- **Impact / evaluation**

  - Market transformation

From 1995 through 1999, KEMCO performed almost 2,000 audits; approximately 80 percent were in the industrial sector. Audits have permitted the incorporation of energy efficiency measures, especially in small- and medium-sized enterprises.

  - Energy savings

No information was available regarding total energy savings related to the audit programme. The following table shows a sample of the results from several industrial and building audits. The overall average payback for the sample is 1.3 years with an annual energy savings of 199,313 toe per year. As can be seen from the table, though some building sector audits have been conducted, most investment has been in the industrial sector.

Table 4 Sample of Korea's Implemented Energy Measures from Audits (1995 – 1999)

Programme Area	Number of Audits	Investment (Million US$)	Annual Savings (Million US$/yr)	Annual Energy Savings (toe/yr)	Simple Payback (years)
Buildings	4	0.66	0.24	709	2.8
Industrial	8	48.65	37.33	198,604	1.3
TOTAL	12	49.31	37.57	199,313	1.31

Note Derived from KEMCO, 2000

- Public costs / Problems / difficulties / adaptations

No public information was available.

- **Accompanying measures**

KEMCO provides financial support to those entities whose audits show energy savings of more than 5 percent in three years; further technical support is also provided. Loans cover up to 90 percent of the investment at 5.5 percent interest rate and a five-year payback period.

- **Main references**

KEMCO. (2000). Energy Audits Suggest Rational Energy Use in Building Industry. December 2000. Korea Energy Management Corporation. Brochure and Personal Communication with Ms. Gyung-Ae Ha.

Thailand: Energy Conservation (ENCON) Programme

- **Objective of the programme**

Audits are considered under the compulsory part of the programme, composed of projects on: (a) government buildings, (b) existing designated[1] factories and buildings, (c) factories and buildings under design or construction, and (d) non-designated factories and buildings.

Legislation passed in 1992 implemented the Energy Conservation Promotion Fund, with requirements to conduct energy audits.

The objectives of the four projects under the compulsory part of the ENCON Programme are the following:

- Government buildings: Promote energy conservation in government buildings in order to be examples for the general public as well as to reduce the government budget for energy consumption.

- Existing designated factories and buildings: Support owners to undertake energy conservation measures as specified by laws and regulations.

- Factories and buildings under design or construction: Support owners of factories and buildings under construction to improve the design considering energy conservation.

- Non-designated factories and buildings: Support the owners of existing factories and buildings of this category that wish to implement energy conservation measures in their facilities.

- **Main characteristics of the programme**

The National Energy Policy Office (NEPO) and the Department of Energy Development and Promotion (DEDP) are in charge of implementing the programme. The ENCON Fund Committee and respective Sub-Committees oversee its implementation.

The main characteristics of the aforementioned projects are the following:

- Government buildings: Emphasis is put on projects that yield an internal rate of return equal to or greater than 9 percent. NEPO and DEDP manage both the audits and the implementation of the energy efficiency measures recommended by the audits. The project is designed in two phases, the second of which incorporates the results of the evaluation of Phase 1 done by NEPO.

[1] Designated buildings and factories correspond to large energy consumers (basically those that consume "more than 1 MW or with electricity and/or commercial energy consumption and/or consumption of steam thermal in the past year in a total volume of 20 million megajoules or more of electrical energy equivalent for buildings and 200 million megajoules for factories").

- Existing designated factories and buildings: A grant is provided for the preliminary energy audit and a financial support for energy conservation planning and investment according to the plan. Both grants and financial support come from the ENCON Fund. Auditors participating in the programme must be registered.

- Factories and buildings under design or construction: This project focuses on factories and buildings that, when construction is completed, will fall into the designated category.

- Non-designated factories and buildings: This project is oriented towards the less-energy consuming factories and buildings.

- **Impact / evaluation**

  - Market transformation/energy savings/public costs

The plan for the years 1995 to 2003 considers auditing a total of 6,075 facilities, mainly in the industrial sector. Total investment will amount to nearly 519 million dollars, of which 21.5 million dollars will cover audit costs. Annual energy savings are projected to be 5,294 GWh and demand savings 1,062 MW. The following table summarizes the results for the different sectors considered in the programme.

Table 5 Summary of Thailand's compulsory programmes, plan 1995 – 2003

Programme Area	**Number of facilities**	**Investment (Million US$)**	**Annual Savings (Million US$/yr)**	**Annual Energy Savings (GWh)**	**Demand Savings (MW)**	**Simple Payback (years)**
Government buildings	1,215	100.4 (2.8 audit)	15.0	297	112	6.7
Designated buildings	1,234	154.5 (9.9 audit)	56.3	1,165	403	2.7
Factories	3,626	263.7 (8.8 audit)	185.3	3,832	547	1.4
TOTAL	6,075	518.6 (21.5 audit)	256.6	5,294	1,062	2.0

Note Derived from ECPF

  - Problems / difficulties / adaptations

The evaluation of the programme showed several areas that needed improvement. In the Government Building Project, the use of levelised audit budgets for all facilities proved inadequate, especially for the large-sized facilities.

Due to the financial crisis that affected Thailand in 1997, many designated facilities had difficulties obtaining the additional resources to make up the investment portion not covered by the ENCON Fund, making unfeasible the implementation of audit recommendations. Moreover, regulations on financial assistance were inflexible and amounts insufficient, deterring owners of designated facilities to pursue further steps in energy efficiency improvement.

Staffing problems also arose, both from the part of inadequate consultants that performed the audits, as well as from insufficient personnel at DEDP to cope with their responsibilities.

- **Accompanying measures**

The audits programme is a component of a broader, integrated energy conservation programme, which apart from the aforementioned compulsory programme considers a voluntary programme and a complementary programme. The voluntary programme is composed of projects on renewable energy and rural industry, industrial liaison, and research and development. The complementary programme considers projects on human resources development, public awareness, and management and monitoring.

- **Main references**

ECPF. (no date). Thailand 2000-2004 Plan, Implemented from Energy Conservation Promotion Act, B.E. 2535. Energy Conservation Promotion Fund. http://www.nepo.go.th/encon/encon-fund00.html.

USA: Industrial Assessment Center (IAC) Audit Programme, Residential Weatherization Assistance Program, and Private Sector Activity

- **Introduction**

In the USA, there is energy audit activity in all segments of the economy. With Federal government support, industrial audits are conducted through university programmes across the USA; this has been in place since 1976.

Low-income homes are inspected and weatherised using state and Federal funds. This programme has also been in place since 1976.

Utility service companies conduct energy audits for their commercial, industrial, and residential customers in a variety of ways. The utility service companies may charge a fee for a home audit and/or they may provide it as a free service, especially to larger customers. Data from the utilities are not usually available to the public.

- **Objectives of the programme**

The main objective of the IAC Audit Programme is to conduct audits for business entities to save energy and to increase the profitability of the entity. The existing energy consuming systems and equipment are assessed for the installation of cost effective corrective measures and replacement with energy efficiency equipment. Installation decisions are based mostly on business practices, such as required rates of return and overall business operation plans.

The Weatherization Assistance Program objective is to assist low-income people by reducing their utility bills. Low-income people spend a disproportionate amount of their income on utility bills. The Weatherization Assistance Program saves energy and reduces this financial burden for eligible participants.

- **Main characteristics of the programme**

The US Department of Energy's Office of Industrial Technology funds over 30 IACs that perform, at no cost, comprehensive industrial assessments for small and medium-sized manufacturers. Assessments are performed by local teams of engineering faculty and students from participating universities across the US. Recommendations from industrial assessments have averaged about US$55,000 in potential annual savings for each manufacturer. To be eligible, each facility must have annual sales below US$75 million, have less than 500 employees, and have annual energy bills between US$75,000 and US$1.75 million. The industrial programmes rely on private investment for corrective actions that generally leads to only the most cost effective measures being pursued.

The US Department of Energy and other Federal agencies work to improve the efficiency of eligible low-income households and pay energy bills for people in need. The programme is geared to helping the elderly, the disabled and families with children. The low-income residential programme has funding restrictions per household that prevent large equipment replacements. Weatherisation activity includes the installation of insulation, caulking, storm windows or new windows, new heating systems if there are safety issues, distribution system duct sealing and other energy saving measures.

In addition, the programme may soon be expanded. Weatherization Plus would allow auditors to consider measures that go beyond basic comfort, such as the installation of new high efficiency refrigerators or dedicated (pin based) compact fluorescent lighting fixtures. The current programme allows for expenditures up to US$2,032 per household with about 40 percent budgeted for materials.

- **Impact/evaluation**

The manufacturers are not the only benefactors of the IAC programme. Students involved in the programme have a unique opportunity to see a range of manufacturing operations first hand. Students, encouraged by their experiences and contributions, often choose energy management as a career field. An additional benefit of the programme is that data generated by the assessments are recorded in a database. With good data on energy use, waste and productivity in small and medium sized industry, researchers may be able to devise ways to further improve efficiency in these firms.

The database currently contains information from 36 research centres on 9,600 industrial site visits. Since 1981, 68,000 efficiency measure recommendations with a savings potential of US$740 million have been identified, with about 50 percent of these recommendations having being implemented. The database and training materials are publicly available on the Internet (see URL http://oipea-www.rutgers.edu/database/db_f.html).

For the Weatherization Assistance Program to date, five million households have been weatherised, and the current rate is approximately 170,000 homes per year. Currently, there are many eligible participants that are waiting for this assistance since the demand exceeds available funds. The programme has resulted in average energy savings of 22 percent and a benefit-cost ratio of approximately 2.4 including societal benefits.

- **Accompanying measures**

In the US, a wide range of energy efficiency programmes exist that includes many incentives (including financial) for the installation of energy efficient equipment. These incentives can be used in the audit process to further increase the profitability of implementing measures identified by the audits.

- **Main references**

US DOE, 2001. US Department of Energy's Weatherization Assistance Program. Web page http://www.eren.doe.gov/buildings/weatherization_assistance/
US DOE, 2001. US Department of Energy's Industrial Assessment Center. Web page http://www.oit.doe.gov/iac/

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Energy Conservation Promotion Fund. (no date). *Thailand 2000-2004 Plan, Implemented from Energy Conservation Promotion Act, B.E. 2535.* http://www.nepo.go.th/encon/encon-fund00.html.

Finnish Ministry of Trade and Industry, Motiva, European Commission, IEA, IFE and CRES. (1999). *Proceedings of the International Conference on Energy Audits AUDIT '99*, Turku, Finland, October 10-12.

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U.S. Department of Energy. (2000). *Office of Building Technology, State and Community Programs, BTS Core Databook.*

Case studies on economic and fiscal incentives: China, Japan, Thailand, Philippines, Brazil, USA, UK, Greece

China

China is unique among developing nations in having committed large amounts of national resources to energy savings, spending between 4.5% and 6.5% of the total energy budget on conservation in each year from 1981 to 1990. Significant energy savings have been achieved through a large-scale programme of energy conservation investments, begun in 1981 and aimed mainly at industrial boilers and energy intensive industries such as steel, cement and chemicals. Evaluation of the investments shows that most were cost-effective according to the central government's investment criteria – the marginal cost of energy savings was below the cost of new supply. The programme is estimated to have resulted in annual energy savings of 28 million tonnes of standard coal equivalent (Mtce)/year in 1985 compared to 1980, and 24 Mtce/year in 1990 compared to 1985. It was estimated that during the Sixth Five-Year Plan period (1981-85) the 'energy savings rate' (calculated as annual energy savings compared to the previous year's intensity) was 4.3% per year without taking net imports of energy embodied in intensive products into account.

In the 1990s, particularly after 1994, China implemented policies to promote energy conservation. One aspect of this strategy has been to force energy users to pay the full costs of energy resources by removing energy subsidies. Another method of encouraging resource conservation is through fiscal incentives such as tax rebates for energy efficient investments.

Price reform in China has increased economic incentives for conservation. In 1994, except for coal used for power generation, all price subsidies for coal were annulled. In 1998, for the first time, domestic crude oil prices were allowed to float with international oil prices. Controls on the prices of oil products were removed in 2000. Prices rose substantially once these subsidies were lifted and, as economists would expect, energy-intensive industries reduced consumption of these resources. In the iron and steel industry, for example, energy prices increased by a factor of three between 1986 and 1995. By forcing users to pay the full cost of their energy inputs, firms responded by finding ways to conserve energy and reduce energy expenditures. Over this ten-year period, the iron and steel industry realized energy savings of 15 Mtoe and avoided an estimated 3.87 billion yuan in energy expenditures.

Tax incentives in China favour low carbon energy and energy efficient equipment. Investment in co-generation facilities, energy efficient buildings and the like are exempt from fixed asset taxes. Since 1998, energy conservation and pollution reduction equipment, which is imported from abroad, has been exempt from value-added import taxes.

Japan

In 1993 the "Energy Conservation and Recycling Assistance Law" was enacted. It included a variety of fiscal incentives such as tax exemptions, special depreciation allowances and soft loans, to promote energy conservation by industry in Japan. A reduction of - 1 percent per year in energy consumption levels by all factories was one of the goals of the new law.

The 1993 law introduced several special tax measures for energy efficient equipment. On corporate tax payable, the government offered a tax rebate equal to 7 percent of the purchase price of energy efficient equipment. In 1999, this tax measure was restricted to small and medium-sized firms. Special depreciation provisions of up to 30 percent of equipment costs were also offered. To qualify for this allowance, the new equipment had to guarantee a 5 percent reduction in energy use. In 1996, 26,606 pieces of equipment qualified for special depreciation. In 1997, the number was 21,271 and in 1998 it was 24,609 pieces of equipment. These special taxation measures boosted investment in energy efficient products by 500 billion yen (US$ 4 billion). Investment rose from 300 billion yen in 1990 to 800 million yen in 1993. Purchases fell back to the 300 billion yen level by 1999.

The New Energy and Industrial Technology Development Organization (NEDO) grants subsidies for financing energy conservation technologies. Under the “High Performance Industrial Furnace Field Test Project,” NEDO paid for up to one-third of the cost of each high-performance furnace. In 1998-9, 109 furnaces were purchased through the programme. NEDO estimates that the project will result in energy savings equalling 5 percent of Japan’s final energy consumption by 2010. NEDO also provides funds for demonstration projects. A third of the equity cost for installation of advanced energy efficient equipment is provided by NEDO. In 1997-8, 47 projects were subsidized at a cost of US$ 50 million. NEDO also provides funding for co-generation systems and energy service companies.

Japan also provides loan support for energy efficient investments by industry. The government offers a rate of 2.2 percent to industry on up to half of the cost of the project for a period of 1-30 years. This policy has been less than effective given the deflationary economic conditions in the 1990s.

Thailand

The Energy Conservation and Promotion Act of 1992 created the Energy Conservation Promotion (ENCON) Program, administered by the Department of Energy Development and Promotion (DEDP) and the National Energy Policy Office (NEPO). Funds for ENCON and the Energy Conservation Promotion Fund (ECF) (created in 1995) come from a 0.07 bath (about 0.002 US$)/litre tax on petrol. As at the end of the fiscal year 1999, the ENCON Fund has an accumulated capital of about 14,000 million baht (US$350 million). The ECF, administered by NEPO, provides financial assistance for energy conservation efforts by both the public and private sectors.

ENCON Fund provides financial assistance to cover up to 50% of the cost of the comprehensive ENCON plan development, but not exceeding 500,000 baht (US$12,000) per facility. Each energy conservation measure must yield a higher real Economic Internal Rate of Return (EIRR) than the level specified by the ENCON Fund Committee. At the initial stage, the minimum rate is set at 9%. The main target of a soft loans and/or subsidies is to raise the financial return rates of each energy conservation project to commercially attractive levels.

The Electric Generating Authority of Thailand (EGAT) administers energy efficiency programmes through its Demand-Side Management Office (DSMO). Funds for these initiatives come from donations and a fuel adjustment levy. In 1998, EGAT estimated that DSM programmes, at a cost of US$ 20 million (1993-1998) or US$ 0.01 per kWh, saved 710 GWh and lowered peak demand by 182 MW.

Over the period 1994-1999, programmes from NEPO, DEDP and EGAT cost US$ 770 million. These programmes funded soft loans for energy conservation investments and reduced import duties on energy efficient equipment. The concept underlying these programmes based on financial incentive measures is to make energy-efficiency measures acceptable by the general public. Such incentives will gradually decrease in the future in order to let the market mechanism work by itself, which will spur investment in increasing energy efficiency.

Philippines

The government of the Philippines provides assistance for energy efficiency and conservation projects. These programmes strengthen institutional capabilities in energy conservation, technology and research and development. The National Energy Program (1996-2025) provides US$ 1,035 million for energy efficiency and US$ 139 million for DSM programmes or about US$ 40 million per year. Over the life of the programme, 1996-2025, a total investment of US$ 1.2 billion is expected to generate cumulative energy savings of 90 Mtoe resulting in a net saving of US$ 5.5 billion. The amount budgeted for 1996-2010 for both energy efficiency and DSM programmes is less than 1 percent of the total energy budget.

The Department of Energy (DOE) in the Philippines provides financial support through soft loans to some energy efficiency projects. The DOE paid for 50 percent. A programme called "Technology Transfer for Energy Management" provided loans to demonstrate new technologies. This programme funded 40 projects at a cost of US$ 7 million and these investments are expected to yield 30 ktoe in energy savings over 10 years. The Strategic Business Unit (SBU) provided funds for 280 energy efficiency projects at a cost of US$ 100 million.

Brazil

Economic incentives are creating in Brazil’s PROCEL program aiming to increase dissemination rates for energy efficiency measures. The government of Brazil established a national electricity conservation programme known as PROCEL at the end of 1985. PROCEL, housed at Eletrobras, funds energy efficiency projects carried out by state and local utilities, state agencies, private companies, universities, and research institutes. Eletrobras/PROCEL also helps utilities obtain low-interest financing for major energy efficiency projects from a revolving loan fund within the electric sector. As of 1998, PROCEL's core budget for grants, staff, and consultants was approximately $20 million, with approximately $140 million per year going towards project financing.

Eletrobras/PROCEL estimates that its cumulative activities resulted in approximately 5.3 terawatt-hours per year (TWh/yr) of savings in 1998, equivalent to 1.8 percent of electricity use in Brazil. The electricity savings and additional generation enabled utilities to avoid constructing approximately 1,560 megawatts (MW) of new capacity, meaning approximately $3.1 billion of avoided investments in new power plants and transmission and distribution (T&D) facilities. In contrast, Eletrobras/PROCEL and its utility partners spent approximately $260 million on energy efficiency and power supply improvement projects during 1986-1998. Consequently, the overall benefit-cost ratio for the utility sector was 12:1.

Approximately 33 percent of the savings in 1998 were due to efficiency improvements in refrigerators, freezers, and air conditioners; approximately 31 percent from lighting efficiency improvements; 13 percent from installation of meters; 11 percent from motors projects; 8 percent from industrial programmes; and 4 percent from other activities. In addition to the energy savings, PROCEL has contributed to the development and commercialisation of various new technologies in Brazil. Moreover, PROCEL has produced environmental benefits by reducing the need for new power plants that are increasingly based on fossil fuels.

The importance of improving distribution and end-use efficiency has not been forgotten as Brazil undergoes utility sector restructuring. In July 1998, the new federal regulatory agency for the electric sector announced that it is requiring all distribution utilities to spend at least 1 percent of their revenues on energy efficiency improvements, with at least one-quarter of this amount (representing approximately $50 million per year) spent on end-use efficiency projects. This is leading to expansion of energy efficiency programmes by most utilities. In addition, Eletrobras/PROCEL is seeking a $43 million loan from the World Bank and a complementary $20 million grant from the Global Environmental Facility (GEF) in order to increase its funding base and range of activities.

United States of America

In 1997 the US administration's five-year Climate Change Technology Initiative aimed at cutting GHG emissions proposed to the US Congress various tax incentives for energy-efficient purchases and renewable energy including tax credits for energy-efficient building equipment.

Investment-based incentives have been proposed for development of individual technologies like black liquor gasification, advanced steel-making, advanced aluminium cells - tax rebates of about $500 million for each technology. Tax rebates typically are based on a share of the cost of purchasing highly efficient products and are intended to lower required capital recovery rates. By covering a large fraction of the incremental cost of technologies, they reduce commercialisation risk, increase the efficiency of new purchases and accelerate the turnover of capital stock. However the whole initiative has not been realized.

Utility run ESCO activity is expanding. Currently 19 states have plans to enforce public benefit charges, which in total will generate over $1.4 Billion annually. Spending 53% on energy efficiency. The revenues will mainly be used to expand the work of ESCOs through standard performance contracting. The ESCO DSM-type programmes could result in savings of 5.8 TWh/year in electricity with a typical cost of $0.06/kWh-saved.

Providing tax incentives to conserve energy is considered as a key instrument in national energy policy elaborated by the new US administration. The May 2001 US administration energy report suggests that the country faces the worst energy crisis since the 1970s, and urgent measures should be implemented in the area of more supply and production as well as in the area of energy efficiency and conservation. Proposals include a package of $10 billion tax stimuli designed to promote energy efficiency and conservation.

UK

Thus in the UK energy efficiency improvements are linked to environmental protection. A new Carbon Trust has been set up in early 2001, which takes responsibility for a programme of energy efficiency support measures for businesses. The **Carbon Trust** will provide a co-ordinated, targeted programme of support measures for businesses investing in energy saving technology and practices. New taxation measure supports this institution - the climate change levy is a major new energy-related tax that comes into operation in 2001. The **Climate Change Levy** is a new energy tax, which will apply to the business and public sectors from April 2001. The levy is expected to raise around £1 billion in its first full year and is expected to save at least 2 million tonne of carbon per year by 2010.

Investment enabling measures include the **Enhanced Capital Allowances scheme which** will give 100% first year capital allowances for approved energy saving instruments for businesses, who will be able to take this into account when calculating their corporation or income tax bills. Business will benefit from a trebling of support for energy efficiency measures under the levy package, to around £150m in 2001 through the introduction of enhanced capital allowances for energy efficiency investments.

Greece

In Greece the **Operational Program of Energy** (OPE) **1994- 2000**, which is co-funded by the Greek Government and the Community Support Framework II (CSF II), is an integrated structural intervention to the national energy system. OPE, through its **allocated actions** and **economic incentives,** contributes to the implementation of important projects of the electricity production sector, enforces investments in the field of **rational use of energy - energy efficiency** and drives the promotion of renewable and other indigenous energy sources.

OPE covers the time period of 1994-1999 and comprises four sub programmes. The programme has a total budget of 434 MECU for 1998-1999, out of which 51.5% derive from the European Commission, 29.5% from national public funds and 33% from private funds. It is estimated that the total energy savings by implementation of the programme will be 360 ktoe/year from energy efficiency investments and 225 ktoe/year from renewable energy sources.

Inside the OPE framework businesses may choose either of the following combination of incentives: - grants (up to 40%), interest subsidies (up to 40%) as well as subsidies for equipment leasing (up to 40%) and tax exemptions (up to 100%).

The programme also supports investments of energy efficiency improvement and use of renewable energy sources in the form of subsidies ranging from 30% to 50% for industrial and tertiary sector.
Energy-related investments in energy saving measures are supported by the Law 2601/1998 aimed at the general economic and regional development of the country

Case studies fiscal measures on cars: Austria, Denmark, France, The Netherlands, UK

Austria: Towards a soft CO_2 base tax system?

Austria is a highly environmental sensitive country, which provides an important support to public transport, bike and environment-friendly policies in towns. In relation to the small size of the country, fuel taxes have to be adjusted to the level of neighbour countries.

It applied up to 1992 a VAT tax at a 33% rate on car purchases, which was higher than the normal rate. For the sake of European convergence, this special rate has been replaced by the normal rate and registration taxes now apply: they are price-based with fuel consumption fixing the rate (linear progression from 3l/ 100 km for gasoline and 2 litres/100 km for diesel). For example, a 10000 Euros car will receive a 200 Euros penalty/ rebate for any additional/ lower L/ 100 km. The maximum rate, primarily fixed to 14%, is now 16% fixed, the level achieved for gasoline vehicles whose specific consumption is 11 l /100 km. This tax system, based on fuel consumption, is original and not widespread. On the other hand, the progression is low.

As regards the annual registration tax, no change can be observed: the tax remains proportional to power, with an additional fee (20 %) for vehicles without catalytic converters.

The evolution of the CO_2 emissions of new car sales in Austria is one of the most favourable in the Union (from 186 to 170 g/ km, a 9 % reduction between 1995 and 1999). However, this good result may be related to the evolution of the share of diesel in sales.

Basic figures for Austria

Purchase tax	Market price* (sec-3)*2 (Gasoline) Market price* (sec-2)*2 (Diesel)
Annual tax	Tax= (Power (kW)-24)*4.8 €
Fuel tax	Gasoline: 0.49 € ;Diesel : 0.34 € LPG : 0.31 €

Source: WEC-ADEME survey; sec: specific energy consumption (l/100 km)

Denmark: the independence of a small, non-car manufacturer country with a strong conservation policy

Denmark is a small country, with a high environmental sensitivity. It is a leading country as regards to energy conservation. Nuclear power is not in use in the country, leading to a high contribution of power generation to CO_2 emissions. Government expenses represent a relatively high share of the GDP.

As regards transport, there is a long lasting tradition of support to public transport and bike, and consistency between land use and public transport networks is researched in planning processes.

As regards cars, the country has a long-lasting tradition of very high levels of taxation of new car sales, in relation to the absence of " national " car manufacturers. Car purchases are submitted to VAT at the normal level. Then a 105% tax is applied to the price up to a threshold (53000DKK). The tax is raised to 180% over the threshold. The first effect of this system is to encourage car manufacturers to propose off-tax prices, which are the lowest of the European market. The second effect is to refrain people to be equipped: among wealthy countries of Europe, Denmark has the lowest motorisation level. It has been argued in the past that such a system discourages car renewal. This does not seem established from recent observations: the ratio between new car sales and the size of the fleet is in the European mean. This may perhaps be related to an incentive to car scrapping (200 E) financed through a tax on insurances, even though this subsidy level may seem quite low. It could also be foreseen that such an important tax level drives the demand towards smaller cars. Statistical data do not confirm that view: for example cubic capacity and power are just a bit below the German figures. There is however an important effect, but it must be linked to the level of car ownership: cars which are bought in Denmark are primarily family cars, while in other countries new car sales feed the market for family cars and second cars as well. In that respect, the car " size " should be higher in Denmark, it is not, and it is probably a side effect of the taxation policy.

Basic elements of the Denmark system

Car purchase tax	VAT +105 % under 7124 Euros, 180 % on the part of the price over 7124 Euros Rebates introduced in 2000 for very efficient cars. From 1/6 of the tax just under 4L/ 100 km (gasoline) and 2.5 L/ 100 km up to 4/6 for cars with a consumption lower than 2.5 l/100 km (gasoline) or 2.2 (diesel)
Fuel tax	0.51 € (G);0.34 € (D); 0.31 (LPG)
Annual registration tax	<600kg : 182 € (G) 279 € (D) 600-800 kg : 222 € (G) 340 € (D) 1500-2000 kg : 727 € (G) 1116 (D)

Source: WEC ADEME Survey; G: gasoline; D: Diesel

The growing attention paid to CO_2 emissions and the apparition of cars which pay their fuel efficiency by higher market prices has led the government to introduce consumption - based elements in the system for purchase taxes. From January 2000, a reduction of the registration tax is proposed for vehicles whose consumption is lower than 4 litres/100 km (gasoline) and 3.5 (diesel). If the consumption is just under the figure, the reduction is 1/6 of the registration tax. A 4/6 reduction of the tax is designed for cars using less than 2.5 l/100 km (gasoline) 2.2 (diesel), but such vehicles will exist in future only.

Compared to car purchase taxes, the weight of annual ownership taxes is lower. Up to 1997, the level of the tax was depending on the weight and on the type of fuel (the tax on diesel is circa 50 % higher than the tax on gasoline). Diesel vehicles (which are more expensive than their gasoline counterparts) are discouraged by the progression of the tax on purchases, the fact that the annual tax is based on weight and the differentiation of the annual tax by fuel. These 3 reasons may explain the small share of diesel in the car sales, despite important differences in fuel taxes in the country. This system remains currently in application for cars bought up to 1997. For newer cars, it has been replaced by a tax dependent on fuel consumption the rate is around 200 € for a gasoline car with a specific consumption of 6.5 L/100 km, and grows by 100 €for every additional litre. In the new system, vehicles under 7 L/100 km pay less than in the old one, and the reverse applies to other vehicles. This system manages a transition and combines fairness and efficiency.

France: surprise when approaching the evolution of the global tax revenue from 1985 to 1999

France is a large, low-density country. The larger part of its power is produced by nuclear power. Together with efforts for energy conservation, this explains its low level of CO_2 emissions, compared to other European countries. France has a long lasting tradition of high gasoline price. The tax level on diesel fuel is much lower, in relation to the importance and influence of the trucking industry and the influence of a car manufacturer specialised in low power diesel cars. It has 2 car manufacturers. One of them conducted important technological and marketing efforts to promote diesel cars in the eighties, in relation to the fiscal situation, and became the leader motorist for diesel in the beginning of the eighties. In our sample, France is the only country for which we have detailed time series for all the types of taxes. The presentation will then be focused on a detailed analysis of the evolutions.

Taxes on car in France comprise taxes on car purchases, taxes on ownership and taxes on use.

From 1985 to 1991, there was a specific VAT rate on car purchases (33 % against 18.6 % for other industrial products), which was considered as a specific tax. It has been suppressed in 1992, to conform to European uses. This tax had a significant impact on the cost of motoring, and it can be assumed that it contributed to drive the demand towards less expensive cars. A tax on car registration remains. It applies to new and old car sales, grows progressively with the fiscal power of the car, but its incidence on the “ purchasing price ” is quite low, since it represents less than 2 % of the price of the typical car.

Taxes on ownership comprise 3 different taxes: an ownership tax on cars for households, an ownership tax for company cars and specific taxes on insurance contracts. The rate of the ownership tax for car households was growing with fiscal power, with a significant gap over 7 hp. The rate was 50 % of the normal rate for vehicles more than 5 years old. This tax has been criticised because of this discount for old vehicles (more polluting) and because fiscal power was an imperfect proxy for CO_2 emissions. Progresses had been achieved in that direction in 1999, but the tax has been suppressed at the end of the year 2000. Ownership tax for companies is designed to prevent companies from having large car fleets (its amount per vehicle is much higher than ownership tax for households) and to prevent companies to buy large cars (its amount is much higher over 7 hp). Car manufacturers consider that the existence of this tax is a major explanation to the lower size of company car fleets in France (compared to UK for example) and to the lower penetration of large car (compared to Germany for instance). The third one is a tax on insurance contracts. A rate is applied to the net price of the contract. As this one is dependent upon the price and type of the car and the accident rate of the car owner, some (indirect) link may be established with the specific consumption, the level of use and the driving habits: the tax is clearly much lower for a small vehicle, an underused vehicle and a “ calm ” driver.

The “ objective ” importance of these taxes in France has decreased significantly between 1990 and 1995, in relation to the suppression of the specific VAT level. For analytical purpose, one can compute the tax level on a per kilometre basis. The decrease is more regular, for at least 3 reasons: new car registrations do not follow the size of the car fleet (car fleet is ageing); the annual mileage of the vehicles is increasing. The costs of insurance are decreasing with progresses in safety. It will decrease again from 2001 onwards, with the suppression of the ownership tax for households.

From a more " subjective " point of view, taxes are considered to have their greatest impact when they are paid separately. Ownership taxes are the only ones in this category. It should then be considered that the suppression of the ownership tax for households could contribute to " higher level " car purchases.

Table 1: Tax on car sales and ownership in France
(Billion 1999 French Francs)

	1985	1990	1995	1999
Additional VAT	17.7	10.3	0	0
Registration fee	4.2	6.5	7.7	9.2
Ownership tax (households)	13.9	16.6	15.8	13.4
Ownership tax (companies)	2.5	2.7	2.8	3.6
Insurance specific tax	12.5	12.8	12.8	12.5
Total	50.8	48.9	39.1	38.7
Total, per km basis	0.161	0.127	0.093	0.084

Source: author's computations from " L'automobile en France ", CCFA, several years, and " Comptes transport de la Nation ", several years

As regards taxes on use, some authors consider total taxes on fuel, other ones specific taxes on fuel, some include freeway tolls, and others do not include tolls. For clarity, we shall consider hereunder the total taxes on fuels (including VAT) paid by car and light trucks users and will shall not consider tolls, which can be considered in France as a fee for a service (there are always " free routes " which are alternative to the use of " paying freeways ".

Let us look first at the prices of each fuel (gasoline and diesel oil). Both decrease quite significantly over the period, mainly between 1985 and 1990.This decrease eases the consumer either to travel more or to buy cars with a higher consumption. This decrease is linked to the pre-tax price of oil: there is a small decrease only of taxes in the late eighties, followed by a more important growth in the nineties. As a result, the level of taxes on each fuel is higher in 1999 than in 1985. This does not mean that the mean level of taxes on fuel consumption of cars and light trucks is growing, because of the strong orientation of the demand towards diesel: gasoline accounted for 81 % of cars and light trucks consumption in 1985, it accounts now for 50%. As a result, the mean tax level on road fuel (any type) is a bit lower. Moreover, the mean tax per km is lower, in relation to progresses in fuel efficiency and lower specific consumption of diesel engines. With important difference in the price and taxes of gasoline and diesel oil, we may observe simultaneously a growth in the tax level of each fuel and a decrease in the mean weighted level of taxes on the fuel used for road. The potential of a move from gasoline to diesel is more important in France than in other countries, where in some cases a specific taxation regime applies to diesel cars and in other cases price differences of the 2 fuels are less important. The evolution towards diesel may be considered as favourable regarding specific CO_2 emissions, because diesel cars emit a bit less and should emit significantly less with the penetration of direct injection. On the other hand, the annual mileage of diesel cars is significantly higher than the one of gasoline cars (19700 against 11700 km/ year). As a result, the annual emission of a diesel car is higher than the one of a gasoline car. Experts from the car industry consider that this difference results from a " selection bias ": people who need to drive a lot buy diesel cars. The economists are more sensitive to the fact that a lower price may induce a higher use. The controversy cannot be closed, but observation of people moving from gasoline cars to diesel cars offers some interesting insights: “ movers ” were intensive “ gasoline car users ”, with an annual distance of 16000 km. When they split to diesel, their mileage goes up to the mean diesel mileage: the transition goes with a 3000 growth of the annual mileage. This suggests a type of “ rebound effect ” linked to the price difference.

Table 2: Price and taxes on fuels used by car and light truck users
(1999 French Francs)

	1985	1990	1995	1999	Evolution 1999/1985
Mean gasoline price	7.73	6.3	6.02	6.37	-18%
Diesel oil price	5.90	4.21	4.03	4.52	-23%
Tax (inc VAT) per gasoline litre	4.78	4.65	4.94	5.16	+8%
Tax (inc VAT) per diesel oil litre	2.71	2.57	2.90	3.25	+20%
% gasoline in cars and light truck consumption	81,2	70,7	56,8	49,8	
Weighted price of oil for cars and light trucks	7.39	5.69	5.16	5.44	-26%
Weighted tax (inc VAT) per litre of oil	4.39	4.04	4.06	4.20	-4%
Tax (inc VAT) per km	0.401	0.346	0.329	0.332	-17 %

Source: author’s computations from L’automobile en France (CCFA, 1995 and 2000 editions) and Comptes Transports de la Nation (INSEE, 1991 and 1999 Editions)

Table 3: Taxes perceived per kilometre driven
(Cars and light trucks, 1999 French Francs)

	1985	1990	1995	1999
Fuel tax (inc VAT) per km	0.401	0.346	0.329	0.332
Eq purchase and ownership on a per km basis	0.161	0.127	0.093	0.084
Total tax per km	0.562	0.473	0.422	0.416

Source: see Table 2

The Netherlands: using every opportunity to alleviate the pressure of road traffic

The Netherlands is a small country with a high density of population, especially in the Randstat zone. It has no “ national ” car manufacturer. As a gateway of Europe, the port of Rotterdam and the related truck traffic are of major importance to the country. Successive transport master plans are oriented to the control of car traffic, either through alternative modes or taxation. It is one of the rare countries in Europe to have projected (but not adopted until now) a global road-pricing scheme. On the other hand, trucks are of major importance to the country. An important differentiation between gasoline and diesel oil taxes is thus required.

The environmental sensitivity is relatively high.

The tax level on car purchases is high, but lower than in Denmark: the normal VAT rate applies to the net price, and an additional 45.2% tax applies to the net price. Then a fixed value tax is recovered (1540 Euros for gasoline, 328 Euros for diesel), with a tax rebate (217 €) for diesel cars meeting the 2005 regulation on pollutant emissions.

The annual ownership tax is based on weight and type of fuel, and there is some differentiation between provinces. Its amount is high, the growth with weight is limited, but the differentiation between gasoline and diesel is high.

Annual ownership tax for a car (randstat region)

	1000 kg	1100 kg	1200 kg
Gasoline	309 €	379 €	451 €
Diesel	651 €	757 €	860 €

Source: WEC ADEME specific survey

In order to assess the potential effect of these taxes, Netherlands can be compared to Belgium and German (see tables in Annex)

Car ownership is lower in the Netherlands than in Belgium and much lower than in Germany, where there is no specific taxation on car sales, despite equivalent GDP. The effect may be related to the taxation policy, but the role of bike in the Netherlands should not be forgotten.

The mean cubic capacity of new car sales is lower than in Belgium, much lower than in Germany, where taxes on sales and ownership are more flat, despite the fact that a lower car ownership level means more “ family cars “ and less “ second cars ”.

The share of diesel vehicles is much lower than in Belgium, but comparable to that of Germany. It is lower than expected from the difference in fuel taxation between diesel and gasoline, probably in relation to the difference in annual taxation: a mean difference of 400 Euros in annual taxation requires a very important mileage to compensate the annual additional cost. Another explanation may be a competition between diesel and LPG, which has some importance in the Netherlands.

United Kingdom: the policy of an island

Even in countries where the sensitivity to the environment is high, governments are reluctant to raise independently fuel taxes, in relation to the risk of " fiscal tourism ": the Dutch government has to take into account the level of taxes in Belgium and Germany, the Belgium government has to take into account the level of taxes in Luxembourg, a.s.o. From that point of view, the United Kingdom has higher degrees of freedom. In relation to the density of the country and the very low level of investment in roads, congestion is a bigger problem than everywhere in Europe. This problem is also linked to the dispersion of the population in rural areas, with jobs concentrated in towns as everywhere in Europe, and to the quality of service of public transport. The problem is especially of importance for low-income people, who are more dependent on car than French low-income households, in relation to their type of residential location. These circumstances refrain policies aimed at discouraging car access, such in Denmark, and this is probably one of the reasons for the absence of specific tax on car sales.

Transport economists proposed road-pricing schemes in the eighties. They have been studied in depth in the nineties, from the point of view of economic rationality and the one of public acceptance. It appeared that public acceptance was low, even though road-pricing schemes including the use of the funds raised to develop public transport were better accepted. As a result, governments decided a long-term policy designed to raise the tax on road fuels, with annual increases of 5 % over the inflation. The 1999 level is 0.81 € for gasoline and 0.86 €for diesel. This policy has been applied over several years, and the price of fuel is now in the UK one of the highest in Europe. Even though the result of this policy is not a decrease of traffic, it must be denoted that the U.K has the lowest growth rate of car traffic in the nineties: passenger-km by cars grew by 12.5 % between 1990 and 1998, as compared to 18.5, 20.0 and 22.1 % respectively in Belgium, France and Italy.

The annual tax on cars was traditionally based on two levels only: 147 €for cars less then 1200 cc, 224 €for cars over 1200cc. This scheme continues to apply to vehicles registered before March 2001, but a new scheme based on CO_2 emissions is now available for new vehicles (see table 12)

Annual road tax in the UK

Band	CO_2 Emission Figure	Alternative Fuel Car	Petrol Car	Diesel Car
	(g/km)	Euro	Euro	Euro
A	Up to 150	126.05	140.06	154.06
B	151 to 165	154.06	168.07	182.07
C	166 to 185	182.07	196.08	210.08
D	Over 185	210.08	217.09	224.09

Source: ADEME specific survey

It could be assumed that the importance of the growth in fuel taxes in the U.K. would drive the demand towards smaller cars. Statistics do not provide evidence on that point. A potential explanation is the role of company cars in the U.K., which represent more than a half of the sales.

TECHNICAL CHARACTERISTICS OF NEW CAR SALES, 1999

	Cubic capacity	Power	% diesel	CO_2 (g/km) 1995	CO_2 (g/km) (1999)
Austria	1826	71	57	186	170
Belgium	1742	67	57	182	170
Denmark	1648	73	9	188	180
Finland			16		
France	1678	65	44	177	168
Germany	1775	78	22	194	182
Greece			1		
Ireland	1455	63	11	179	171
Italy	1513	62	29	180	168
Luxembourg	1902	82	42	197	183
Netherlands	1650	69	23	188	176
Norway	1659	77	8	196	
Portugal	1405	59	21	171	160
Spain	1721	65	51	177	167
Sweden	1927	93	7	221	201
Switzerland	1957	95	7	216	
United Kingdom	1697	76	14	191	185

Source: CCFA, 2000 and ECMT 2000

NEW CAR SALES

	Mean sales 1995-1999/million inh	FLEET95/mean annual new car sales
Austria	36750	11.8
Belgium	41500	10.0
Denmark	28300	11.0
Finland	21370	17.1
France	34000	12.7
Germany	43700	11.2
Greece	16700	
Ireland	48300	
Italy	36940	14.1
Luxembourg	82500	
Netherlands	33120	11.6
Norway	26050	14.7
Portugal	23300	
Spain	27100	
Sweden	25568	14.9
Switzerland	40714	11.1
United Kingdom	36440	11.6

Source: CCFA

Case studies on energy efficiency regulation for new buildings: Australia, California, China, European Union, Germany, Hong Kong, Japan, Poland, Slovakia, Thailand[2]

[2] A longer version if this paper is available on the WEC internet site http://www.worldenergy.org

AUSTRALIA

- **Current standard specified in the thermal building codes**

Degree days 1) Heating Cooling				
Climatic zones				By Territory ACT: 1 Victorian: 1 South Australia: 3
Steps 2)				1996 (Depending on Territory)
Type 3)				Type 2 Type 1
				Heating/Cooling demand
Mandatory/Voluntary				M/V
Typical standard				3 or 4 star rating / R-value external wall (insulation only!)
				1.3-1.7 m^2K/W
Standard varying according size 4)				S M
A/V dependence 5)				no
Building certificate				yes (star system)
Distinction energy carriers				no
Additional costs 6)				none (economic potential !)

1) Mean long-term
2) First year is when the regulation was published in the official Journal, the second year is, when it became active
3) See main report Table 1
4) Different standards according to single family (S), multi-family residential (M) and non-residential buildings (NR)
5) The surface to volume ratio A/V measures the compactness of the building. Single family houses have higher ratios than multi-family houses
6) Compared to previous step of building code

In Australia, building control is the responsibility of the eight States and Territories. As such, each State and Territory has its own Building Act and Regulations. The Building Code of Australia is referenced by all regulations as the construction standard for buildings, or building work. The Australian Building Codes Board (ABCB) was formed in 1994 by an inter-government agreement as the representative body for all the governments. It has a clear mandate for nationally consistent building regulations. The ABCB is made up of representatives of the eight States and Territories as well as representatives from industry and the Commonwealth Government. In 1996, BCA96 was introduced with national adoption achieved by July 1997. BCA96 is a performance-based code incorporating Performance Requirements and Deemed-to-Satisfy (DTS) Provisions and Verification Methods. Currently the Australian Capital Territory (ACT) and Victorian require energy efficiency measures under building control. The details are contained in their Appendices to the BCA. South Australia also have details of energy efficiency measures in their Appendix to the BCA but have not yet cast the measures into law. Both the ACT and Victorian requirements apply only to the following classification of buildings:

- houses (Class 1);
- multi-storey residential units (Class 2);
- residential occupancies for long term or transit living for a number of unrelated persons such as hotels, motels, aged care facilities and boarding houses. (Class 3); and
- a residential unit attached to a commercial building (Class 4).

- **Philosophy of building code**

The Australian building code(s), mainly in the Australian Capital Territory and Victorian, consider the building envelope and its performance for heating and cooling. No building equipment is taken into account. To a certain degree, materials are specified with which the performance can be achieved. With this respect the Australian approach to building codes is, compared to some of the further case studies such as California, Germany, European Union etc. still relatively far away from considering the building as a system.

- **Historic development**

A country wide building code with a certain number of minimum specifications was only introduced in 1996 but which contains no energy efficiency elements. Only Two Australian territories have mandatory features (DST). Australian building codes can therefore be considered a fairly young development.

- **Revisions of the thermal building codes envisaged in the near future**

Introduction of energy building codes, which are so far introduced in Australian Capital Territories and Victorian are currently in the phase of introduction in South Australia (for houses only, class 1).

- **Other accompanying measures**

Australian Territories have introduced a star system, which is easy to understand and to communicate. The stars are based on computer programmes used in practice in the different territories.

- **Main references**

Australian Greenhouse Office, *International Survey of Building Energy Codes*, ISBN 1 876536 32 2000 (www.greenhouse.gov.au/energyefficiency/buildings)

CALIFORNIA

- **Current standard specified in the thermal building codes**

Degree days [1)] Heating Cooling				
Climatic zones		16 (S,M) 5 (NR)		
Steps [2)]	1978	about 1985	Revisions every 3-5 years but no major increase in prescriptions since mid-eighties	
Type [3)]		Type 4		
		Space-conditioning (heating/cooling) Service Water Heating (SWH), lighting.		
Mandatory/ Voluntary		M		
Typical standard		External walls (wood frame), Package D		
		R13 (about 40 W/m^2K)		
Standard varying according size [4)]	S M NR	S M NR	S M NR	S M NR
A/V dependence [5)]		no		
Building certificate		yes		
Distinction energy carriers		yes		
Additional costs [6)]				

Footnotes: see case study Australia

The California Building Standards Code is administered by the California Building Standards Commission. California's building energy standard is called Title-24, which is one of the 26 titles of the California Code of Regulations. Its Part 6 (California Energy Code) applies to new construction, as well as additions to existing buildings. There are different requirements by building type (esp. residential versus commercial buildings) and climate zone. Basically it is a performance standard; there are no prescribed insulation levels for any building component. Nevertheless, typical component packages, depending on the location and the type of the building can be followed. The maximum allowable energy budget includes both heating and cooling. Heating is calculated assuming natural gas. Cooling is calculated assuming electricity. A source multiplier is applied to cooling electricity use when added to the heating to get the total energy budget. Title-24 is a mandatory standard; on the energy aspect, every new building must meet Title-24 before it is permitted to be completed.

- **Philosophy of building code**

Title-24 is primarily a performance standard that emphasizes the overall thermal efficiency of the building shell and HVAC system. The standard allows trade-offs between different building components (wall, roof, windows, infiltration, equipment, etc.), as long as the overall building energy consumption is shown to be within the maximum allowable values of kBTU/ft2. These trade-off are determined either through hourly computer simulations or derived from simulation results. However, for ease of use, there are prescriptive envelope criteria by building type and climate zone that can be referred to not requiring any calculations.

- **Historic development**

Title-24 was first adopted in 1978. The standard is supposed to be updated every three years, although in practice the time period for revisions has been from 3-5 years. Title-24 was significantly strengthened in the mid-1980's, but the changes since then have been relatively minor. In the original development of Title-24, the state was divided into 16 climate zones, each for which a standard weather file was produced for use in the simulations. These 16 climates zones are still applicable for residential buildings, but for commercial buildings, the requirements generally fall into only five climate regions.

- **Impact / Result of evaluation**

Local building officials are required to inspect conformance to Title-24 during building construction. However, there is no evaluation or verification of building energy use after construction. The California Energy Commission has commissioned a few studies on occupant behaviour and energy use in new houses, and concluded that in general Title-24 requirements are being followed during construction. The California Energy Commission estimates a net savings through 1997 of $12.6 billion due to the improved construction required by Title-24. The building energy efficiency levels in California are significantly higher than that in other U.S. states in similar climates with no mandatory energy standards.

- **Problems encountered with the introduction of thermal building codes / Main critical issues in the public debate**

There was substantial resistance to Title-24 when it was first introduced in 1978. The California Energy Commission have conducted numerous workshops and training programmes in the standard. In addition, a network of energy consultants have developed who provide assistance or commercial software for Title-24 calculations. During the revision process, the California Energy Commission endeavours to involve builders, architects, engineers, and environmental interest groups over a 2-4 year process. After 20 years, the building industry in California have come to accept Title-24 as necessary and beneficial to their industry. In terms of problems or issues, (1) the Title-24 process have become quite complicated and specialised over the years, (2) the inclusion of new technologies always requires a balance between encouragement or leaving a loophole for unproven technologies.

- **Revisions of the thermal building codes envisaged in the near future**

Title-24 has been revised every 3-5 years. However, the level of thermal integrity has not changed a great deal in the 1990's. The Commission is now working on the next revision to take place in a couple of years. There might, most likely be major changes in the calculation methods, but not necessarily in the required level of efficiency stringency.

- **Other accompanying measures**

The Title-24 building standard by itself is a mandatory requirement that must be met before a building is allowed to be built. In theory and largely in practice, every new building in California now meets the Title-24 requirements. The limitation of a building standard is that it does not provide any incentive for the builder or architect to exceed the standard. However, by setting a universally understood and accepted baseline, Title-24 also provides a useful reference target for other non-regulatory programmes. For example, the two large California utility companies (PG&E and SCE) both have incentive programmes that rewards architects, builders, and building owners if they construct a building that exceeded Title-24 by 10% or 20%. In the first two groups, the utility company pays for the additional design and analysis to improve the building design. In the last group (owners), the utility company gives a monetary reward if the measured energy usage of the building is actually lower than the Title-24 budget by the specified amount.

- **Main references**

California Energy Commission, Energy Efficiency Standards for Residential and Non-Residential Buildings, P400-98-001, July 1999

Australian Greenhouse Office, *International Survey of Building Energy Codes*, ISBN 1 876536 32 2, 2000 (www.greenhouse.gov.au/energyefficiency/buildings)

CHINA

- **Current standard specified in the thermal building codes**

Degree days 1) Heating (18°C) Cooling		1431-7159		1431-7159
Climatic zones				15 (by mean outdoor temp. during heating season)
Steps 2)		1986		1995 (1996)
Type 3)				Type 3/4 Type 1
				Index of heat consumption (heating demand); Heat transmission
Mandatory/ Voluntary		M (trial regulation, cold regions, some cities)		M (cold and severe cold regions)
Typical standard				Index heat consumption; Heat transfer coefficient ext. walls
				20-22.7 W/m^2 ; 0.40-1.10 W/m^2K
Standard varying according size 4)		S M		S M NR
A/V dependence 5)				yes
Building certificate				no
Distinction energy carriers				Yes (coal)
Additional costs 6)				

Footnotes: see case study Australia

At present, there are two sets of building energy codes in mainland China, one for residential buildings and one for tourist hotels. The residential energy code (JGJ 26-95) emphasizes thermal insulation to reduce heating energy, and its trial version (first released in 1986) has been implemented in a few cities in China, including Beijing and Tianjin. The energy code for tourist hotels (GB 50189-93) is a mandatory national standard and was developed primarily for tackling the rapid growth of hotel buildings in many cities of China. The Chinese thermal building standard is issued for the energy efficiency design of building envelope and space heating for new construction and expansion of residential buildings with central heating in severe cold and cold regions. For residential buildings without central heating at the moment, the design of envelope may follow this standard. The standard is a rather complex mixture of prescriptions and specifications depending on the exact situation. The index of heat consumption (taking into account thermal losses from the building envelope, air leakage, solar gains and gains from internal sources) and the index of coal consumption (derived from the index of heat consumption with the help of a standard efficiency) for heating residential buildings in various regions should not exceed the numeral values given in the Appendix A of the standard and which vary in the following ranges: index of heat consumption 20-22.7

W/m^2 of floor area; index of coal consumption 8.7-29.4 kg/m^2. Thermal insulation levels of building envelopes for dormitories, guest houses, restaurants and nurseries etc. should reach the same levels as heating residential buildings in the same region. Nevertheless, a large number of particular specifications enter the context, not only concerning the building envelope but also the heating system including the distribution pipes.

- **Philosophy of building code**

The Chinese building code has elements from several types of building codes. Its main feature is a limitation of the heating demand (index of heat consumption) (Type 3 of typology in main report), but in many cases detailed specifications are made with respect to individual building elements (Type 1), while for other purposes the heating system is to a certain degree integrated into the code (Type 4), especially with the index of coal consumption or with respect to prescriptions concerning the use of local and urban district heat systems.

- **Historic development**

China is at its first real step of thermal building codes with the residential energy code (JGJ 26-95) from 1995/1996 after the trial version (first released in 1986), which has been implemented in a few cities in China, including Beijing and Tianjin.

- **Revisions of the thermal building codes envisaged in the near future**

MOC (The Ministry of Construction, which has authority over building energy efficiency standards) encouraged cities in the "transition zone" (approximately the middle third of the country, where there is significant demand for space heating in the winter and space cooling in the summer) to develop residential building efficiency standards. Chongqing developed a draft standard, with assistance from NRDC, and Shanghai and Wuhan have also been working on standards. These have been mainly based on the standards developed for the heating zone, however, and do not represent any advance. MOC recently decided to develop a unified set of standards for the transition zone, based on analytic methods more appropriate to the climate. CSEP is providing funds for Chinese experts and LBNL to give technical assistance in this area. Canada (CIDA) is currently assisting MOC to produce national standards for commercial buildings. The standards are currently in draft form and under revision. A building energy code for commercial and office buildings is now being investigated by the Chinese Academy of Building Research; Shanghai, a key financial centre in China, is studying the feasibility of a high-rise building energy code; the independent municipality of Chongqing is developing a new energy code which includes both heating and cooling requirements. There are currently no initiatives to develop efficiency standards for buildings in areas south of the transition zone (e.g. Guangdong), or for buildings in rural areas.

- **Main references**

Industrial standard of the People's Republic of China, JGJ 26-95 + Annexes, Energy conservation design standard for new heating residential buildings, Enforcement July 1, 1996 (http://arch.hku.hk/research/BEER/jgj26-95/JGJ26-95.htm)

Hui, S. C. M., 2000. Building energy efficiency standards in Hong Kong and mainland China, In *Proc. of the 2000 ACEEE Summer Study on Energy Efficiency in Buildings*, 20-25 August 2000, Pacific Grove, California.

Joseph C. Lam and S. C. M. Hui: A review of building energy standards and implications for Hong Kong. Building Research And Information Volume 24, Number 3, 1996

Sinton et al.: Status Report on energy efficiency Policy and Programmes in China, 1999, URL http://eetd.lbl.gov/EA/partnership/China/pubs/China.061299.PDF

EUROPEAN UNION

- **Current standard specified in the thermal building codes**

Degree days [1)] Heating Cooling				0-7500 (depending on Member States)
Climatic zones				Climatic zones of EU Member States
Steps [2)]				2001
Type [3)]				Type 4
				Heating demand Heating system Hot water Cooling, ventilation, lighting, position / orientation of building, heat recovery, active solar gains Other renewable energy sources
Mandatory/Voluntary				M
Typical standard				Energy consumption (performance)
				Heating demand under Danish conditions: 50 kWh/(m^2 year) (but performance level to be fixed by Member States
Standard varying according size [4)]				S M NR
A/V dependence [5)]				Member States Regul.
Building certificate				yes
Distinction energy carriers				Member States Regul.
Additional costs [6)]				None (economic potential)

Footnotes: see case study Australia

The European Commission has published in May 2001 the first draft of a Directive aiming to improve the energy performance of buildings (COM(2001)226 final), which constitutes and amendment of the Council Directive 93/76/EEC to Limit Carbon Dioxide Emissions by Improving Energy Efficiency (SAVE). The basic motivation for this initiative was the recognition of the fact, that the previous Community programmes for the support and promotion of new technologies have not succeeded to bring about the application of new standards on energy efficiency in buildings in many Member States, or at least not above a level which compensates for the increasing level of comfort in buildings which partially offset the technical progress. The proposed Directive which continues measures initiated with the SAVE Directive and the boiler directive on energy performance aims therefore to provide a clear legislative framework along the following lines for buildings in the residential and the tertiary sector:

- Establishment of a general framework of a common methodology for calculating the integrated energy performance of buildings

- Application of minimum standards on the energy performance to new buildings and to certain existing buildings (larger than 1500 m^2) when the buildings undergo larger renovations. The standards itself should be fixed by the Member States and revised every 5 years.
- Certification schemes for new and existing buildings on the basis of the above standards and public display of energy performance certificates and recommended indoor temperatures and other climatic factors in public buildings and buildings frequented by the public
- Specific inspection and assessment of boilers and heating/cooling installations

The proposed Directive lays down a framework that will lead to increased co-ordination between Member States of legislation in this field. The practical application of the framework, however, will remain primarily the responsibility of the individual Member States.

The proposed framework directive concentrates on the economic potential to reduce carbon dioxide emissions in the residential sector, i.e. it considers mainly cost-effective measures.

- **Philosophy of building code**

The introduction to the framework for a European Thermal Building Code recognises that there is a strong tendency towards an integrated approach in building standards and codes that are being developed in and outside the EU (e.g. in the U.S., Australia, Canada and New Zealand). Such an approach can integrate, in addition to the quality of insulation of the building, heating installations, cooling installations, energy for ventilation, lighting installations, position and orientation of the building, heat recovery, active solar gains and other renewable energy sources. With today’s highly insulated new buildings and the trend towards low energy houses, these additional factors play an increasingly large role and should therefore be included in regulatory provisions. Such an integrated approach will give more flexibility to de-signers to meet energy reduction standards in the most cost-effective way. An integrated approach for the energy performance of buildings has to varying degrees already been applied in D, F, UK, I and NL and some other Member States intend to do the same. In some cases it is mandatory. A common approach on this basis as proposed by the framework directive would contribute to a more level playing field as regards the efforts made by Member States to achieve energy savings in the buildings sector. It would also facilitate the comparison of buildings throughout the EU for prospective users and make it easier for designers and constructors to apply standards in other Member States.

A common methodology could then form the basis for integrated minimum energy performance standards for different building categories to be adopted by the Member States, reflecting local circumstances, particularly climatic differences.

- **Historic development**

The framework directive for a European building code has two rationales:

First of all, a comparison of thermal building regulations in the European Union shows that rather extreme differences exist in building regulations even after these have been made comparable by correcting for climatic differences using so-called "degree days". The comparison illustrates that a European initiative intended to improve the energy performance of buildings by promoting improved Member State thermal insulation regulations to a level already attained by some Member States could result in substantial energy savings for the EU as a whole.

The second rational for the directive is that it is a building block in the European Climate Change Programme ECCP which has been worked out in 2000/2001, of which the proposed framework directive is one important building block aiming at the large reduction potential in the building sector.

- **Impact / Result of evaluation**

The directive is only a proposal so far. Estimates of the cost-effective potential for 2010 from a study on sectoral targets for greenhouse gas reduction are in the range of 25 Mt CO_2. This estimate seems low, given that the direct emissions from the sector in the European Union are 447 Mt CO_2 equivalent according to the study, that roughly 50 Mt are concerned in the next 10 years and that new buildings are typically 60 % better than the stock already under current legislation. If the directive is to have an impact than the savings should be rather around 30-40 Mt CO_2).

- **Other accompanying measures**

The proposed framework directive does not only aim at new buildings but in the case of larger buildings also obliges to renovate existing buildings (article 5).

It further creates a building certificate, which shall make the energy performance of the building transparent to the user (article 6) and obliges in particular public buildings to display the information in central locations.

Regular checks of boilers and air conditioning systems complete the regulation by insuring continuous maintenance of the heating and cooling systems (articles 7 and 8).

- **Main references**

CEC (2001): *Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings*, COM(2001) 226 final, Brussels, 11.5.2001 (http://europa.eu.int/eur-lex/en/com/pdf/2001/en_501PC0226.pdf)

FhG-ISI (1999), *A Comparison of Thermal Building Regulations in the European Union, MURE Database Case Study N° 1*, Study carried out in the framework of the MURE project, financed by the SAVE Programme of the EC, http://www.mure2.com/Mr-fr5.htm

GERMANY

- **Current standard specified in the thermal building codes**

Degree days [1)] Heating Cooling	3600 -	3600 -	3600 -	3600 -
Climatic zones	1	1	1	1
Steps [2)]	1977 (1978)	1982 (1984)	1994 (1995)	2001 (2002)
Type [3)]	Type 2 Type 1 (S)	Type 2 Type 1 (S)	Type 3 Type 1 (S)	Type 4
	Heat Transmission	Heat Transmission	Heating demand	Heating demand Heating system Hot water Renewables
Mandatory/ Voluntary	M	M	M	M
Typical standard			Heating demand	Heating demand
			54-100 kWh/m²	37-92 [7)] kWh/m²
Standard varying according size [4)]	S M NR	S M NR	S M NR	S M NR
A/V dependence [5)]	no	no	yes	yes
Distinction energy carriers	no	no	no	Electricity [8)]
Building certificate	no	no	(yes)	yes
Additional costs [6)]			S: 2.5-4 % M: 1.5-2 %	

Footnotes: see case study Australia

On 1 January 1995 the third version of the *Thermal Insulation Ordinance* in Germany came into force, which is still valid in the beginning of 2001. The building code distinguishes between new buildings with normal temperature, new buildings with low temperature and existing buildings in case of substantial renovation work.

For *new buildings with normal temperature* (private, public, and business buildings, operational buildings heated to at least 19°C, buildings used for sports and public functions heated ≥15°C during at least 3 months/a, building with mixed uses, the annual space heating requirement (Q_H) as a function of the enclosing surface to the heated volume (A/V) is limited (see Table). The annual space-heating requirement (Q_H) is calculated according to the following formula:

$$Q_H = 0.9 * (Q_T + Q_L) - (Q_I + Q_S) \text{ in kWh/a}$$

with Q_T = transmission heating requirement; Q_L = heating requirement by airing; Q_I = internal heat gains; Q_S = solar heat gains

Only for small private houses (≤ 2 floors and 3 flats) the insulation standards can also be fulfilled when maximum heat transmission values (U-values[3]), which are different for individual components of the building (outer walls, windows, ceilings, roofs, basement ceilings) are not exceeded.

[3] The U-value indicates the amount of heat that flows through a square metre of a building component with a temperature difference of 1 K (unit: Watt/m²K).

Maximum annual space heating requirement (Q_H) referring to the heated building volume (V) or the usable floor space (A_N) and depending on the relationship of the enclosing surface to the heated volume (A/V)

	Maximum yearly thermal heat demand[1)]	
A/V	referring to V	referring to A_N
in m^{-1}	in $kWh/(m^3 \cdot a)$	in $kWh/(m^2 \cdot a)$
≤ 0.2	17.3	54.0
0.3	19.0	59.4
0.4	20.7	64.8
0.5	22.5	70.2
0.6	24.2	75.6
0.7	25.9	81.1
0.8	27.7	86.5
0.9	29.4	91.9
1.0	31.1	97.3
≥ 1.05	32.0	100.0

1) For small private houses (≤ 2 floors and 3 flats) maximum thermal transmittance coefficients can be used as an alternative

- **Philosophy of building code**

The Thermal Insulation Ordinance prescribes a limitation of the annual space heating requirements as a function of the enclosing surface to the heated volume (A/V). Therefore, it is a more integrating approach, which focuses on the house as a system. This means that not just the building shell has to be optimised, but a reduction of the energy demand can also be achieved by e.g. improved ventilation or an increased use of passive solar energy through relevant architectural design. Only for small private buildings, the less integrative building component approach specifying maximum values for walls, windows, roofs, ceilings etc. is allowed as an alternative.

- **Historic development**

The Thermal Insulation Ordinance in Germany was introduced in 1977. A first revision took place in 1982 and came into force in the beginning of 1984. The second revision was in 1994 and is valid since 1 January 1995. Whereas the revision of 1982 was mainly a tightening of the maximum U-values by about 25 %, the second revision was not only a further tightening of the limits, reducing thermal heat demand of new buildings by about 30 % compared to the 1982 building code. It was also a shift to a more integrative approach, defining maximum values for the heating demand of a building.

- **Impact / Result of evaluation**

The *energy saving and CO_2 reduction potential* of the 1994 regulation compared to the former 1982 regulation was estimated by two studies. For residential buildings, both studies estimate a CO_2–reduction of about 5 Mt in the year 2005 compared to the year 1995 due to the new regulation. There are also some hints from interviews with affected groups, that there is a *degree of non-compliance* with the building codes, which is not negligible. This can both be observed in the case of new building and even more in the case of existing buildings when retrofitting measures are made. Due to the lack of a specific evaluation of the Thermal Insulation Ordinance, no concrete figures can, however, be quantified.

- **Problems encountered with the introduction of thermal building codes / Main critical issues in the public debate**

Since the introduction of the new Thermal Insulation Ordinance in the beginning of 1995, it was discussed that the standards prescribed for new buildings did not correspond to what was, even then, technically possible. Another point, which was contrivers discussed in Germany, is the further inclusion of existing buildings into the regulation.

- **Revisions of the thermal building codes envisaged in the near future**

The revision of the 1994 Thermal Insulation Ordinance has been announced by the German Government since some years. The last draft version of the new Energy Saving Ordinance is from 29 November 2000. The new Energy Saving Ordinance chooses a fully integrated approach covering heating supply as well as heating demand including warm water. The new Energy Saving Ordinance is geared around a primary energy approach, which impedes that electricity based heating is favoured compared to other types of heating. It will not only take into account passive solar heat gains, but also total use of renewable energies. Compared to the present thermal insulation and heating installation regulations, the new Energy Saving Ordinance will include a further tightening of the limits and allow a wider choice of energy saving measures to reach these limits. The target is to reduce the energy requirements of new buildings by an average of 30 percent compared to previous standards.

- **Other accompanying measures**

What concerns space heating and hot water consumption, there are the following regulations accompanying the Thermal Insulation Ordinance: (i) The *Heating Installation Ordinance*, valid since 1978, is prescribing energy saving standards for boilers and sanitary hot water production. (ii) The *Ordinance on Small Firing Installations* concerns small furnace equipment. It sets standards of heat loss carried by chimney gas graded by date of installation. (iii) The *Individual Heating Metering Ordinance*, which is in force since 1981, concerns all collective houses with central heating and central hot water systems. (iv) Building certificates. What concerns *economic instruments*, the *ecological tax* on oil, gas, and electricity is also effective for energy use for space heating and hot water production. *Financial measures* to promote energy savings in the building sector mainly aim at existing building, which are only partially considered by the Thermal Insulation Ordinance, though the energy saving potential is considerable.

- **Main references**

BMU (2000): Nationales Klimaschutzprogramm. Beschluss der Bundesregierung vom 18. Oktober 2000. Berlin. http://www.bmu.de

BMWi (2000): Dr. Müller/Bodewig: Die neue Energieeinsparverordnung bietet große Chancen für den Bausektor und den Klimaschutz. Pressemitteilung vom 29.11.2000. Berlin. http://www.bmwi.de

BMWi/BMBau (1997): Neue Energieeinsparverordnung – Eckpunktepapier. Bonn

Eichhammer, W., Schlomann, B. (1998): A Comparsion of Thermal Building Regulations in the European Union. MURE Database Case Study. Karlsruhe

HONG KONG

- **Current standard specified in the thermal building codes**

Degree days [1)] Heating Cooling				
Climatic zones			1	1
Steps [2)]			1995	2000
Type [3)]			Type 3	Type 3
			Overall thermal transfer value OTTV	Overall thermal transfer value OTTV
Mandatory/Voluntary			M	M
Typical standard			OTTV	OTTV
			35 W/m^2 (Tower) 80 W/m^2 (Podium)	30 W/m^2 (Tower) 70 W/m^2 (Podium)
Standard varying according size [4)]			NR	NR
A/V dependence [5)]			no	no
Building certificate			yes	yes
Distinction energy carriers			no	no
Additional costs [6)]				

Footnotes: see case study Australia

A revision of the 1995 code took effect on 17 July 2000 and is applicable to all new building projects for which building plans are submitted for the first time for approval. As a result of the review, the amendments made to the Code of Practice for Overall Thermal Transfer Value in Buildings 1995 are:

- in the case of a building tower, the OTTV should not exceed 30 W/m^2 (previously 35 W/m^2); and
- in the case of a podium[4], the OTTV should not exceed 70 W/m^2 (previously 80 W/m^2).

- **Philosophy of building code**

Generally speaking, there are two types of building codes, prescriptive (Types 1-3 specified in the main report) and performance-based (Types 4 and 5). The prescriptive approach specifies the minimum requirements for each building component to satisfy the standards, such as minimum insulation levels and equipment efficiencies. The Hong Kong OTTV standard is prescriptive. It is envisaged that the comprehensive building energy code, which the Hong Kong government is working on, will be performance-based.

- **Historic development**

In October 1990, a consultancy study was commissioned by the Hong Kong government on the possibility of legislative controls of building envelope designs for air-conditioned commercial buildings. A draft OTTV handbook was produced, suggesting OTTV limits of 16

[4] Podium refers to the lower part of a building, which is within 15 m above street level. Most large commercial building developments have office towers on top of commercial podiums such as shopping arcades and restaurants.

and 30 W per m^2 for commercial buildings and hotels, respectively. The building professions expressed concerns about the proposed legislative controls. The architects considered the draft OTTV code too stringent and over-restrictive, and suggested it remain strictly for guidance purposes only. The engineers also perceived the proposed code too stringent, which could lead to considerable architectural constraint and environmental impact. After lengthy consultations with the building professions, an OTTV limit of 35 W per m^2 was agreed for commercial buildings (including hotels) and a much relaxed 80 W per m^2 was stipulated for podiums. The OTTV legislative controls finally became effective on 21 July 1995, under the Building (Energy Efficiency) Regulations. A revision took place in 2000 as mentioned above.

- **Impact / Result of evaluation**

The revision of control figures were based on the result of a survey on some building submissions. 83 submissions, including 46 for podium and 37 for towers, were studied. Percentage of compliance against OTTV limit was as shown below in the table. Regarding energy savings, conservative estimation by EMSD shows that a savings of 7.5% can be achieved by the enforcement of OTTV control.

Compliance against OTTV limit in Hong Kong

Type of building	OTTV (W/m^2)	Compliance
Tower	35	100%
	30	81%
	25	65%
	20	54%
Podium	80	100%
	70	98%
	60	94%
	45	90%

Source: EMSD

- **Problems encountered with the introduction of thermal building codes / Main critical issues in the public debate**

The discussion in Hong Kong centred on the issue whether thermal building codes should be voluntary as guidelines or mandatory. There is no hard and fast rule about which one is more effective since the success of BES depends not only on how it is designed and coded but also on how it is implemented and publicised. Protagonists of mandatory approach argue that voluntary guidelines will not ensure high building energy efficiency. The market force which is found useful in domestic appliance standards (e.g. refrigerators and room air-conditioners) cannot be easily applied to buildings. Statutory requirements will help level the playing field for developers and builders as energy-conscious designers and building professionals will not have to compete with others who achieve construction cost savings by eliminating or ignoring energy-efficient features. It is the government's responsibility to make sure that the efficient, not the easy path is followed. Supporters of the voluntary approach, however, believe that mandatory standards are limiting design freedom and innovations if the BES are not comprehensive and flexible enough. Setting appropriate standards is difficult since what may be desirable in one building may be inappropriate in another, and various buildings show widely different energy use patterns which are difficult to explain and analyse. Mandatory codes, voluntary codes, and a mixture of both are now found in different parts of the world. It is envisaged that Hong Kong will have a mixture of mandatory codes and voluntary guidelines to cater for certain aspects of the building and building services designs that cannot be well defined. No matter what approach is used; a crucial factor is the acceptance of the policy as a whole by the public and the professions.

- **Revisions of the thermal building codes envisaged in the near future**

Hong Kong is working on the introduction of more performance based building codes.

- **Other accompanying measures**

To encourage wider acceptance of the building energy codes, a scheme of accreditation for energy efficient buildings has been introduced in late 1998. Under this scheme, any buildings (new and existing) that fully comply with the codes will be eligible for accreditation as an energy efficient building. A certificate of accreditation will be issued to the building's owner and its name entered into a register kept by the Government. The aim of the scheme is to arouse public awareness and stimulate greater interests in energy efficient buildings. An energy-efficiency building award, held in 1994 and 1997 in Hong Kong, also serves similar functions for drawing attentions from the public and the professionals.

A labelling scheme for electrical appliances, room coolers (unitary air-conditioners) and compact fluorescent lamps, was implemented in Hong Kong since 1995 to provide consumers and decision makers with information on opportunities for energy efficiency.

In association with an initiative for demand-side management (DSM) for electricity, the Government is considering programmes to promote high efficiency appliances and thermal storage air-conditioning systems, through rebates to the consumer from the power company which collects DSM incentive earnings from the Government.

To improve energy efficiency of existing buildings, energy audits have been conducted in government buildings since 1993 and measures have been implemented to achieve energy savings in these buildings. Information on retrofitting existing buildings with energy-efficient equipment is being disseminated to the private sector. The Government is also examining the potential for wider use of water-cooled air-conditioning systems (which could produce electricity savings of 20-30%) for non-domestic developments, in order to raise the efficiency of air-conditioning plants.

- **Main references**

Joseph C. Lam and S. C. M. Hui: A review of building energy standards and implications for Hong Kong. Building Research And Information Volume 24, Number 3, 1996

Hui, S. C. M., 2000. Building energy efficiency standards in Hong Kong and mainland China, In *Proc. of the 2000 ACEEE Summer Study on Energy Efficiency in Building*s, 20-25 August 2000, Pacific Grove, California.

Internet: http://arch.hku.hk/research/BEER/.

JAPAN

- **Current standard specified in the thermal building codes**

Degree days [1)] Heating Cooling		500-2500	500-2500	500-2500
Climatic zones		6	6	6
Steps [2)]		1980	1992	1999
Type [3)]		Type 2	Type 2	Type 3/4 Type 2 (S)
		Heat Transmission	Heat Transmission	Heating/cooling demand + building equipment (NR)
Mandatory/Voluntary		M	M	M
Typical standard		heat loss coefficient	heat loss coefficient	annual heating + cooling load
		3.26-7.21 (S) (W/m^2 *K)	1.74-6.40 (S) (W/m^2 *K)	81-128 kWh/m^2 (S, M)
Standard varying according size [4)]		S M NR	S M NR	S M NR
A/V dependence [5)]		no	no	no
Building certificate				
Distinction energy carriers		no	no	no
Additional costs [6)]				

Footnotes: see case study Australia

Japan sets standards (Evaluation Criteria) for Residential and Non-residential building under the Energy Conservation Law. The outline of the evaluation criteria for the housing sector is shown in Table 1 below. Those values are set for new residences and new buildings. Existing buildings are not subject to regulation.

Development of energy-saving standards for housing in Japan

Factors for the energy-saving standard	＊ Regions	Year of notification		
		1980	1992	1999
Specifications for annual heating and cooling load [MJ/ (m^2 * year)]	I			390
	II			390
	III			460
	IV			460
	V			350
	VI			290
Specifications for heat loss coefficient (W/m^2 *K) (for single-family houses)	I	3.26	1.74	1.6
	II	4.19	2.67	1.9
	III	5.12	3.14	2.4
	IV	5.58	3.95	2.7
	V	7.91	4.30	2.7
	VI		6.40	3.7

- **Philosophy of building code**

The building codes in Japan are increasingly integrating the building, which is particularly visible for the non-residential buildings which show that over time more and more building equipment is taken into account, even elevators, depending on the sub sector.

- **Historic development**

Japan had three major steps of thermal building codes in 1980, 1992 and 1999. The development for non-residential buildings was slightly deviating from these steps depending on the sub sector. It is difficult to show the strictness of the standards sweepingly but from the point of specification for heat loss coefficient the 1999 values are around 30 – 40 % stricter than 1992 values, which in turn were about 30-40 % stricter than the 1980 values.

- **Impact / Result of evaluation**

Recent construction conditions of residence and building are as follow.

Residence: The rate of house (this means single-family house) which was newly constructed under the Regulation of newest standard is 1% of the whole newly constructed house in 1998. The average heat loss coefficient value of newly constructed house is decreasing gradually year by year; the value of 1998 is 4.68(W/m^2 K).

Building (means Business use specific building larger than 2,000 m^2): The rate of building which was newly constructed under the regulation of newest standard is 89% of the whole newly constructed building in 1998.

Those notifications are not compulsory and the enforcement of the standard is entrusted to traders. Buyers are to buy their house with the comparison between cost and performance. There may be some differences between residence house buyer's awareness and office building buyer's awareness and the difference between 1% and 98% occurred.

As mentioned above the notification is not absolute one and the average coefficient value of newly constructed house in a year becomes lower than the standard value. But the user's awareness is coming up year by year and the average value comes close to the standard value.

- **Revisions of the thermal building codes envisaged in the near future**

No revision envisaged currently.

- **Other accompanying measures**

- Voluntary training of construction techniques for building constructors to construct the building fitting according to newest energy-saving standard for (non-residential) buildings.
- Financing up to 2.5 million yen through Housing Loan Corporation to adapt houses to the energy-saving standard for housing.

- **Main references**

Internet: http://www.eccj.or.jp

POLAND

- **Current standard specified in the thermal building codes**

Degree days [1)] Heating Cooling				
Climatic zones		1	1	1
Steps [2)]		1982	1991	1997
Type [3)]		Type 1	Type 1	Type 3 (M, S) Type 1 (S, NR)
		Heat Transmission	Heat Transmission	Heat demand
Mandatory/Voluntary		M	M	M
Typical standard		heat loss coefficient for walls	heat loss coefficient for walls	Heating demand
				29-37.4 kWh/m^2 (S, M)
Standard varying according size [4)]		S M NR	S M NR	[S M] NR
A/V dependence [5)]				yes
Building certificate		no	no	yes
Distinction energy carriers		no	no	no
Additional costs [6)]				

Footnotes: see case study Australia

The current Polish Building Code specifies values in kWh/m^2 for new buildings as follow:

for multifamily buildings:

- E_0=29 [kWh/m^2] if A/V ≤0.20
- E_0=26.6 + 12 x A/V [kWh/m^2] if 0.20<A/V><0.90
- E_0=37.4 [kWh/m^2] if A/V>0.90

for industrial buildings: $U_{max}<U_0$

- U_0 = 0.45 to 0.55 W/(m^{2}K) for outside walls if room temperature is above 16°C (0.75 to 0.9 W/(m^{2}K) if it is between 8°C and 16°C, and 1.2 W/(m^{2}K) if it is below 8°C);
- U_0 = 0.3 W/(m^{2}K) for roofs if temperature is above 16 °C (0.5 W/(m^{2}K) if it is between 8°C and 16°C, and 0.7 W/(m^{2}K) if it is below 8°C);

for single family buildings: $U_{max}<U_0$ or $E_{max} \leq E_0$. This is decided by the architect which designs the building. If U_0 is taken, the following limits have to be respected:

- U_0 = 0.3 W/(m^{2}K) for insulated outside walls (0,5 W/(m^{2}K) for „others" and 0,8 W/(m^{2}K) if room temperature is below 16°C),
- U_0 = 0.3 W/(m^{2}K) for roofs if temperature >16 °C (0,5 W/(m^{2}K) if it is >8°C but below 16°C);
- U_0 = 0.6 W/(m^{2}K) for cellar ceiling if it is not heated (but has closed bottom and walls)
- U_0 = 2.0-4.0 W/(m^{2}K) for windows and balcony doors

If E_0, is chosen for the limit, it is the same values as stated above for multifamily buildings.

- **Philosophy of building code**

The Polish building codes in their earlier versions were essentially based on a component approach, which is still maintained for non-residential buildings in the current version, while multi-family houses and to a certain degree single family houses should obey requirements restricting their heating demand.

- **Historic development**

The historic development was as follow:
- up to 1982 $U_{max} < U_0 = 1.16$
- 1982 was established new code PN-82/B-02020
- 1991 was established new code PN-91/B-02020
- 1997 DzU97.132.878 (Polish law which is established in Parliament) includes a maximum level for the U value
- 1998 adaptation of Polish insulation codes to European Codes PN-EN-ISO

The consecutive Building Code have been more and more stringent.

In 1998 the Polish Government passed the Act of Thermo modernisation. It assumes
- Minimal saving of energy 25 % for complete thermo modernisation or 10 % saving for modernisation of heating system and distribution network
- Max. simple payback time can be up to 7 years
- Max. credit level 80 % of the investment
- Value of saved energy must exceed the monthly instalment rate
- Abolishment possible if saving target are achieved (25 % of the total cost of investment)

- **Impact / Result of evaluation**

Rather rare in general. If yes, measurement of temperature and consumption of energy. The following impacts were observed:
- very significant thermal renovation activity in existing houses (mostly external wall insulation and installation of new windows)
- high degree of compliance motivated by existence of subsidised credits for existing houses
- decreasing energy consumption,
- decreasing consumption of coal
- Factors partially favouring investments in energy savings, partially hindering investments were: high credit interest (20-22 %), high inflation rate, oil price + 70-100 % in 2000

- **Revisions of the thermal building codes envisaged in the near future**

The Act of Thermo modernisation is being reviewed.

- **Other accompanying measures**

Trainings for engineers and architects; each building should have a certificate with general parameters, including energy data (introduced only recently).

- **Main references**

Dziennik Ustaw (bulletin of Polish Parliament) DzU 132/97, 15/99

SLOVAKIA

• Current standard specified in the thermal building codes

Degree days [1)] Heating Cooling				
Climatic zones		1	1	1
Steps [2)]		1977	1992	1997
Type [3)]		Type 1 Type 3 (M)	Type 1 Type 3 (M)	Type 3
		Thermal resistance /heat demand	Thermal resistance /heat demand	Heat demand
Mandatory/Voluntary		M	M	M
Typical standard		Thermal resistance /heat demand	Thermal resistance /heat demand	Heat demand
		9.3 MWh/year	7.3 MWh/year	85 kWh/m^2 (S, M)
Standard varying according size [4)]		S M NR	S M NR	S M NR
A/V dependence [5)]		no	no	no
Building certificate				no
Distinction energy carriers		no	no	no
Additional costs [6)]				

Footnotes: see case study Australia

The current values are 85 kWth/m2/year for new residential buildings and 130 kWth/m2/year for reconstruction of residential buildings. The administrative buildings are allowed to have their energy demand values higher by 15%.

The norm STN 730540 also sets standards for
- -minimum exchange of air in rooms
- -hygienic criterions -temperature higher than moisture point
- -temperature avoiding the risk of mildew

• Philosophy of building code

The Slovak building code is based on a component approach (thermal resistance) or limitation of the heating demand. There has been fairly little change in the philosophy of building codes over the past three revisions; however, the recent discussion seems to point towards a more integrated approach.

• Historic development

1977 - The Slovak technical norm governing the thermal-technical properties of constructions and buildings, the STN 730540, respectively its first version, was issued. It was setting the obligatory minimum values of thermal resistance for walls and vertical constructions as well as binding values of energy demand for specific flat (200 m^3), which was 9.3 MWht/year.

1977 - 1972 - there were 3 changes, that e.g. specified all the types of buildings and involved several new parameters, which are not that significant from the energy consumption point of view. 1992 - 4th Amendment of the STN 730540, was setting a higher minimum value of thermal resistance for walls and consequently a lower binding value of heat demand for specific flat (200 m^3), which was 7.3 MWht/year. 1997 - 5th Amendment of the STN 730540 (see above, binding value for the specific heat demand of 85 kWh_t/m^2/year for new residential buildings and 130 kWh_t/m^2/year for reconstruction of residential buildings). Since 1997, there have not been any changes.

- **Impact / Result of evaluation**

The impact of thermal insulation legislation is just estimated, in accordance to the planning procedures, since there is no ex post evaluation system established in Slovakia by now. But there are plans to introduce ex-post evaluation.

- **Revisions of the thermal building codes envisaged in the near future**

As far as for the STN 730540, a deeply going revision is prepared in order to harmonise the standard with EU criteria and to approximate to EU legislation in this area. Especially valuable in this regard are the examples from countries like Austria or Germany (Wärmeschutzverordnung).

- The norm STN 730542 governing calculation procedures shall be revised and incorporated into the above mentioned STN 730540.
- Provisions for in-door climate of buildings shall be amended according to EU standards.
- The Slovak Hydrometheorologic Institute SHMU is currently preparing statistics, which shall be also incorporated in the future norms – e.g. weather statistic between 1961-99, solar radiation, degree days.
- Temp. gradients for individual sites shall be calculated per meter and degree days as well.

Also energy passports shall be established for buildings. The basic conditions for energy certification of buildings shall be prepared jointly by the Ministry of Economy and Ministry of Construction and Public Labours.

- **Other accompanying measures**

Establishment of an energy passport for buildings (planned).

- **Main references**

STN 730540

THAILAND

- **Current standard specified in the thermal building codes**

Degree days [1)] Heating Cooling				
Climatic zones			1	
Steps [2)]			1995	
Type [3)]			Type 3	
			Overall thermal transfer value OTTV	
Mandatory/Voluntary			M	
Typical standard			OTTV	
			45 W/m^2 (ext. walls) 25 W/m^2 (roof)	
Standard varying according size [4)]			M NR	
A/V dependence [5)]			no	
Building certificate			yes	
Distinction energy carriers			no	
Additional costs [6)]				

Footnotes: see case study Australia

The thermal building code in Thailand is valid for designated buildings. Designated buildings are defined as those using an amount of energy or electric capacity above certain levels (buildings: electrical capacity of more than 1 MW, or installed transformer capacity more than 1175 kVA, or a total consumption of more than 20 TJ/year useful energy. The Ministerial Regulations from 1995 defines and sets limits for four parameters related to energy efficiency in buildings. The parameters and their quantitative limits are:

(1) The Roof Thermal Transfer Value (RTTV) of the existing and the new building shall not exceed 25 W/m^2 of the roof area.

(2) The Overall Thermal Transfer Value (OTTV) of the exterior walls of an air-conditioned building or of its part shall be valued as follows:
  (a) For a new building, it shall not exceed 45 W/m^2 of its exterior walls.
  (b) For an existing building, it shall not exceed 55 W/m^2 of its exterior walls.

(3) The lighting power density shall not exceed 16 W/m^2 for office buildings, hotels, and schools, and 23 W/m^2 for department stores

(4) In addition a number of standards for air-conditioners are set.

- **Philosophy of building code**

The building code of Thailand is similar in nature than the code of Hong Kong by making use of the OTTV approach (see the case study for this city).

- **Historic development**

In 1992 the Thai Parliament endorsed the Energy Conservation Promotion Act. A set of building energy codes for so-called designated buildings and government buildings was endorsed in 1995 and further elaborated through a Ministerial Regulation that same year. A revision is currently under preparation.

- **Impact / Result of evaluation**

6 monthly energy reports and mandatory energy audits to be carried every 3 years. Evaluation currently ongoing

- **Revisions of the thermal building codes envisaged in the near future**

The Department of Energy Development and Promotion DEDP is currently working on a revision of the standards according the following lines:

- Standards are considered to be lower than the economic optimum when balancing the additional costs of investment with the energy savings potential.
- Building Energy Codes set the same standards for the entire country despite the fact that Thailand spans some 1600 km from south to north
- The previous code was rather simple with very few parameters

The new code should correspondingly

- Be adjustable to local climatic conditions
- Incorporate moisture as a determining parameter
- incorporate thermal transfer from the ground and an overall thermal transfer value
- use of day lighting should be encouraged through the code
- special considerations should be given to differences between high- and low-rise buildings

- **Other accompanying measures**

Thailand has introduced at the same time the obligation of reporting of energy consumption and regular energy audits, which are currently analysed with the aim to evaluate the impact of energy saving measures.

- **Main references**

Internet site BERC (http://203.150.24.2/index-e.html and http://203.150.24.2/laws/lawe.html)
Ministerial Regulation (B.E. 2538) issued under the Energy Conservation Promotion Act, B.E. 2535

Energy Efficiency Policies and Indicators:

WEC Report 2001

Annex 2

Questionnaires synthesis

Content

1 Institutions and programme ... 207

1.1 Institutions in charge of the implementation of energy efficiency programmes ... 207
1.1.1 OECD countries ... 207
1.1.2 Non OECD countries/economies ... 208
1.2 Existence of national programmes of energy efficiency ... 209
1.2.1 OECD countries ... 209
1.2.2 Non OECD countries/economies ... 210

2 Thermal energy efficiency standards for new buildings ... 211

2.1 OECD countries ... 211
2.1.1 Europe ... 211
2.1.2 Asia and Pacific ... 212
2.2 Non OECD countries ... 212

3 Labelling, efficiency standards and target values for household electrical appliances ... 213

3.1 Labelling ... 213
3.1.1 OECD countries ... 213
3.1.2 Non OECD countries/economies ... 214
3.2 Standards or target values ... 215
3.2.1 OECD countries ... 215
3.2.2 Non OECD countries/economies ... 216

4 Fiscal measures on cars and motor fuels ... 217

4.1 Overview of fiscal measures on cars ... 217
4.1.1 OECD countries ... 217
4.1.2 Non OECD countries/economies ... 218
4.2 Car purchase taxes ... 219
4.2.1 OECD countries ... 219
4.2.2 Non OECD countries/economies ... 220
4.3 Characteristics of annual registration tax ... 221
4.3.1 OECD countries ... 221
4.3.2 Non OECD countries/economies ... 222
4.4 Subsidies for old car scrapping ... 223
4.4.1 OECD countries ... 223
4.4.2 Non OECD countries/economies ... 223
4.5 Subsidies/incentives for clean and efficient cars ... 224
4.5.1 EU countries ... 224
4.5.2 Non OECD countries/economies ... 224
4.6 Motor fuel taxes ... 225
4.6.1 OECD countries ... 225
4.6.2 Non OECD countries/economies ... 226

5 Energy audits ... 227

5.1 OECD countries ... 227
5.2 Non OECD countries ... 228

6 Other energy efficiency measures ... 229

6.1 OECD countries ... 229
6.1.1 Europe ... 229
6.1.2 Asia and Pacific ... 230
6.2 Non OECD countries ... 231

List of Agencies / Ministries that answered to the questionnaire

(alphabetic order)

Algeria	APRUE, National Agency for the promotion and the rationalization of the utilization of the energy
Australia	APERC
Austria	EVA
Belgium	ECONOTEC
Bulgaria	SEEA, State Energy Efficiency, Agency
Cameroon	Ministry of Mines, Water Resources and Energy
Canada	Office de l'efficacité de l'énergie
Chile	National Energy Commission
Colombia	UPME, Mining and Energy Planning Unit
Czech Republic	Czech Energy Agency
Denmark	DEA, Danish Energy Agency
Egypt	National WEC Committee
Estonia	Estonian Energy Research Institute
Finland	MOTIVA, information Centre for energy Efficiency
France	ADEME, Agency for environment and Energy Management
Germany	Fraunhofer/ISI
Greece	CRES, Centre for Renewable Energy Sources
Hong Kong, China	Energy Efficiency Office
Hungary	Energy Centre
India	Energy Management Centre
Indonesia	Directorate General of Electricity and Energy Development, Ministry of Energy and Natural Resources
Ireland	Irish Energy Centre
Italy	ENEA
Japan	Energy Conservation Centre
Korea	KEMCO, Korea Energy Management Corporation
Latvia	Institute of Physical Energetics, LAS
Lithuania	SC Energy Agency
Malaysia	Ministry of Energy
Mexico	Secretaria de Energia
Netherlands	ECN
New Zealand	APERC (from NZ Ministry of Economic Development)
Nigeria	Energy Commission

Norway	IFE, Instittutt for Energiteknikk
Peru	Ministry of Energy and Mines
Philippines	Department of Energy
PNG	APERC (from PNG Ministry of Petroleum & Energy)
Poland	KAPE, Polish Energy Agency
Portugal	CCE, Centro para Conservacao de Energia
Romania	Romanian Agency for Energy Conservation
Russia	Ministry of Energy
Slovakia	Slovak Energy Agency
Slovenia	Agency for Efficient Energy Use
South Africa	South African National Energy Association
Spain	IDEA, Instituto para la Diversificacion y Ahorro de Energia
Sweden	STEM
Switzerland	Swiss Federal Office of Energy
Taiwan, China	MOEA
Turkey	EİE/ National Energy Conservation Center
UK	ETSU
USA	APERC
Vietnam	APERC

Note:

For EU countries, the questionnaires were filled up through a project sponsored by SAVE, Ademe and all energy efficiency agencies; the SAVE survey only covered item 2, 3 and 4; item 1 was covered by the technical co-ordination from information available from the countries. Some countries however filled up item 1, 5 and 6 (Austria, France, Germany, Italy, Ireland)

For APEC economies, the co-ordination of the survey was carried out by APERC.

For OLADE countries, outside the APEC members (i.e. Chile, Mexico and Peru), the coordination was under the responsibility of OLADE, Latin American Energy Organisation.

The results present the countries into two main groups: OECD and non-OECD.

1. Institutions and programme

1.1. Institutions in charge of the implementation of energy efficiency programmes

1.1.1. OECD countries

1.1.1.1. Europe

	National Agency	Regional Agencies	Local Agencies
Austria	● (EVA)	●(13)	●(2)
Belgium		●(3)	
Denmark	●[5]		
Finland	● (MOTIVA)	●(10)	
France	● (ADEME)	●(5)	
Germany	● (DEnA)	●(12)	●
Greece	● (CRES)	●(16)	●(2)
Italy	● (ENEA)	●(3)	●(29)
Ireland	● (IEC)		●(11)
Portugal	● (AGEN)[6]	●(7)	●(5)
Spain	● (IDAE)	●(11)	●(7)
Sweden	● (STEM)	●(9)	
Netherlands	● (NOVEM)	●	
UK	❍	●	
Norway	❍[7]	●	●
Switzerland	●		
Turkey	● (NEEC)		
Czech Rep.	● (CEA		
Hungary	● (Energy Center)		
Poland	● (KAPE)	●	
Slovakia	● (SEA)	❍	

● National agency and Ministry department ❍ Ministry department rather than separate Agency

1.1.1.2. Asia Pacific

[5] Denmark: agency covering energy efficiency and supply
[6] CCE was transformed in September 2000 in a new agency (AGEN)
[7] New agency to be set up in 2001

	National Public Agency	Regional Agencies
Australia	❍	●
Canada	❍	❍
Japan	❍	
Korea	● (KEMCO)	
Mexico	● (CONAE)	
New Zealand	● (EECA)	
USA	❍	❍

1.1.2. Non OECD countries/economies

	National Public Agency	Regional Agencies
Chile	❍	
Colombia	● (UPME)	
Hong Kong, China	❍	
India	● (EMC)	●
Indonesia	● (KONEBA)	
Malaysia	● (PTM)	
Philippines	❍	
Peru	❍	
Russia	❍	●
Taiwan, China	❍	
Vietnam	❍	
Bulgaria	● (SEEA)	
Estonia	❍	●
Latvia	❍	
Lithuania	● (EA)	
Romania	● (ARCE)	
Slovenia	● (AURE)	
Algeria	● (APRUE)	
Cameroon	❍ (P)	
Nigeria	● (ECN)	
Egypt	❍	
India	● (EMC)	●
South Africa		

P : planned; ❍ Ministry department rather than separate Agency
Note: no agency or Ministry department in PNG and South Africa

1.2. Existence of national programmes of energy efficiency[8]

1.2.1. OECD countries

1.2.1.1. Europe

		Objectives
Austria	●	National Climate Strategy 2000-08/12 (-15.5Mt CO2)
Belgium	❍	National Climate Change Programme planned by June 2001
Denmark	●	General Act on the promotion of energy savings (March 2000): reduction of CO2 emissions by 21% in 2008/12 compared to 1990
Finland	❍	National Climate Strategy (under preparation)
France	●	National Programme Against Climatic Change (1995; reinforced in January 2000): objective of CO2 reduction of 16 MteC in 2008/12 compared to 1990
Germany	●	National commitment to reduce CO2 emissions by 25% by 2005
Greece	❍	OPE (1996-1999)
Italy	●	Law n0 10of 1991 about National Energy Plan on energy efficiency and energy saving and renewable development
Ireland	●	National Climate Change Strategy 2000 – Reduce overall emissions by 15.4 Mt CO_2 by 2010, of which 11.4 Mt CO2 related to energy
Netherlands	●	33% energy efficiency improvement (1.5%/year) over 1995-2020 (Third White Paper) Action Programme Energy Conservation 1999-2002 (June 1999): increasing the energy efficiency improvement from 1.6% to 2%/year Climate Policy Implementation Plan: reduction of CO2 emissions by 6% (50 Mt)
Spain	❍	ECEP:6.3 Mtoe savings over 1991-2000 (10.4%energy efficiency improvement)
Sweden		Government Bill on Climate Change expected in 2001from a proposal for an action plan prepared by the Parliamentary Climate Committee's aiming at a reduction of GHG by 2%
UK	●	Government climate change programme aims for 20% reduction in CO_2 emissions from 1990 levels by 2010.
Switzerland	●	Energy 2000
Czech Rep.	❍	Government Program for support of energy savings 1999-2000
Hungary	●	Energy Efficiency Programme 2000-2010: 3.5%/year of energy intensity decrease; 1.8 Mtoe/year savings
Slovakia	●	Programme for Reducing the Energy Intensity

● National law or programme with specific objectives of energy savings (or CO2 reduction)
❍ Plan no longer valid or plan under preparation
Note: no national energy efficiency programme in Norway, Poland, Portugal and Turkey

[8] Programmes driven by the national agency and/or the Ministry

1.2.1.2. Asia and Pacific

		Objectives
Australia	●	National Greenhouse Response Strategy 1997-2001
Canada	●	Energy Efficiency and Alternative energy Programme (EAE)
Japan	●	Outline for Promotion of Efforts to Prevent Global Warning
Korea	●	Second Energy Rationalisation Energy Plan 1999-2003 (10% saving in 2003)
USA	●	Office of Energy Efficiency and Renewable Strategy Plan 2000-2010

Note: no national energy efficiency programme in Mexico and New Zealand

1.2.2. Non OECD countries/economies

		Objectives
India	❍	Energy conservation Law under preparation
Indonesia	❍	National Energy Conservation Plan 1991-2000
Malaysia	●	Malaysian Industrial Energy Efficiency Programme 2000-2004 (10% saving)
Peru	❍	Saving Energy Project 1995-2000 ; Promotion of Energy Efficient Use Law (2000)
Russia	●	Energy Conservation in Russia 1998-2005: savings of 21-35 Mtoe by 2010 and 13.5% of GDP intensity
Taiwan, China	●	28% savings by 2020
Vietnam	❍	Master Plan for Energy Efficiency and Conservation 1996-2000 ; 8-10% saving, (1.2 to 1.5 Mtoe) ; savings of 150-200 MW
Bulgaria	❍	National Energy Strategy and Energy Efficiency Development (NEEES) by 2010 Widespread Energy Saving Programme (WSESP)(to be finalised by July 2001) 200% reduction of GDP intensity by 2010
Estonia	●	Target program on energy conservation 1992-2005: elasticity of energy consumption to GDP < 0.5; 8% reduction of CO_2 emissions
Latvia	❍	Strategy of State's Energy Efficiency approved in November 2000; plan under development
Romania	●	National Energy Strategy 2000-2004: reduction of GDP intensity of 3%/year
Slovenia	●	Strategy of Energy Use (1996) (reduction of energy intensity by 2%/year between 1996 and 2010); new National Energy Programme under preparation
Egypt	❍	10% savings by 2010

● National law or programme with specific objectives of energy savings (or CO_2 reduction)
❍ Plan no longer valid or plan under preparation or sectoral programme
Note: no national energy efficiency programmes in Chile, Colombia, Hong Kong, China, Philippines, PNG, Lithuania, Algeria, Cameroon, Nigeria and South Africa

2. Thermal energy efficiency standards for new buildings

2.1. OECD countries

2.1.1. Europe

	Dwellings			Buildings			Monitoring
	Year	Status	Savings	Year	Status	Savings	
Austria	1991/98	M		1991/98	M		✔
Belgium	2000	M		2000	M		✔
Denmark	1998 2005	M P	25 % 33 %	1995 2005	M P	25 % 33 %	✔
Finland	1987 2002	M P	6% 15-20%	1987 2002	M P	6% 15-20%	✔
Portugal	1988 2001	M M	25 % 7.5 %	1988 2001	M P	25 % 25 %	✔
Germany	1995 2001	M P	30% About 30%	1995 2001	M P	30% ~ 30%	✔
Greece	1979 2001	M P	 30 %	1979 2001	M P		
Ireland	1991/97	M	30 %	1991/97	M	30 %	
Italy	1994	M	10%	1994	M	10 %	✔
Netherlands	1995	M		1995	M		✔
	2000	M	40%	2000	M	40%	✔
Portugal	1990	M		1990	M		
Spain	1998	M		1998	M		
Sweden	1984	M		1984	M		
UK	1995 2002/04	 Pr	15% 17/23%		M		
Norway	1998	M	15%	1998	M		
Switzerland	1992 1995	M V	 50%	1992 1999	M V	 50%	 ✔
Turkey	2000	M		2000	M		
Czech Rep.	1983	M		1983	M		
Hungary				1991	M	40%	
Poland	1994	M	15-20%	1994	M	15-20%	
Slovakia	1997	M	33%	1997	M	33%	✔
Romania	1997	M	35%	1997	M		

M = mandatory; P = planned; Pr = proposed
Savings: consumption reduction compared to dwellings/buildings built before the enforcement of the standards

2.1.2. Asia and Pacific

	Dwellings			Buildings			Monitoring
	Year	Status	Savings	Year	Status	Savings	
Australia	1997	M		1997	M		✔
Canada	1982 1997	V V	20-50%	1997	V		✔
Japan	1999	M	18%	1999	M	23%	
Korea	1994	M		1994	M		
Mexico	2001	P, M		2001	P, M		
New Zealand	1999	M		1999	M		
USA[9]	1998	V, M		1998	V		✔

M = mandatory; P = planned; V = voluntary
Savings: consumption reduction compared to dwellings/buildings built before the enforcement of the standards

2.2. Non OECD countries

	Dwellings			Buildings			Monitoring
	Year	Status	% savings	Year	Status	% savings	
Chile				1999	M		
Hong Kong, China				1995	M		✔
India				2001	P		
Indonesia				2000	V		
Malaysia				2001	P, V		
Philippines				1994	M		
Peru	V				V		
PNG	M				M		
Russia	1990	M		1990	M		
Taiwan, China				1998	M	5-10%	
Vietnam		P			P		
Bulgaria		P			P		
Estonia		M			P		
Latvia		P			P		
Lithuania	1999	M	Up to 63%	1999	M	30%	✔
Romania	1997	M	35%	1997	M		
Slovenia	2001	M		2001	M		
Algeria	2000	M		2000	M		

M : mandatory, P : planned, V : voluntary
Savings: consumption reduction compared to dwellings/buildings built before the enforcement of the standards
Note: no existing or planned standards for Cameroon, Colombia, Egypt, Nigeria and South Africa

9 There is no mandatory federal standards but mandatory standards exist in a majority of States

3. Labelling, efficiency standards and target values for household electrical appliances

3.1. Labelling

3.1.1. OECD countries

3.1.1.1. Europe

	Refrigerators	Washing machines	Lamps	Air conditioners	Monitoring
Austria	M	M	M		
Belgium	M	M	M		
Denmark	M	M	M		✔
Finland	M	M	M		
France	M	M			✔
Germany	M	M	M		✔
Greece	M	M	M		✔
Italy	M	M	P		✔
Ireland	M	M	M		
Netherlands	M	M	P		✔
Portugal	M	M	M		
Spain	M	M	M		
Sweden	M	M	P		✔
UK	M	M	M		✔
Norway	M	M	M		
Switzerland	V	V	V		
Turkey	V, P (2001)	V, P (2001)		P	
Czech Rep.	M (2001)	M (2001)		M (2001)	
Hungary	M (1998)	M (2000)			
Slovakia	P (2001)	P (2001)		P (2001)	

P: Planned, V: Voluntary, M: mandated
For EU countries: Refrigerators: EU Directive 94/2/EC; Washing machines: EU Directive 95/12/EC; Lamps: EU Directive 98/11/EC

3.1.1.2. Asia and Pacific

	Refrigerators	Washing machines	Lamps	Air conditioners	Monitoring
Canada	M	M		M	
Korea	M (1992)		M (1992)	M (1993)	✔
Japan	V (2000)		V (2000)	V (2000)	
Mexico	M (1997)	M (1996)		M (1995)	
New Zealand	M (2001)	M (2001)		M (2001)	
USA	M,V	M,V	V	M,V	✔

3.1.2. Non OECD countries/economies[10]

	Refrigerators	Washing machines	Lamps	Air conditioners	Monitoring
China	P	P, M		P	
Colombia	P	P		P	
Hong-Kong, China	V (1995)	V (1997)	V (1998)	V (1996)	✔
India	P (2002)			P (2002)	
Indonesia	P (2000)		P (2000)	P (2000)	
Iran	M (1998)				
Malaysia	P			P	
Philippines	M (2000)		M (1999)	M (1993)	✔
Peru	P	P		P	
Taiwan, China	M (1985)		P (2001)	M (1981)	✔
Thailand	M (1995)		P, M	M (1996)	
Viet Nam	P	P		P	
Bulgaria	P	P			
Estonia	P (2001)	P (2001)		P (2001)	
Latvia	P (2001)	P (2001)		P (2001)	
Lithuania	P	P			
Romania	M (1996)	P (2002)	P (2005)		
Slovenia	M (2001)	M (2001)	M (2001)		
Algeria	M (2000)				
Egypt	P (2001-04)	P (2001-04)		P (2001-04)	

Note: no label schemes in Chile, PNG, Russia and South Africa

[10] Labels schemes exist in Brazil for refrigerators and air conditioners (1986, revised in 1997) and in Iran for refrigerators (1998)

3.2. Standards or target values

3.2.1. OECD countries

3.2.1.1. Europe

	Refrigerators	Washing machines	Air conditioners
Austria	M (1997)		
Belgium	P		
Denmark	M (1998)		
Finland	M (1999)		
France	P		
Germany	M (1998)		
Greece	P (1999)		
Italy	P	V (1997)	
Ireland	M (1999)	V (1997)	
Netherlands	M (1999)		
Portugal			
Spain	M (1998)		
Sweden	M (1999)	V (2000)	
UK	M (1999)	V (2000)	
Switzerland[11]	V (1995)	V (1997)	
Turkey	P, M (2001)		
Slovakia	P (2001)		

M: mandatory; P: under preparation; V: voluntary
Refrigerators and freezers: EU Directive 96/57/EC
Note: no standard in Czech Republic, Hungary and Poland

[11] Target values

3.2.1.2. Asia Pacific

	Refrigerators	Washing machines	Air conditioners
Australia	M	M	M
Canada	M (1995)	M (1995)	M (1995)
Korea	M (2001)	M (2001)	M (2001)
Japan[12]	M (2004)	P (2004)	M (2004)
Mexico	M	M	M
USA	M	M	M

M: mandatory; P: under preparation
No standard in New Zealand

3.2.2. Non OECD countries/economies[13]

	Refrigerators	Washing machines	Air conditioners
China	M (1989/00)	M (1989)	M (1989/01)
Colombia	P (2002)		P (2002)
India	P (2002)		P (2002)
Iran	M (1998)		
Indonesia	P (2000)		P (2000)
Malaysia	P		P
Philippines			M (1993)
Peru	P	P	P
Taiwan, China	M (1985)	P (2001)	M (1981)
Viet Nam	Pr	Pr	Pr
Latvia	P (2001)	P (2001)	P (2001)
Lithuania	P (2001/03)	P (2001/03)	
Romania	M (1996)		
Slovenia	P (2001)		
Egypt	P (2001)	P (2010)	P (2010)

M: mandatory; P: under preparation; Pr: proposed
Note: no existing planned standard in Chile, Hong Kong China, PNG, Russia, Algeria, Bulgaria, Estonia, Nigeria and South Africa

[12] Japan: in bracket: target year for the efficiency gain ("target value")
[13] Standards exist for refrigerator in Brazil (1996) and Iran (1998); Source: P Menanteau- Labelling programs and efficiency standards for household electrical appliances; ADEME/IEPE, September 2000

4. Fiscal measures on cars and motor fuels

4.1. Overview of fiscal measures on cars

4.1.1. OECD countries

4.1.1.1. Europe

	Purchase tax(1)	Annual registration tax(1)	Incentives for car scrapping(2)	Incentives for clean/efficient car
Austria	●	●		✔
Belgium	●	●		
Denmark	●●	●	✔	✔
Finland	●●	●		
France	❍		T	✔
Germany	❍	●		
Greece	●	●	✔	
Italy	●	●	T	
Ireland	●	●	T	
Portugal	●	❍	P	
Spain	❍		✔	
Sweden		●	T	
Netherlands	●	●		✔
UK	❍	●		
Norway	●●			
Switzerland		●		✔[14]
Turkey	●	●		
Czech Rep.				
Hungary	●	●	✔	
Poland				
Slovakia		✔		

(1) ●: average tax

●●: very high tax

❍: low tax

(2) T: terminated ; P: planned

[14] Only in one community, as a pilot project

4.1.1.2. Asian and Pacific

	Purchase tax	Annual registration tax	Incentives for car scrapping	Incentives for clean/efficient car
Australia			P	
Canada	✔	✔	✔	
Japan	✔	✔	T	✔
Korea	✔	✔		
Mexico	✔			
USA[15]		✔		✔

4.1.2. Non OECD countries/economies

	Purchase tax	Annual registration tax	Incentives for car scrapping	Incentives for clean/efficient car
Chile		✔		
Colombia		✔		
Hong Kong, China	✔	✔	✔	✔
Indonesia	P			
Malaysia	✔	✔		
PNG		✔		
Russia		✔		
Taiwan, China	✔	✔	✔	✔
Bulgaria	✔	✔		
Estonia	✔	✔		
Latvia		✔		
Romania	✔	✔		
Slovenia	✔	✔		
Egypt	✔	✔		

Note: no tax or incentives in India, Peru, Philippines, Peru, Vietnam, Lithuania, Algeria, Cameroon and South Africa

[15] There exist purchase tax, annual registration tax in some States

4.2. Car purchase taxes

4.2.1. OECD countries

4.2.1.1. Europe

	Austria	Belgium	Denmark	Ireland	Finland
by engine size		✔		✔	
by weight					✔
by fuel type?	✔	✔			
by car value			✔		
by efficiency	✔		✔		

	France	Greece	Italy	Netherlands	Portugal
by engine size	✔	✔	✔		✔
by weight				✔	
by fuel type?	✔		✔	✔	
by car value					
by efficiency					

	Spain	UK	Turkey	Hungary
by engine size	✔		✔	✔
by weight				
by fuel type?	✔			
by car value				
by efficiency		✔		

Germany, **Sweden** and **Switzerland**: no tax
Austria: for **gasoline cars,** the purchase tax is calculated as follows: tax (%)=(Average fuel cons.[l/100 km]-3[l/100 km]) 2. The maximum tax is 16 % of the net price. The average tax amounts to 9% of the net car price or 1050 € (based on an average price of 15000 € and specific consumption of 7.5 l/100km. For diesel cars the formula is: tax (%)=(average fuel cons.[l/100 km]-2[l/100 km]) 2. The average tax for diesel amounts to 9% of the net car price (based on 6.5 l/100km).
Denmark: car purchase tax based on the car's value. The tax is progressive (the car owner pays 105 % tax of the car value less than 53000 DKK and 180 % above 53000 DKK). The average purchase tax is about 15 000 € (1997). From January 2000, very efficient cars are exempted (reduction for gasoline: 1/6 for cars in a consumption range of 25 – 28.6 (in km/l), 2/6 for a range of 2.6- 33.3 km/l; 3/6 for 33.3-40 km/l and 4/6 above 40 km/l ; for diesel the range are slightly different (28.1-32.1 ;32.1-37.5;37.5-45 and above 45)
Finland: decreasing tax with the weight of the car.
France: tax quite small based on the horsepower of the car, the availability of luxury equipment (air conditioning); it is on average 200 € (280 € for a large car and 140 € for a small car)
Ireland: Vehicle Registration Tax (VRT) (subject to VAT); 22.5% tax rate <1 400 cc, 25% for 1401-2000 cc and 30%>2000 cc; average tax: 4017 Euro (1998).
Netherlands: car purchase tax (BPM) 45.2% of the ex-tax price of the car (not subject to VAT); the price paid is 1.627 times the ex-tax price (1+0.452+0.175) plus a fuel correction factor VAT (17.5%) (average price of a car 1 800 € in 1997).
Spain: tax rate is 7% for small cars (< 1 600 cc. for gasoline and < 2 000 cc. for diesel) and 12% for the rest.
Norway : tax based on three components, weight, engine size (cm^3) and power (kW) and progressive for each component. A 1200 kg car with a 80 kW 1600cm3 engine will get a tax of 7500 €. (8.1 NOK = 1.0 €)
Hungary: tax of 0.033 US$/cm3 (typical average size; 1 300-1 400 cm3)

4.2.1.2. Asia and Pacific

	Canada	Korea	Japan	Mexico	USA[16]
by engine size		✔			
by weight	✔				
by fuel type?					✔
by car value			✔	✔	
by efficiency					✔
Not specified					

Canada: air conditioning tax (100 Can $ flat)

4.2.2. Non OECD countries/economies

	Hong-Kong, China	Malaysia	Taiwan, China
by engine size		✔	✔
by weight			
by fuel type?		✔	
on car value	✔		
by efficiency			

	Estonia	Romania[17]	Egypt
by engine size	✔		✔
by weight			
by fuel type?			✔
on car value		✔	
by efficiency			
by emissions		✔	

[16] In some States only

[17] **Romania:** car purchase tax vary with engine size in cc: 1 % of selling price < 1600cc; 3.5% between 1600-1800cc ; 6% for 1800-2000; 12% for 2000-2500 and 18% above 2500 (value depends on degree of pollution according to Government ordinance 27/31.01/2000)

4.3. Characteristics of annual registration tax

4.3.1. OECD countries

4.3.1.1. Europe

	Austria	Belgium	Denmark	Germany	Finland
by engine size	✔	✔		✔	
by weight			✔		
by fuel type?				✔	
by age					✔
by efficiency			✔		
by emissions				✔	

	Greece	Ireland	Italy	Netherlands
by engine size	✔	✔	✔	
by weight				✔
by fuel type?				✔
by age				
by efficiency				
by emissions				

	Portugal	Sweden	UK	Switzerland
by engine size	✔		✔	✔
by weight		✔		✔
by fuel type?	✔	✔		
by age	✔			
by efficiency				
by emissions				

	Turkey	Hungary	Slovakia
by engine size	✔	✔	✔
by weight			
by fuel type?			
by age	✔		
by efficiency			
by emissions			

Austria: annual registration tax calculated according as follows: tax [Euro]=(power [KW]-24 KW) 4.80 Euro/KW; the minimum annual registration tax amounts to 52 €, average annual tax is 220 €.
Denmark: green tax base on car efficiency for cars purchased after July 1997; for cars purchased before weight tax.
Finland: tax by age decreasing for old cars: 84 € (first registration < 1994) and 117€ after; tax for diesel much lower.
France: cancelled in September 2000 (was function of the horse power and fuel); lower for diesel.
Germany: annual registration tax depending on engine size, emission and motor fuel; rate per 100 cc between 5 € and 25 € for diesel and between 13.5 € and 37 € for gasoline.
Ireland: tax rates increase for each 100 cc between 1000 cc and 3000 cc; average estimated as follows: 195€ up to 1400 cc, 359 € for 1400-2000 cc and 758 € > above.
Netherlands: average annual registration tax (MRB) 380 € for gasoline (range of 310-450) (310 € for 950-1 050 kg, 450 € for 1 150-1205 kg), of 750 € for diesel (range of 650-860 €), of 820 € for LPG (range of 710-930 €), of 500 € for clean LPG(range of 390-610 €). No tax for electric cars.
Hungary: tax of 0.02 US$/kg (typical average weight of a car: 1 000 kg).

4.3.1.2. Asia and Pacific

	Canada	Korea[18]	Japan	USA[19]
by engine size	✔	✔	✔	
by weight				
by fuel type?				✔
by age				
by efficiency				
by emissions				

4.3.2. Non OECD countries/economies

	Chile	Colombia	Hong-Kong, China[20]	Malaysia	Taiwan, China
by engine size		✔	✔	✔	✔
by weight					
by fuel type?			✔		
by age	✔				
by efficiency					
by emissions					

	Philippines	PNG	Slovenia	Latvia	Estonia
by engine size	✔	✔	✔		✔
by weight				✔	
by fuel type?					
by age					✔
by efficiency					
by emissions					

	Egypt
by engine size	✔
by weight	
by fuel type?	
by age	
by efficiency	
by emissions	

[18] Korea: about 20 US cents/cc for a range of 1500-2500 and 14 US cents for a range of 1000-1500 cc.

[19] USA: some States only

[20] For gasoline: 3 900 HK$ (500 US$) < 1 500 cc and 5 800 HK$ (745 US$) between 1 500 and 2 500 cc; for diesel: 5 400 HK$ (690 US$) < 1 500 cc and 7 250 HK$ (930 US$) between 1 500 and 2 500 cc

4.4. Subsidies for old car scrapping

4.4.1. OECD countries

4.4.1.1. Europe

Denmark	Ireland	France	Greece	Italy	Portugal
✔	T	T	✔	T	P (2001)
	(1997)	(1995-97)		(1998-99)	

Spain	Sweden	Hungary
✔	T	✔
(1994-)	(1998)	

T: terminated (in brackets period under which the subsidies scheme was implemented)

Denmark: scrapping subsidy of 161 €/car, increased to 201€ in January 2001
Ireland: ended in December 1997
Italy: such incentive existed in 1998/99
Portugal: measure planned for 2001, subsidy deducted from car purchase tax (about 1 000 €)
Spain: Plan RENOVE I (from 04/1994 until 12/10/1994): reduction of 601 € on the registration tax (only for cars more than 10 years). Plan RENOVE II (until 06/1995): reduction of 481 € for cars more than 7 years.

4.4.1.2. Asia and Pacific

Australia	Canada	Japan
P	✔	T
		(1997-1999)

4.4.2. Non OECD countries/economies

Hong-Kong, China	Taiwan, China
✔	✔

4.5. Subsidies/incentives for clean and efficient cars

4.5.1. EU countries

4.5.1.1. Europe

	Austria	Denmark	France	Netherlands
Electric cars	✔	✔	✔	✔
CNG			✔	

	Portugal	UK	Switzerland
Electric cars	✔	✔	✔
CNG	✔	✔	

Austria: no direct subsidy but electric cars are exempted of the car purchase tax.
Denmark: exemption of car purchase tax and green owner fee from 1983 to 2003 for electric cars.
France: incentives only apply to local authorities vehicles.
Netherlands: exemption of annual vehicle tax (registration tax) for electric cars
Portugal: vehicles powered by gas only are exempt from car purchase tax.

4.5.1.2. Asia and Pacific

	Australia	Canada	Japan	USA
Electric cars	P		✔	
CNG	P	✔	✔	

USA: incentives exist for non-conventional cars

4.5.2. Non OECD countries/economies

	Hong-Kong, China	Taiwan, China
Electric cars	✔	✔
CNG		✔

4.6. Motor fuel taxes[21]

4.6.1. OECD countries

4.6.1.1. Europe[22]

US$/ l	Austria	Belgium	Denmark	Germany	Finland
- motor gasoline	0.44	0.60	0.46	0.48	0.69
- diesel	0.31	0.37	0.31	0.32	0.41
- LPG	0.28		0.17		
- CNG	0.06		0.28		

US$/ l [23]	France	Greece	Ireland	Netherlands	Portugal
- motor gasoline	0.70	0.36	0.50	0.71	0.38
- diesel	0.48	0.31	0.41	0.44	0.32
- LPG			0.13	0.13	

US$/ l	Spain	Sweden	UK	Norway	Switzerland[24]
- motor gasoline	0.43	0.68	0.73	0.81	0.50
- diesel	0.32	0.50	0.77	0.68	0.45
- LPG			0.23		
- CNG			0.23		

US$/ l	Turkey	Czech Rep.	Hungary	Poland	Slovakia
- motor gasoline	0.57	0.41	0.48	0.41	0.24
- diesel	0.41	0.32	0.44	0.30	0.26
- LPG			0.09		

[21] Data from questionnaires except for the following countries for which data were taken from IEA "Energy Prices and Taxes»: Czech Rep., Poland, Australia, Canada, Japan (diesel), Mexico, and India

[22] 1 € = 0.9 US $

[23] kg for LPG for UK and CNG for Austria and UK

[24] 1 US$ = 1.7 CHF. The motor fuel tax is calculated as a function of the energy content (kWh); the same for all fuel types.

4.6.1.2. Asia and Pacific

US$/ l[25]	Australia	Canada	Korea	Japan	Mexico
- motor gasoline	0.27	0.21		0.49	0.07
- diesel	0.26	0.15		0.32	0.21
- LPG				0.17	
- CNG				0.0065	

US$/ l	New Zealand[26]	USA
- motor gasoline	0.13	0.10
- diesel	0.04	0.12
- LPG		
- CNG	0.11	
- electricity	0.04	

4.6.2. Non OECD countries/economies

US$/ l	Chile	Hong-Kong, China[27]	Malaysia	Philippines	Taiwan, China
- motor gasoline	0.29	0.78			0.20
- diesel	0.07	0.26			0.12

US$/ l	Peru[28]	PNG	Russia	Vietnam	Bulgaria
- motor gasoline	0.34		0.022	0.09	
- diesel	0.16		0.02	0.085	
- LPG	0.07				

US$/ l	Latvia[29]	Lithuania	Romania	Algeria	India
- motor gasoline	0.26	0.23[30]	0.55		0.26
- diesel	0.16	0.12	0.51		0.08
- LPG			0.47		

[25] kg for CNG for Japan
[26] 1 NZ $ = 0.395 US$
[27] Respectively 6.06 and 2.0 HK$ for unleaded gasoline and diesel
[28] Tax for 95 motor gasoline; range for the 4 categories of gasoline is 0.25-0.37 US $/ liter
[29] Tax on diesel: 0.21 US$/l from January 2003
[30] Data from Ministry of Transport and Communications of Lithuania

5. Energy audits

5.1. OECD countries[31]

	Dwellings	Commercial Buildings	Public Buildings	Industry
Australia	M	M, P	M	M, P
Canada	V	P	V	
Czech Rep.	M, P	P	M, P	M, P
Japan		F	F	F
Finland	P	P	P	P
Greece	F	P, C	F, C	P, C
Korea		P	M	C
Ireland				
Hungary		P	P	P
Italy	F	F	F	F
Mexico				
Poland	C		C	C
Netherlands	P,C	P,C (2001)		
Slovakia	P	P	P	P
Turkey				P

M : mandatory ; V : voluntary ; F : free for the consumers; P : partly paid by consumers ; C : condition for receiving a subsidy ; T : terminated

Notes:
Czech Republic: Subsidies; 50% for industry, 60% for households and commercial buildings and 80% for public buildings; audits mandatory above 1500Gj/year
Finland: large audit schemes for all sectors with public support
Hungary: maximum support of 75% of the audit cost
Italy: from 1991 to 1998 except for public buildings, still going on: 15000 dwellings, 200 commercial buildings, 100 public buildings and 501 industrial plants; total budget for the whole period: 3.1 Million US$
Netherlands: new audit scheme for existing dwelling (EPA) that aims at raising their efficiency up to that of new dwellings; if the recommended measures are implemented, the consumer get a refund of almost 80%; scheme to be extended to the service sector in 2001
Poland: period 1998-2005; minimum of 15-25% energy saving for repayment

[31] Information only available for 6 EU countries

5.2. Non OECD countries

	Dwellings	Commercial Buildings	Public Buildings	Industry
Taiwan. China		F, M	F, M	F, M
Indonesia		T	T	T
Colombia				F
Hong Kong, China		F		
Vietnam				P
Malaysia			F	F
Peru	F	F	F	F
Philippines		Fee	F	Fee
Lithuania	F		P	P
PNG			F	P
Romania	M	P		
Russia			M, C	M
Slovenia	P	P	P	P
Egypt		F,P	F,P	F,P
Nigeria				M, P, F

M : mandatory ; V : voluntary ; F : free for the consumers ; P : partly paid by consumers ; C : condition for receiving a subsidy ; T : terminated . Fee: with fee

Notes:
Colombia: since 1981 for large industries
Indonesia: 1994-1998, free for the consumer (identification study)
Egypt: 220 audits planned for 2000-04
Nigeria: textiles industry (start in 2001)
Vietnam: for companies consuming > 500 toe/year

6. Other energy efficiency measures

6.1. OECD countries[32]

6.1.1. Europe

	Industry	Service Buildings	Households	Transport
Regulation on:				
- Consumption reporting	Hu, Sk,Sw, Tu	Hu, Sk,	Cz	Hu, Sk,
- Energy managers	Hu, Sk, It,Tu	Hu, Sk, It	It	Hu, Sk, It
- Energy saving plan	Hu, Tu	Hu	Cz,Hu	Hu, Gr
- Heat metering	Hu, Sk, Tu	Hu, Sk	Cz, Ge, Hu, Sk, Sw	
- Maintenance	Ge , Sk	Cz, Ge, It, Sk	Cz, Ge, It, Sk	Ge, Gr
Investment subsidies	Au, Ge, Gr, It, Sk	Au,Ge, It, Sk	Au, Ge, Hu, Sk, It	It, Sk
Soft loans	Fr, Ge, Gr, Hu,	Ge, Hu,	Ge	Hu,
Tax credit or tax deduction	Sk	Fr, Gr, Sk	Fr, Gr, Sk	Fr, Sk
Accelerate depreciation	Fr, Sk	Sk	Ge, Sk	Sk
Sectoral agreements	Fi,Fr, Ge, Ir, It	Fi,Fr, Ge		Fi,Fr, Ge, It
Tax reduction[33]	Fr, Sk	Gr, It, Sk	Gr, Ir, It, Sk	It, Sk
Information programmes on:				
- Best practices	Cz,Ge,Ir,It, Sk,Sw	Cz,Ge,It,Sk, Sw	Cz,Ge,Ir,It, Sk, Sw	Cz,It,Sk, Sw
- Comparative information	Cz,It,Ge,Sk Sw, Tu	Cz,It,Ge,Sk, Sw	Cz,It,Ge,Sk, Sw	Cz,It,Ge,Sk, Sw

Au: Austria
Cz: Czech republic
Fr: France
Fi: Finland
Ge: Germany
Gr: Greece
Hu: Hungary
It: Italy
Ir: Ireland
Sk: Slovakia
Sw: Switzerland
Tu: Turkey

[32] Information available only for 6 EU countries
[33] On energy efficient appliances (VAT, Import tax, …).

6.1.2. Asia and Pacific

	Industry	Service Buildings	Households	Transport
Regulation on:				
- Consumption reporting	Ja, Ko	Ja, Ko		Us
- Energy managers	Ja	Ja		
- Energy saving plan	Au, Ja, Ko	Au, Ca, Ja, Ko	Au	Au
- Heat metering	Ja	Ja		
- Maintenance	Au, Ja	Au, Ja	Au	Au
Investment subsidies	Au, Ja, Us	Au, Ca, Ja, Us	Au ,Us	Au, Ca, Us
Soft loans	Ko, Me, Us	Ko, Me, Us	Ko, Me, Us	Ko, Me, Us
Tax credit or tax deduction	Ca, Ko	Ko	Ko	Ca, Ko, Us
Accelerate depreciation	Ja	Ja	Ja	
Sectoral agreements	Ca, Ko, Nz	Ca, Nz, Us	Us	Ca, Nz, Us
Tax reduction[34]	Ko, Us	Ko, Us	Ko, Us	Us
Information programmes on:				
- Best practices	Au, Ca, Me, Nz, Us	Au, Ca, Me, Nz, Us	Au, Ca, Ja, Me, Nz, Us	Au, Ca, Me, Nz, Us
- Comparative information	Ca, Nz, Us	Ca, Nz, Us	Ca, Me, Nz, Us	Ca, Nz, Us

Au: Australia
Ca: Canada
Ja: Japan
Ko: Korea
Me: Mexico
Nz: New Zealand
Us: USA

[34] On energy efficient appliances (VAT, Import tax, …).

6.2. Non OECD countries

	Industry	Service Buildings	Households	Transport
Regulation on:				
- Consumption reporting	La, Li, Ph, Ro, Ru, Tw, Sl	La, Li, Ph, Ro, Ru, , Tw	La, Li, Ro	Li, Ph, Tw, Sl
- Energy managers	Ro, Ru, , Tw	Ro, Ru, , Tw	Ro	Tw
- Energy saving plan[35]	Li, Ph, Ru, Tw, Id	Li, Ph, Ru, Tw, Id		Ph, Id
- Heat metering	Li, Ro, Ru, Tw, Sl	Li, Ro, Ru, Sl	Bg, Li, Ro, Sl	
- Maintenance	Li, Ru, , Tw	Li, Ru, , Tw	Li,	Tw
Investment subsidies	Hk, Ro, Tw	Hk, Li, Ro, , Tw	Bg Li, Ro, Sl, Tw	Tw
Soft loans	La, Li, Ph, Ru, Tw, Cl, Vi, Sl	La, Li ,Ph, Ru, Tw, Sl	La, Li	La, Tw
Tax credit or tax deduction	Co, Tw, Sl	Tw, Sl	Li,	Co
Accelerate depreciation	Tw, In	Tw		
Sectoral agreements	Ph, Cl	Ph	Ph	Ph
Tax reduction[36]	Co, In, Vi		Sl	Co
Information programmes on:				
- Best practices	La, Li, Ru, Sl, Vi	Hk, La, Li, Ph, Ru,	Hk, La, Li,	Hk, La
- Comparative information	Co, La, Ru, Sl, Tw, Vi	La, Ru, Sl	Co, La, Li, Ru,	Co, La, Ru, Tw

Bg: Bulgaria
Cl: Chile
Co: Colombia
Tw: Taiwan, China
Hk: Hong Kong, China
In: India
Id: Indonesia
La: Latvia
Li: Lithuania
Ph: Philippines
Ro: Romania
Ru: Russia
Vi: Vietnam
Sl: Slovenia

[35] Planned for Colombia for all sectors
[36] On energy efficient appliances (VAT, Import tax).