# ENERGY EFFICIENCY POLICIES AND MEASURES : LESSONS FROM IMPLEMENTATION OF SELECTED MEASURES IN OECD AND NON-OECD COUNTRIES

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**Abstract***: Domestic policies and measures to increase energy efficiency in various sectors have been implemented recently in many countries responding to several goals (energy security, climate change issues…). The World Energy Council set up since 1995 a "service" to its members in order to analyze trends in energy efficiency and identify most relevant policies and measures implemented. A collaborative study conducted in 2001 through this WEC framework aimed at analyzing the conditions of implementation of selected measures in a large number of different countries.*

*The selected measures cover all sectors and different types (regulatory, market instruments) : thermal efficiency standards for new buildings, labeling, standards and target values for electrical appliances, fiscal measures on car purchase and using, energy audits, financial incentives for investments. The study analyzes the effectiveness and the conditions of implementation of these measures in more than 50 countries, developing as well as developed ones), identifying national circumstances and factors of success.*

*The study stresses several conclusions concerning some convergence between policies implemented in different countries and some discrepancies due to national circumstances.*

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Energy efficiency policies and measures have been implemented in many countries for several years, responding to different stakes such as oil shocks and energy dependency, lack of funding resources for investments on the supply side, environmental concerns. This paper rests on a study carried out in the framework of the World Energy Council services to its members aimed at sharing experiences on energy efficiency policies[1]. The study, performed by ADEME (French agency for environment and energy efficiency) with APERC (Asian Pacific Energy Research Center), the collaboration of OLADE (Latin America energy organization) and the technical support of ENERDATA, analyzed energy efficiency policies among more than 50 participating countries through a questionnaire and identified several "good practices" policy measures, implemented in several countries (OECD and non-OECD), in different sectors.

[11] Energy Efficiency Policies and Indicators, F. Moisan, D. Bosseboeuf, a report to the World Energy Council to be presented and published at the 18th Congress of WEC, Buenos Aires, October 2001

The objective of this presentation is to identify convergence and discrepancies among countries in the design and the implementation of similar measures, trying to reveal national circumstances or other specific situations and evaluations conducted. The presentation focuses on the following measures :

- Energy efficiency standards for new dwellings and buildings
- Labeling and energy efficiency standards for household electrical appliances
- Fiscal measures on cars and motors fuels
- Energy audits (in industry and building sector)

These measures have been selected through two criteria : the adoption of these measures by a large number of countries, the objective of covering the various sectors of energy consumption and different types of instruments (regulation, fiscal, incentives…). The study allows to stress some first conclusions on the common characteristics related to each measure and the specific ones related to national circumstances.

## 1) Efficiency standards for new dwellings and buildings

Efficiency standards for the building sector concern both residential (single and multi-family) dwellings and non-residential buildings (public and private service sector and to a certain degree industrial buildings). Buildings, in cold and perhaps even more in warm regions (use of electricity for air conditioning combined with relatively bad building performance) contribute largely to the energy consumption of a country.

Most OECD countries have set up standards for new dwellings and service sector buildings: all European countries, Australia, Canada, the USA, Japan, Korea and New Zealand. Non OECD countries have set up recently mandatory or voluntary standards for service buildings: Singapore and Philippines were among the first. Finally, several new countries planned to introduce efficiency standards in 2000/2001: Mexico, Turkey, Algeria, India, Malaysia, and Indonesia.

The countries considered for comparison, detailed information being available through the questionnaire, are: Australia, USA (California), China, the European Union, Germany, Hong Kong China, Japan, Poland, the Slovak Republic, and Thailand.

Thermal building codes exist in many variants relying on as many different approaches as there are countries. Nevertheless, it seems possible to attempt a certain classification into five different types from simple one to more complex ones (**Table 1**).
The most common types of prevailing building codes by far are type 3 and 4, i.e. thermal building codes that are performance based. There is a clear trend over time from the component approach prevailing in the seventies to a performance-based approach. In addition, the performance-based approach could be implemented jointly with standards on specific equipment or materials (insulation, windows, boilers, …) in order to ensure the dissemination of the most efficient equipment in the retrofitting of existing buildings. France adopted such a mix approach in its national climate change program (2000). Over the past 20-25 years, standards have been generally reinforced in 2 to 4 steps, some of which in very recent times. **Table 2** identifies the

type of regulation implemented in several countries at different years and applied to residential (R) and /or commercial sector (C).

**Table 1 : Typology of thermal building codes**

| Type 1 | Type 2 | Type 3 | Type 4 | Type 5 |
|---|---|---|---|---|
| Envelope Component Approach | Overall Envelope Approach | Heating/Cooling Demand Standard | Energy Performance Standard | Life Cycle Standard |
| Limitation of heat transfer (losses/gains) through individual building components | Limitation of heat transfer (losses/gains) through the building shell | Limitation of the annual heating/cooling demand of buildings | Limitation of the annual (final or primary) energy consumption of the building | Limitation of the lifecycle energy / primary energy consumption of the building |
| k-value (U-value) or r-value of components: $W/m^2K$ (or inverse) | Mean k-value (U-value) or r-value of building shell: $W/m^2K$ (or inverse) | Mean annual heating/cooling demand per $m^2$ / $m^3$ | Mean annual (final or primary) energy consumption per $m^2$ / $m^3$ | Lifecycle (primary) energy consumption per $m^2$ / $m^3$ |
| | | Includes:<br>• Transmission through the building envelope<br>• Ventilation losses or gains<br>• (Passive ) solar gains<br>• Internal heat sources | Includes:<br>• All energy consumption for heating or cooling, including heating or cooling system<br>• Energy consumption for hot water including distribution, for ventilation, lighting, motors/pumps, elevator,...<br>• All energy gains from active solar energy (e.g. PV, solar collectors, etc) | Includes:<br>• Energy use for production of material and products, transport, construction of building, maintenance and decommissioning<br><br>Note: primary energy contents of building products in Germany currently 30% of cumulated energy consumption (50 years), in the near future 50 % |

**Table 2 : type of regulation (year of implementation, sector : Residential, Commercial)**

| Type 1 | Type 2 | Type 3 | Type 4 |
|---|---|---|---|
| EU (70's) : R, C<br>Slovakia (77) : R, C<br>Poland (82/91) : R, C | Australia (96) : R<br>Germany (77/82): R, C<br>Japan (80/92): R, C | Germany (94): R, C<br>Japan (99): R, C<br>China (95): R, (C)<br>Hong Kong (95, 2000): C<br>Thailand (95): R, C<br>Poland (97): R<br>Slovakia (97): R, C | Germany (2001): R, C<br>France (2001): R, C<br>California (85…): R, C<br>EU (proj. dir.): R, C |

The case studies considered present a variety of common features:

- Revisions in thermal building codes have become increasingly regular (about every 6-8 years compared to 12-13 previously; 5 years sometimes envisaged). The European Union has for the first time integrated the dynamics of revisions to the building codes to every five years.

- Type 4 (performance standard for the energy consumption of the building system) is prevailing (but still with different degrees of complexity depending on the equipment integrated: heating/cooling; warm water; lighting: energy for motors/pumps; elevators...).
- Simpler buildings (single family) are often still Type 1 (component standards) or sometimes type 3 (standard for heating or cooling demand excluding building equipment).
- It might sound contradictory, but the introduction of the sophisticated calculation procedures and the move towards performance based indicators has made it easier to introduce building certificates, for example in the form of "number certificates" (Germany) or a star system (Australia). Building certificates enable the buyer to know the energy consumption of his dwelling.
- Relatively few countries have carried out field evaluations of their thermal building codes for example by energy audits.
- Fairly little countries have estimated the additional costs, which each round of new building codes has caused. Nevertheless, from the few results available it can be estimated that the additional costs to the building were limited to a few percentages.
- Existing buildings present the largest short term potential in the building sector but can, for various reasons, be tackled by mandatory standards only in the case of larger extensions to an existing building. For this reasons alternatives have to be developed, e.g. incentive programmes as in Germany.

## 2) Labelling, efficiency standards for household electrical appliances

The household electricity consumption is increasing dramatically in both industrialized and developing countries with the increase in the use of lighting and the rising ownership of household appliances and electronic equipment. In the former, the saturation in the ownership of larger appliances is offset by the continual diffusion of new appliances, like PC's. To slow down and even reverse this trend, many countries have introduced energy efficiency programs. Among the different instruments available, labelling programs and minimum energy performance standards (MEPS) have proved to be very effective. Most countries first focused on refrigerators along with air conditioners in certain countries, since they account for a large part of household electricity consumption.

### 2.1 Labelling

Providing information to the consumers on the energy efficiency performance of new appliances is a well-known and widespread energy efficiency measure. It is usually referred to as labelling. Labelling programs aim at drawing the attention of consumers to the energy consumption of their appliances. Indeed, lack of information is generally considered to be one of the main barriers to improving energy efficiency.

Labelling programs may differ from one country to the next, although there exist two general approaches: "comparison labels" and "endorsement labels" (**Figure 1**). Comparison labels enable consumers to compare the energy efficiency of all the appliances on sale (e.g. European Label or Energy Guide in USA). Endorsement labels simply identify appliances, which are particularly

energy efficient (e.g. Energy Star in USA). Comparison labels are usually mandatory, which implies to set up a regulation. Indeed, it is only meaningful if all manufacturers provide the information, and if the information is expressed in a similar way. Manufacturers usually implement endorsement labels on a voluntary basis.

Mandatory labels for several electrical appliances exist in all EU countries based on the same regulations ("EU Directives"). The EU regulation is mandatory and replaces the existing national regulation. The EU labels give each appliance a grade between A and G (A most efficient), with a corresponding easy-to-read colour code (from red for G to green for A), and the average specific consumption in kWh/year. For the first year, the regulation only concerned refrigerators and freezers; it has been later extended to other appliances (washing machines, dish washers and lamps). These labels are also applied or under implementation in some non-EU countries, in Europe (e.g. Norway, Hungary, the Baltic countries, the Czech Republic, Slovakia, Slovenia), in other regions (e.g. Mexico, Brazil or Iran) (**Table 3**).

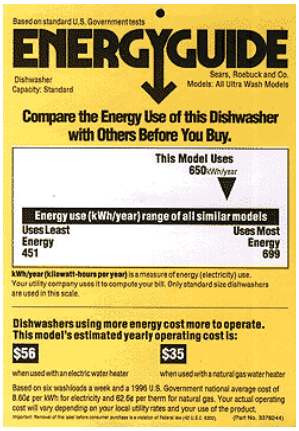
**Figure 1 : Examples of endorsements and comparison labels**

***Endorsements labels***

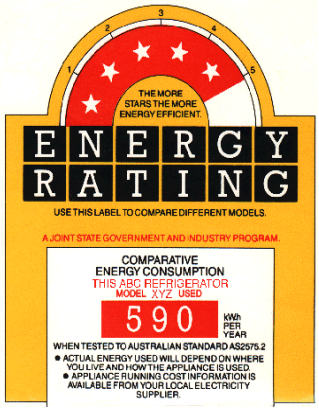

Energy Star (USA)


E 2000 (CH)

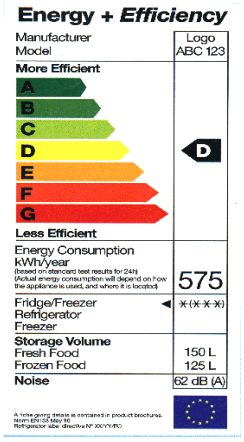
***Comparison labels***




USA




Australia




EU

In the Asia Pacific region, about ¾ of the economies have implemented a label, some very recently, such as Japan, Indonesia or Philippines. As opposed to Europe, they are not always mandatory; they are, for instance, voluntary in Japan and Hong Kong China. Another difference with Europe, due to climatic conditions is that labelling programmes also concern air conditioners; they even are often the first appliances to be labelled (e.g. Mexico, Chinese Taipei, Hong Kong China or Philippines) (**Table 4**).

**Table 3 : Labelling in OECD countries: implementation status**

| | Mandatory | Voluntary | Planned |
|---|---|---|---|
| **Refrigerators** | EU, Norway, Hungary, Canada, Korea, Mexico, New Zealand, USA | Switzerland, Japan, USA | New Zealand, Turkey[1], Czech Rep. [1], Slovakia[1] |
| **Washing machines** | EU, Norway, Hungary, USA | USA | New Zealand, Czech Rep. [1], Slovakia |
| **Air conditioning** | Canada, Korea, Mexico, USA | Japan, USA | New Zealand |
| **Lamps** | EU, Norway | USA | |

Notes: EU: 15 countries ;USA depending on the States: planned or voluntary (1) planned for 2001

**Table 4 : Labelling in non OECD countries : implementation status**

| | Mandatory | Voluntary | Planned |
|---|---|---|---|
| **Refrigerators** | Brazil, Chinese Taipei, Iran, Philippines, Thailand, Romania, Algeria, Slovenia | Hong Kong China | China, Colombia, India, Indonesia, Malaysia, Peru, Viet Nam, Bulgaria, Estonia, Latvia, Lithuania |
| **Washing machines** | Slovenia | Hong Kong China | Brazil, China, Colombia, Viet Nam, Peru, Bulgaria, Estonia, Latvia, Lithuania, Romania, Egypt |
| **Air conditioning** | Brazil, Chinese Taipei, Philippines, Thailand | Hong Kong China | China, Colombia, India, Indonesia, Malaysia, Peru, Viet Nam, Egypt |
| **Lamps** | Philippines, Slovenia | Hong Kong China | Chinese Taipei, Indonesia, Romania |

Labels can be considered, as a first step towards efficiency standards.

### 2.2 Efficiency standards

Performance standards for electrical appliances, usually known as "MEPS (Minimum Energy Performance Standards)", impose a minimum energy efficiency rating or a maximum consumption for all the products on the market. In some countries, they aim at a sales-weighted

average energy efficiency ("target values" in Switzerland or "Top Runner Program" in Japan). Some programs are based on the voluntary participation of manufacturers (e.g. washing machine in Europe, Iran, Brazil).

Efficiency standards levels may be set up in a number of different ways. In Europe, a statistical approach is used: the energy efficiency of the appliances already on the market is used as a basis and the standard is drawn up so as to obtain an improvement of 10 to 15% in the average energy efficiency of new appliances. In other countries, regulations are based on a cost benefit evaluation (e.g. energy efficiency of appliances up to a level which corresponds to a maximum return on investment of 3 years for the consumers in the USA). In Europe, several countries experienced in the 80's and 90's voluntary agreements (Germany in the eighties, Nordic countries in the nineties, Switzerland in 1995). Now, since 1999, an EU Directive defines mandatory energy efficiency standards for refrigerators and freezers for EU countries.

Japan chose a different approach that consists in defining a voluntary target of energy efficiency improvement for a given year (2004). Apart these countries, efficiency standards exist for refrigerators, washing machines and air conditioners in Australia, Mexico, Chinese Taipei (except washing machines), Romania (refrigerators only), and in the Philippines (since 1993 for air conditioners). Minimum efficiency standards are planned in a near future for refrigerators and air conditioners in several additional countries: for instance, for refrigerators in Korea, Indonesia, Slovakia, Turkey, Lithuania and India; or for air conditioners in Korea, Indonesia and India.

**Table 5 : Mandatory efficiency standards in OECD countries: implementation status**

| | Mandatory | Voluntary | Planned |
|---|---|---|---|
| **Refrigerators** | EU, Australia, Canada, Japan, Mexico, USA | Switzerland | Turkey, Korea[1] |
| **Washing machines** | Australia, Canada, Mexico, USA | EU, Switzerland | Korea[1], Japan |
| **Air conditioning** | Australia, Canada, Japan, Mexico, USA | | Korea[1] |

Notes: Target values for 2004 for Japan [1] 2001

**Table 6 : Efficiency standards in non OECD countries: implementation status**

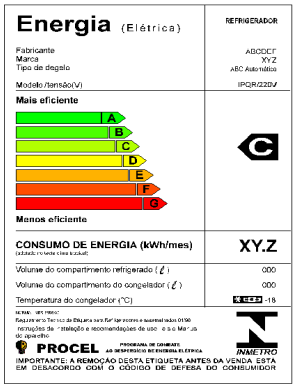
| | Mandatory | Planned |
|---|---|---|
| **Refrigerators** | Brazil, Chinese Taipei, China, Iran, Romania | Colombia[2], India[2], Indonesia, Malaysia, Peru, Lithuania, , Latvia[1],Slovenia[1], Egypt |
| **Washing machines** | China | Taipei[1], Peru, Lithuania, Slovenia[1], Latvia[1], Egypt |
| **Air conditioning** | Taipei, China, Philippines | Colombia[2], India[2], Indonesia, Malaysia, Peru, Slovenia[1], Latvia[1], Egypt |

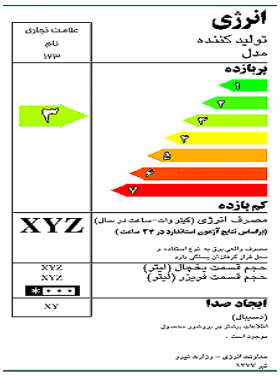
[1] 2001 [2] 2002

## 2.3 Impact of labelling and standards

Generally speaking, the experience has shown that labelling programs and performance standards are effective instruments both for governments (low-cost energy savings) and consumers (less expenditures). Consumers not only have to recognize the label but also have to be able to interpret it. The European label, for example, is easy to understand and was recently adapted in several developing countries (Brazil, Iran, and Mexico). Thailand has adopted the Australian model (**Figure 2**).

**Figure 2 : Transfer of energy labels (Thailand, Mexico , Iran)**

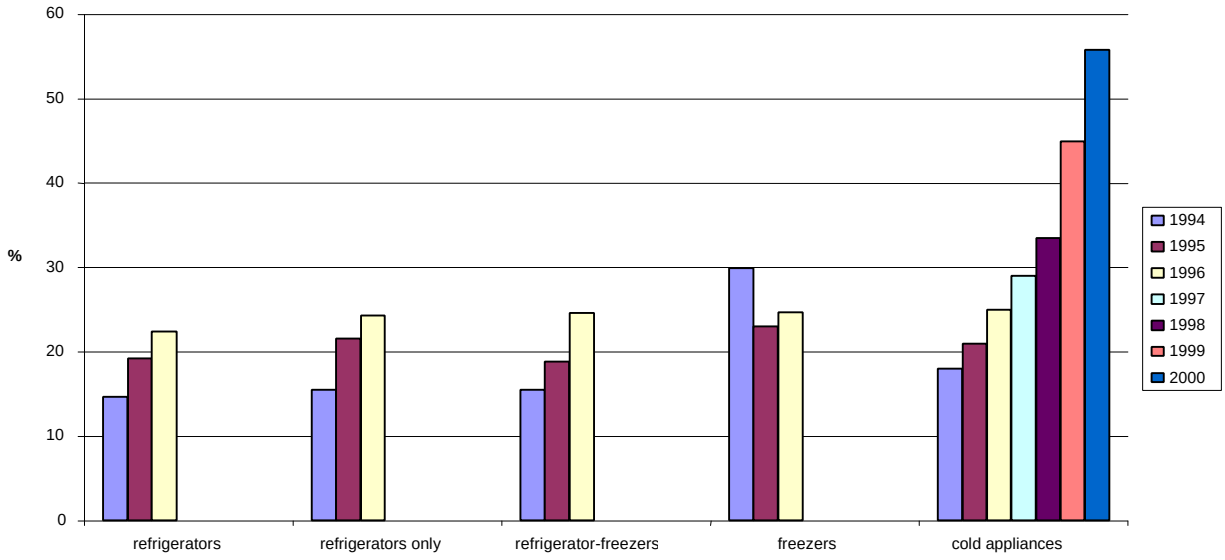




**Comparison labels are more effective than endorsement labels :** By helping consumers identify the most energy efficient products or choose more efficient models, comparison and endorsement labels encourage manufacturers to focus on improving energy efficiency. Although these two types of labels can be complementary (e.g. Brazil with refrigerators), comparison labels are considered to be the most effective since they enable comparison of all the appliances on the market rather than simply identifying the most efficient ones. This is why comparison labelling is generally mandatory. Nevertheless, voluntary comparison labelling programs also exist, and some have proved their effectiveness (e.g. Thailand).

**Impact of labels programs on the market :** In European countries, evaluations indicate increased sales of more energy efficient appliances over the period 1995-97 (**Figure 3**), though with differing results depending on the country (greater impact in northern countries). The introduction of labelling has thus resulted in a transformation of the market. This transformation stemmed from both a change in consumer preferences and changes in the structure of sales: indeed, manufacturers have discontinued some inefficient models that had become difficult to sell and have gradually introduced new more efficient products. This impact on innovation strategies is one of the main purposes of labelling.

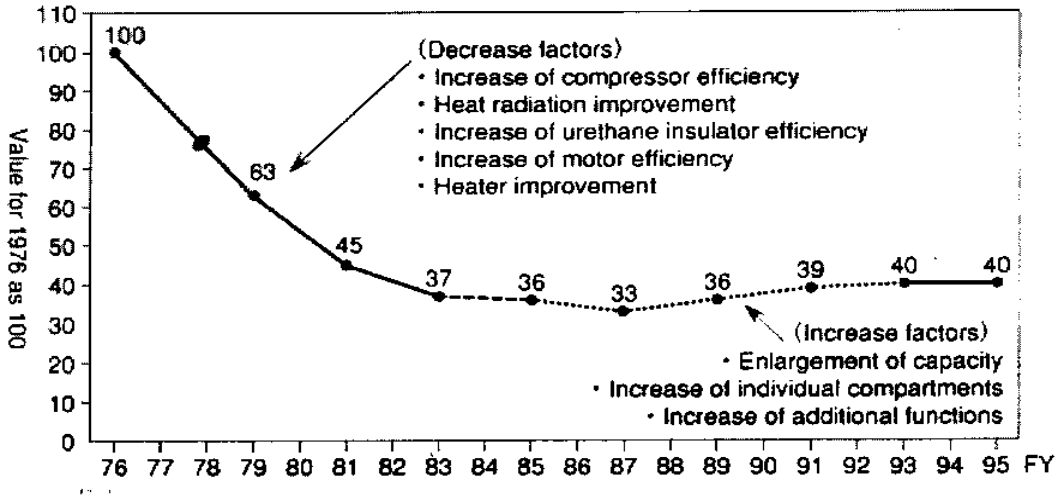
**Figure 3 : Sales of cold appliances (refrigerators /freezers) of label class A and B in the EU**
Source: 1994-1997 ADEME/SAVE Monitor, 1998-2001 estimates from GFK




**Voluntary versus mandatory standards?**
Some countries have negotiated voluntary energy efficiency standards with manufacturers. The limits of such agreements have been demonstrated in Brazil, where some inefficient models have not been withdrawn from the market. In Switzerland and Japan, voluntary agreements have produced more convincing results: in the first case the government threatened to introduce restrictive regulations in the event of failure, and in the second, the commercial consequences of not meeting the objectives would be considered too negative for manufacturers. The European Commission has also set up agreements of this type for washing machines and electronic equipment for the general public with certain success.
The efficiency level imposed by standards varies from one country to the next. In the case of China, standards have had very little impact, since most appliances on sale complied with the proposed standards. In Europe, standards have had a greater impact (40% of the appliances on the market in 1996 did not comply with the standards which were to be introduced in 1999), while in the USA the effect has been considerable (no refrigerator in the US market at the end of the 1980s met the standards to be introduced in 1993).

It is difficult to measure the impacts of the programmes themselves in terms of energy savings, as other factors may intervene at the same time as explained above. What can be observed in the reduction is the average consumption of the electrical appliances that are targeted in the programmes. The savings brought about by standards on refrigerators and freezers have been very significant in Japan (63% between 1976 and 1983, until removal of standards) (**Figure 4**)

**Figure 4 : Impact of efficiency standards on refrigerators and freezers in Japan**




Note: removal of standards in 1983

## 2.4 Conclusions and recommendations

### Labelling and efficiency standards are complementary

Labelling programs cannot completely transform the market. They need to be complemented by minimum performance standards. Standards are necessary to remove inefficient but cheap products from the market, which labelling programs alone cannot do. They are also needed in areas where the selection criteria of consumers totally exclude energy efficiency (TV for example), or when the economic stakes for the consumer are very limited.
It would be possible to introduce standards, which could gradually be made stricter without a labelling program, but it would be more difficult to impose such standards on manufacturers. Basically, labelling stimulates technological innovation and the introduction of new more efficient products, while standards complement this development by organizing the gradual removal from the market of the least energy efficient appliance

### Accompanying measures

Labelling programs and performance standards are effective in promoting energy efficiency, but their effectiveness can be reinforced when accompanied by other instruments (information and training, financial incentives or technology procurement). Accompanying measures involving appliance distributors can help reinforce the impact of a labelling program. Experience has shown that training of sales staff and supports given to distributors reinforces the effectiveness of labelling programs. Similarly, public awareness campaigns designed to improve recognition of the label and facilitate its interpretation are essential for the success of programs (e.g. Thailand).

In certain countries, financial incentive programs, as a complement to labelling, have also proved successful in encouraging the diffusion of energy efficient appliances (e.g. Brazil). In Europe, a technology procurement program was recently introduced to stimulate technical innovation in very energy efficient products; this will ultimately enable a revision of efficiency classes and standards. Such technology public procurement program is identified in the recent European Climate Change Program as a measure to be implemented at the EU level.

# 3 Fiscal measures on cars and motor fuels[2]

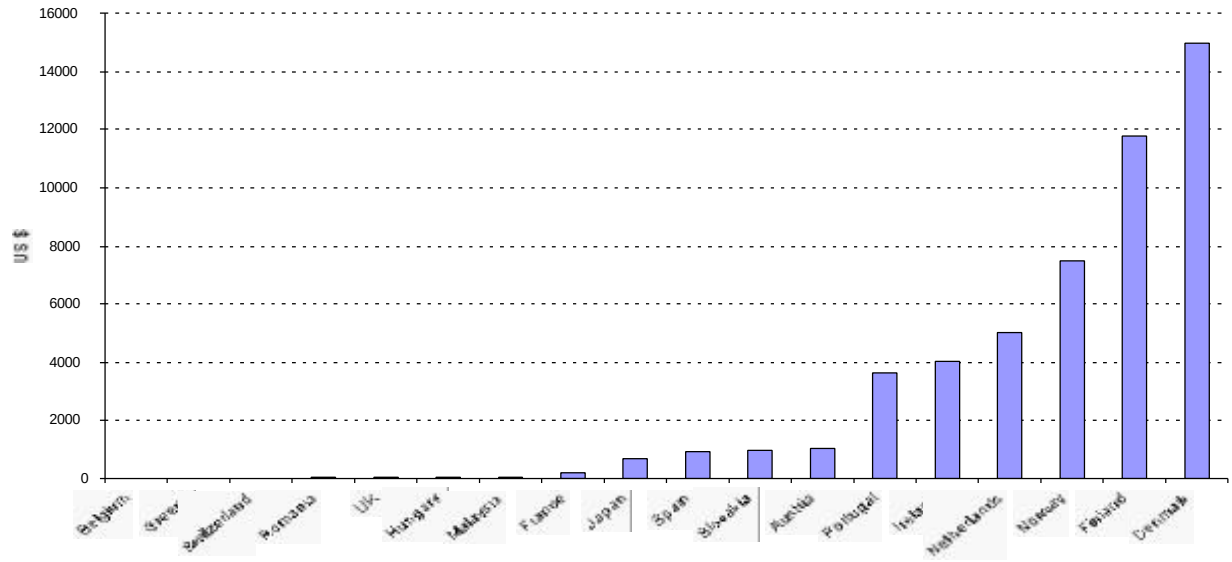
This section focuses on fiscal policies towards car ownership and use. The share of car in household's budgets (around 15%) suggests that these policies should have some influence on the key factors that influence the energy use and $CO^2$ emissions of cars: ownership levels, annual mileage and specific consumption/ emissions. Fiscal policies include taxes on car purchases, taxes on ownership, fuel taxes and road user charges.

## 3.1 Car purchase tax

The first level of taxation is on car purchases (**Figure 5**). Some countries rely only on the VAT (Value Added Tax) system, with a normal rate for cars, and registration fees which are of minor importance. This is very often the case in car producing countries, such as France, Germany, the U.K or Italy. It is now the case in Sweden, where a specific level of tax on car purchases existed up to 1997. In other countries, there may be specific tax on car purchases. Some, such as the "gas guzzler tax" in the United States, are only designed to refrain people to buy highly consuming cars. Car manufacturers have the ability to adapt through technology, and the effect is relatively limited, because a few cars only are concerned. In other cases, such taxes result from long-term policies designed to deter people to buy a car (Singapore, Denmark, Norway, Finland and developing countries where car is an important component of the imports).

[2] This section is based on a case study prepared for the project by JP Orfeuil from Paris University. This case study is available on the WEC web site "Tax regimes and CO2 emissions".

**Figure 5 : Average car purchase tax**
**(excluding VAT, US$/vehicle)**



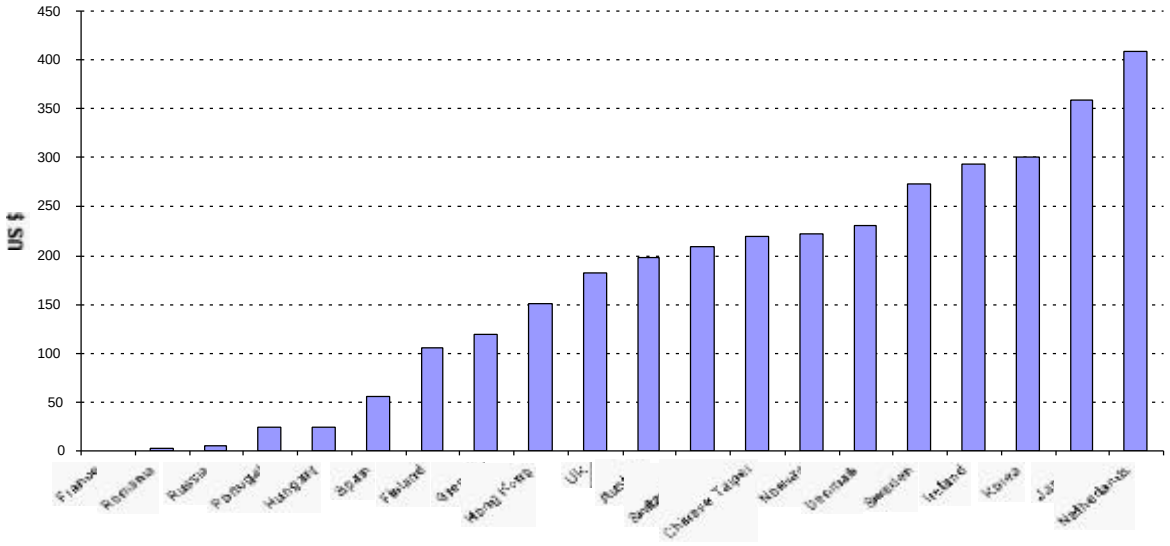

Source : ADEME / WEC survey

The pre-tax price of the car reflects indirectly the level of consumption of the car, since consumptions are related to weight and power. There is now some concern on side effects: for example, high taxes at this level can refrain the consumers from buying new cars, and thus the penetration of new technologies is slower. Economic studies show that fee bate schemes (tax reduction for vehicles under a given goal of consumption, higher taxes for vehicles over the goal) can provide important improvements at low economic and political costs. These schemes are studied but not applied in the USA. In Europe, some countries such as Austria integrate the consumption or the CO2 emissions as component of the basis for taxation.

### 3.2 Car ownership tax

The second level of taxation is on car ownership (annual registration tax). The main interest of this tax is its visibility: because it is not associated to any other payment, people know the level, and car manufacturers take it into account in their strategy. In most countries, this taxation varies according to an index representative of the power of the car , which has a link with the fuel consumption. On the other hand, the link is not absolute and in few cases a more powerful engine may be more efficient. A move towards more explicit consideration of CO2 emissions is observed in few countries (**Figure 6**).

**Figure 6 : Annual tax on cars**




Source : ADEME /WEC survey

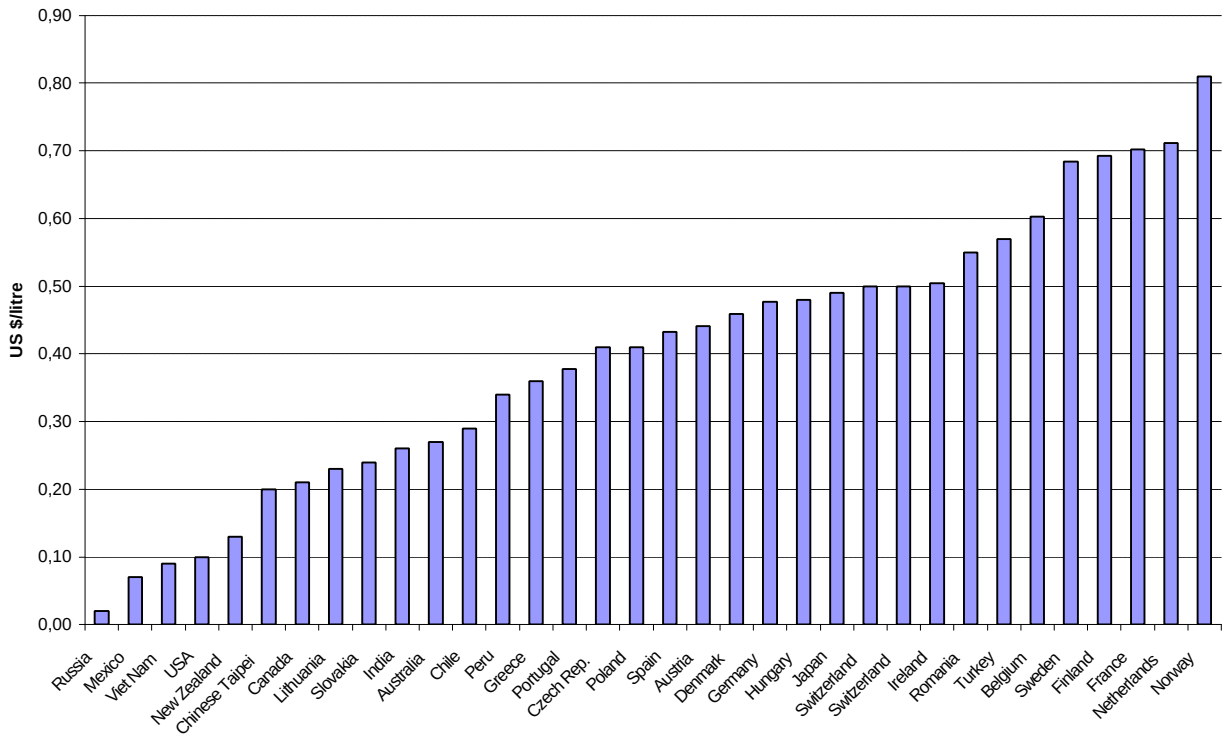
### 3.3 Taxation on motor fuels

The third level of taxation is related to motor fuels. There are large differences among countries in the tax on motor fuel, for gasoline and diesel respectively. Europe has definitely a level of taxes much higher than in the rest of the world, for three reasons: most countries are oil importers; the revenue from the motor fuel tax is an important source of income for the government budget; finally, there is a strong commitment to meet the Kyoto target and one way is to regularly increase the tax on motor fuels (by adding CO2/environment taxes). The last phenomenon is clear in Denmark, Germany and UK and to a lower extent in the Netherlands and Austria. Motor fuel taxes have two dimensions: the average level of taxes and the difference between fuels (gasoline and diesel). **Figure 7** describes the discrepancies of taxes on gasoline between countries.

With regards to the average price level, many studies (Goodwin 1988, Orfeuil, 1990, Johansson and Schipper, 1997) have demonstrated the link between the quantity used and the price over time. Their results are consistent and converge towards a long run elasticity of the fuel consumption to the fuel price of -0.7 (a 10% growth on the price of motor fuel goes with a total reduction of the consumption of 7%). While the short term elasticity is not very high (between -0.2 to -0.3).. The intervals of variation around the median of these estimates are relatively large, which means that other components of policy (other types of fiscal measure and non fiscal measures) are of importance as well.

**Figure 7 : Taxes on motor gasoline (2000)**

Source: ADEME/WEC survey




### 3.4 Other economic of fiscal instruments

Other economic or fiscal tools may influence the car fuel demand: road pricing, possibility of deduction of travel cost from taxable incomes, company cars, and, finally, incentives for car scrapping or for clean and efficient cars.

Road pricing and tolls for road use are never in place on the total territory of a nation. Tolls are generally limited to some freeways. Freeways with tolls are important in France, Italy or Spain for example, but freeways are generally free of charge in countries such as the Netherlands, the U.K. or Germany. Road pricing occurs only in some countries (Norway, Singapore) and in some urban areas, such as Singapore, Oslo, Trondheim, Bergen.. Road pricing may have some effect on CO2 emissions, because it leads to smoother traffic conditions.

Two other fiscal measures must be quoted, even though no international comparison is available. The first one is the compensation on the income tax related to the journey to work. The second one is the policy towards company cars. Companies are important players on the new car sales market, either for company needs or to provide their employees with a car, as a part of their retribution. In UK, around 50 % of cars are bought by companies. Cars are kept by companies 2 or 3 years, and then sold to households. As the criteria of companies regarding the choice of cars may be different compared to households, this mechanism may lead to an « upsizing » of the car fleet.

Incentives for old car scrapping has often a double objective: accelerate the renewal of the car fleet to stimulate the car industry, and remove from the stock the old cars, usually inefficient and with high level of emissions. This is usually a temporary measure implemented over 1 or 2 years, with an immediate effect. This measures has been implemented in about 10 countries and in 5 of them the measure is no longer in application as it was set up for a limited period. Evaluations show that this measure accelerates the renewal of the fleet but may have side effects, including free riders and a shift to bigger cars.
Subsidies for clean and efficient cars are not so common: only 10 countries in our sample are proposing subsidies to buyers of electric or CNG cars. The objective is first to reduce the price of these cars that are more expensive to buy but that have lower utilization cost. A second objective is to create a market so as to reduce the production cost through larger production series.

### 3.5 Conclusions and recommendations

Even though there are limitations in empirical findings, the basic conclusion is quite simple: the consumer is responsive to the price signals at every level.
As regards car purchase taxes, countries with high car purchase fees (Denmark, Finland, Norway, The Netherlands, Ireland and Portugal) have lower motorisation rates (per inhabitant or per unit of GDP) than the European average. Countries with no significant registration fees have higher motorization rates. High levels of taxes on car purchases do not seem to orientate the demand towards more efficient cars. In the high levels of taxation, Denmark and The Netherlands do not have lower CO2 emissions per km ; in the low levels of taxation, countries such as Italy and France share with Portugal the lower levels of CO2/ km.
The annual tax on cars may play an additional role, either to orientate the demand towards less powerful cars or to prevent from using diesel cars, when the tax is significant and when there is a significant difference between these two types of cars.
The role of a fuel tax is primarily to orientate the demand towards more efficient vehicles, and secondary to drive less.

The right criterion to assess the position of a country is probably the unit consumption on the carbon emissions of passenger cars per GDP unit. Fulton estimated it for recent years for several countries (**Table 7**). The Netherlands, France and Italy are in equivalent positions, despite quite different policies regarding taxes in the Netherlands and in Latin countries. The Netherlands achieves its result through higher levels of taxes on car purchases, while the Mediterranean countries concentrate on fuel tax. Denmark has clearly the best result, in relation to the quite high pressure of taxes on purchases. From an economic viewpoint however, it could be considered as more efficient to reduce the tax level for efficient cars (that is the way followed by this country) and to compensate by higher fuel prices.

**Table 7 : Carbon emissions from passenger cars per GDP unit**

| | Carbon emissions from passenger cars per unit GDP |
|---|---|
| USA | 50-75 |
| Canada | 60-70 |
| Australia | 42-48 |
| UK | 25-30 |
| Sweden | 22-28 |
| Germany | 20-25 |
| Netherlands | 16-21 |
| France | 16-20 |
| Italy | 14-20 |
| Denmark | 7-10 |

Source: derived from Fulton

From a policy point of view, the European situation is far from optimal due to an heterogeneous market, with quite different taxation regimes (see **Table 8** for a global approach of the tax paid over the lifetime of a car). The fact that purchase taxes are concentrated on small markets, and that these taxes are not directly related to fuel consumption is not an incentive for them to promote better technologies. According to the agreement between ACEA (the European Automobile Manufacturers Association) and the European Commission, the specific emissions of new cars are planned to decrease from 185 g CO2 per km in 1995 to 140 g/km in 2008.
A combination of instruments would be useful. For gasoline, an acceptable approach towards convergence and efficiency could be to use a tax/GDP ratio, in order to meet the needs of the less affluent countries of Europe (this level could be around 0.03 €/l/unit of GDP and it would ensure that the tax level follows the economic growth). Taxes on car purchases and taxes on ownership should depend, at least partly, on the specific consumption of cars, and as a result help car manufacturers to comply with their commitment and probably to go further (a step at 120 g of CO2 / km in 2012 is considered).

**Table 8 : Estimation of specific taxes paid over the lifetime of a car[3]**

| | **Car purchase** | **Annual tax** | **Fuel tax** | **Total** |
|---|---|---|---|---|
| AUSTRIA | 1300 | 2000 | 5000 | 8200 |
| DENMARK | 15000 | 2300 | 5400 | 22700 |
| FINLAND | 12000 | 1000 | 7800 | 20800 |
| FRANCE | 0 | 0 | 7200 | 7200 |
| IRLAND | 4000 | 3000 | 5760 | 12760 |
| NETHERLANDS | 5000 | 4000 | 9750 | 18750 |
| NORWAY | 8000 | 2300 | 9600 | 19900 |
| PORTUGAL | 4000 | 300 | 4320 | 8620 |
| U.K. | 0 | 2000 | 9840 | 11840 |

Author's estimates from ADEME data

[3] 8 l/100 km, 15 000 km/year, 10 years, without depreciation index

# 4 Energy audits[4]

Energy audits consist of a detailed survey of the energy used in an industrial firm, in a transport company or in a building by a specialist. The objective is to provide technical and financial information to the consumers about what actions can be taken to reduce their energy bills and at which costs. The actions cover both a reduction of consumption (i.e., energy efficiency actions), shift to another fuel (i.e., energy substitution), and changes of tariff (e.g., load management).

Energy audits are used to identify cost effective actions for energy efficiency improvements in existing buildings and facilities. Through normal failures and attrition, existing equipment are replaced with more advanced equipment. Energy audits are a way to accelerate this replacement process, in doing so, the most advanced equipment available on the market is considered.

## 4.1 Description and scope

Energy audits are often funded by government agencies or by utility service companies. These programmes are intended to reduce energy consumption and peak energy demand for a building or industrial facility. To encourage participation, the audit is either provided free of charge or is cost shared with the customer. These subsidised audits are usually provided to firms based on their size, the amount of energy consumed, and/or the number of employees. The auditor will assess and develop a suggested list of improvements that can be made to the property.

In some countries, regulation mandates large energy consumers (industrial plants, commercial buildings, transport companies) to make regular audits. In Portugal, Thailand and Tunisia, for instance, energy audits are mandatory for large buildings (> 1000 toe/year in Portugal and Tunisia) and large factories (> 1000 toe/year in Portugal and 2000 toe/year in Tunisia). In Tunisia, mandatory energy audits also apply to large transport companies (yearly consumption above 500 toe).

## 4.2 Impact of audit programme and efficiency measures

The audits reviewed in the study show that a broad range of measures has been proposed, including small and large equipment replacements, entire system replacements, and facility structure retrofits. Common efficiency suggestions involved air conditioning, water heating, industrial equipment, lighting, and others. A broad range of the suggested measures were actually installed: around 50% in the US to around 75% in France and 80% in New Zealand. These measures represented significant energy and monetary savings opportunities and the investments were recovered in about 1.3 to 3 years, based on the applicability (industrial versus commercial buildings) and the economy. Box 2.4 gives a summary of the findings of an evaluation of an industry audit program in France.

[4] This section is based on a report prepared for the project by Marc LaFrance and Ivan Jaques from APERC.

**Box 2.1: Evaluation of the cost effectiveness of industry audits subsidy program in France**

An evaluation of the French audit scheme in industry has been conducted in 1997. The program was implemented in 1990-1991 through subsidies by ADEME to audits conducted on industrial sites (subsidy of 50%). About 75% of the interviewed companies (beneficiary of the audit subsidies) declared they have implemented an investment following the audit but it was not possible to assess with precision the energy savings induced. However the evaluation report allows to assess the cost effectiveness of the subsidy:

- for 90% of the investments induced, the audit was necessary for the investment decision
- the public cost of the measure is estimated at 76 € (1994) per toe saved (each year over the lifetime of the equipment, (including the management cost by ADEME), to be compared with a toe cost of about 190 €.
- the investments induced by the audits have an average cost of 570 € /toe saved/year.

The measure appears as very profitable from a collective point of view : the public cost is paid in average by a half year of energy savings while investments time of return is 3 years.

The long-term impacts of audit programmes have not been fully analysed or such analysis is not available. The US has attempted to establish an independent ESCO industry through the regulation of government building and facility requirements for energy efficiency improvements and energy consumption reduction. Additionally, the US Department of Energy has established large contracts with ESCOs to serve the government customers nationally. Activity with the government customers has been positive, but results from the private sector are still too early to tell. Some economies, such as Japan have decided to approach the industrial sector through industrial standards. These efforts have been extremely effective and have resulted in Japan's industrial sector being the least energy intensive in the world. Thus, the audit process has become a normal business practice in Japan with company energy managers addressing the efficiency improvement investment decisions. The goal of the Japan programme is to improve efficiency by one percent per year. While Japan's industrial GDP has doubled in the past 25 years, the energy consumption has remained almost constant. Other approaches include requirements for energy managers and the submission of detailed energy plans. Korea has such a policy.

### 4.3 Conclusions and recommendations

From the sample data gathered in the study it is obvious that the investments generated in the industrial and private building sectors are extremely cost effective and will lead to reduced operating cost and thus greater profit. At the same time, it also shows how only the best options are pursued in a private environment. Thus, with proper analysis and greater access to financing the obtainable positive impacts from audits can be even greater. Audits are a way to actually save energy and carbon at a negative cost, or with a net positive benefit.

Financing can be a major hurdle to the installation of energy efficient measures and practices. Therefore, as part of public policy, governments that have audit programmes often offer low interest (subsidised) loans to encourage installation of the audit suggested measures. Other incentives such as accelerated depreciation, reduced sales or import taxes, or guarantee mechanisms can lead to reduced tax burden that also encourage the adoption of audit recommendations. Incentives for investments and financing mechanisms are addressed in the WEC study. Another creative option is the formulation of an energy service company (ESCO) industry. In such an industry, the ESCO can arrange the entire audit and installation process for the firm including bringing financing to the agreement.

# 5 General conclusions

The measures selected in this presentation represent, of course, only a small part of the whole policy implemented in each country and they are often integrated in a wider mix of measures within each specific sector. Some general remarks could be made :

- Regulatory measures, such as energy efficiency standards for buildings, are adopted even in countries favouring market driving forces versus government mandatory regulation because of strong market imperfections (in most cases the owner/builder of the building is not the occupant who will be paying energy bills). The different approaches observed, from the most simple to the more complex, are rather successive steps of implementation and we could observe that regulation is now considered as a dynamic process of increasing thresholds. However, the fact that, in several developing countries with warm climate, regulation is focused on commercial buildings rather than dwelling is due to national circumstances.

- Measures concerning the energy performance of mass products such as electrical appliances are more and more widely implemented, including in developing countries (because of electricity consumption growth inducing heavy investments in the electricity generation sector and also because manufacturers in developing countries are acting in a global market). The opposition between regulation through standards and information measures like labels are now less pregnant than in the past since both measures could be articulated in order to optimise the intervention of governments : the labels allow to identify classes of products, induce market transformation, and facilitate the introduction of standards. One could identify however "national circumstances" where countries adopt a more collaborative approach with manufacturers (in the case of target values approaches such as the top runner program in Japan). It is interesting to observe that, in the context of mass products, some international coordination is necessary at the scale of the international market in order to avoid protectionism behaviour : the example of the agreement between the European Commission and the European association of cars manufacturers with Japanese and Korean cars manufacturers illustrates this point.

- Audits are often identified as "good practice" since it is generally a very cost effective option. Some countries remain with mandatory approach while other are more in favour of voluntary approach with subsidies for diagnostics. The role of State in the economy could explain these discrepancies since the mandatory option suppose controls from administration. The

development of audits is also necessary for the negotiation of voluntary agreements (and will be for $CO^2$ emission permits allocation).

- In the sector of transport, the analysis of fiscal measures reveals very large differences between countries. Car purchase tax, car ownership tax and motor fuel tax have different impacts on $CO^2$ emissions. This instrument was implemented initially for other reasons than climate change issue. It is clear that "national circumstances" may explain discrepancies : the historical dependency of countries on foreign oil resources, the geography (small vs large countries), the governance practices, the economic weight of car manufacturing within the GDP are some of the explanatory factors. At this stage, it is not possible to observe clear convergence in the implementation of such instruments, even if experts agree on the long term impact of fiscal signals. The fiscal instrument, studied in this report, could not be however assessed alone without taking into account the other instruments implemented in the transport sector since it could not be the unique measure aiming at reducing greenhouse gases emissions increase (for example a general trend toward green labelling of cars is observed).

The approach through specific measures does not allow to identify the packages of measures responding to specific greenhouse gases emissions, even if we observed that these measures are sometimes linked (labelling with standards for example). Further work may allow to identify these "good mix" as already experimented and implemented in many countries.

It is of interest to observe that the types of measures implemented (fiscal versus standards or incentives) are much more different from one sector to the other, than from one country to the other. National circumstances explain discrepancies in the implementation approach but some convergence among countries is observed. Information exchange procures mutual benefit. This service of World Energy Council to its members will continue in the next future and a broader international collaboration is welcomed.

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