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Energy Efficiency: A Recipe for Success

World Energy Council

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Summary

This report describes and evaluates energy efficiency trends and policies around the world. While ADEME coordinated this WEC project, the study was carried out over three years with the technical assistance of ENERDATA.

The first objective of the study was to identify the recent trends in energy efficiency performance for different countries. A selection of indicators has been used for that and they are available on the WEC web site: www.worldenergy.org. These indicators were analysed by main world regions and presented by country using maps.

The second objective was to describe and evaluate energy efficiency policies carried out throughout the world. About 90 countries are covered, a survey was conducted out in about 70 countries and a literature review for the remaining countries. The survey was completed with detailed case studies and focused on seven policy measures: prepared by experts: innovative communication tools, good practices in the public sector, successful financial tools for households, energy efficiency measures for low income households, obligation of energy savings, regulation and compliance and smart meters.

Beyond a review of the energy efficiency measures the evaluation aimed to pinpoint the most interesting experiences and draw some conclusions about advantages and drawbacks of different policies. These conclusions should enable countries embarking on energy demand management policies to benefit from the experience of the most developed countries.

More and more countries are introducing regulatory or incentive measures for an increasing number of equipment and sectors to slow down the energy demand growth. Despite the continued important role of market instruments (voluntary agreements, labelling information, dissemination), regulatory measures are increasingly used, in particular in sectors in which the market fails to give appropriate signals (e.g. buildings, appliances, etc). The study highlights a number of innovative measures, such as taxes related to the efficiency of cars, the phase out of incandescent lamps, energy savings targets by sector, mandatory installation of efficient equipment, obligation of energy savings for energy companies and others.

The study ends ups with 10 main recommendations, emphasising the need for:

1) incentive energy prices,
2) sustainable institutional support,
3) innovative financing,
4) quality standards for energy efficient equipment and services,
5) regular review and strengthening of regulations,
6) packages rather than single measures;
7) measures adapted to less developed countries;
8) measures focused on behaviour;
9) monitoring of the impact of measures; and
10) enhancement of international cooperation.

Given a broad geographical coverage and the correlation between indicators and policy measures, this report represents an original approach to energy efficiency evaluation.

Résumé

Cette étude a pour but de décrire les tendances de l'efficacité énergétique dans le monde et d'évaluer les politiques d'efficacité énergétique mises en œuvre. Cette CME étude a été coordonnée par l'ADEME et a été menée durant les trois dernières années avec l'assistance technique d'ENERDATA.

Le premier objectif de cette étude est de décrire et expliquer les tendances des performances d'efficacité énergétique dans ces pays. Dans ce but une sélection d'indicateurs a été produite pour tous ces pays ; ces indicateurs sont consultables sur le site web du CME. Ils ont été analysés et comparés dans ce rapport, principalement par grande région du monde, mais aussi pour certains par pays sous forme de carte.

Au-delà d'une description des mesures mises en œuvre, cette évaluation vise à repérer les expériences les plus intéressantes et à en tirer des conclusions sur leurs avantages et limites. Ces conclusions doivent permettre aux pays les moins avancés dans les politiques de maîtrise de leur consommation de profiter de l'expérience des pays les plus avancés.

De plus en plus de pays mettent en œuvre des mesures réglementaires ou incitatives pour un nombre croissant d'équipements et de secteurs pour ralentir ou infléchir le rythme de croissance de la demande d'énergie. Malgré un rôle toujours important des instruments de marché (accords volontaires, label, information, dissémination), les mesures réglementaires sont de plus en plus utilisées, en particulier dans les secteurs où les mécanismes de marché sont insuffisants pour donner le bon signal aux consommateurs (bâtiments, équipements électroménagers).

L'étude fait ressortir un certain nombre de mesures innovantes, comme la fiscalité liée à l'efficacité des automobiles, l'élimination des lampes à incandescence, les objectifs d'économies d'énergie par secteur ou d'installation d'équipements efficaces, les obligations d'économies d'énergie pour les compagnies énergétiques.

L'étude se conclut par 10 recommandations sur la nécessité 1) de prix de l'énergie incitatifs, 2) d' un support institutionnel durable, 3) de modes de financement innovants, 4) de normes de qualité pour les équipements et les services liés à l'efficacité énergétique, 5) d'un renforcement régulier des réglementations, 6) de paquets plutôt que de mesures individuelles, 7) de mesures adaptées aux pays les moins avancés, 8) de mesures sur les comportements et pas l'impact des mesures, et 10) d' un renforcement de la coopération internationale. seulement sur la technologie, 9) d'un suivi de

Ce rapport, avec sa couverture très large des pays et l'association des indicateurs aux politiques fournit une source d'information exhaustive et constitue une approche originale d'évaluation de l'efficacité énergétique.

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Contents

1. Introduction

Objectives and contents of the report

This report presents the results of a three-year study on "Energy Efficiency Policies" co-ordinated by ADEME with the technical assistance of ENERDATA and contributions from more than 70 WEC member countries. The study was aimed at monitoring energy efficiency trends through various indicators and evaluating energy efficiency policies. The report provides updated information and expands the range of countries covered in previous reports prepared by ADEME and WEC for the last five World Energy Congresses[1].

The first objective of the study was to identify and explain trends in energy efficiency performance in selected countries and regions. For that purpose, a selection of indicators was analysed and compared. The methodology used is directly adapted from the European project on energy efficiency indicators, ODYSSEE[2].

The second objective was to describe and evaluate energy efficiency policies throughout the world. For that purpose, a survey was carried out in about 90 countries. The evaluation was completed by seven in-depth case studies on policy measures. The following measures were selected as they correspond to new concerns or areas of actions for policy makers in charge of energy efficiency[3]:

Innovative communication/information tools from utilities or energy agencies

- Good practices in the public sector
- Successful financial tools for households
- Energy efficiency measures for low income households
- Obligation of energy savings for utilities
- Regulation and compliance
- Smart meters

Experts were requested to carry out a comprehensive evaluation of these six types of instruments. Each of the experts prepared a core report, completed with concrete examples of country experiences ("country case studies").

This report consists of two main parts: a review of the energy efficiency progress achieved around the world (Chapter 2) and the evaluation of energy efficiency policies and measures (Chapter 3). Beyond a description of measures already implemented, this chapter aimed to identify the most effective proven policy measures. In the final part (Chapter 4) conclusions and recommendations are

[1] Rome (2007), Sydney (2004), Buenos Aires (2001), Houston (1998), and Tokyo (1995).

[2] Project on energy efficiency indicators co-ordinated by ADEME and supported by the programme "Energy Intelligence for Europe" of the European Commission and all energy efficiency agencies in Europe or their representative (30 countries).More information at http//odyssee-indicators.org.

[3] The following measures have already been evaluated in the previous reports: building codes, energy audits, labelling and standards of electrical appliances, incentives for cars, voluntary/sectoral agreements, local energy information centres, new energy efficiency financing schemes, packages of P&M 's., Energy Service Companies (ESCO's), energy efficiency obligation for energy utilities, measures for solar water heaters.

summarised to help the readers learn from the experiences of the most advanced countries in terms of energy efficiency policies.

Given its broad geographical coverage, the report provides a comprehensive and valuable source of information. The methodology of relating energy efficiency indicators to policy measures represents an original approach to the evaluation of policies.

Energy efficiency is “a low hanging fruit” on the “energy tree” which can help address a number of objectives at the same time and at a low or negative cost: security of supply, environmental impacts, competitiveness, balance of trade, investment requirements, social implications and others.

Many studies point out the large improved potential for energy efficiency but progress is slow due to the complexity of the decision making chains to get producers to market more efficient appliances and equipment and consumers to buy them[4]. A large potential exists also in existing buildings and facilities and here a particular effort is required, the barriers to overcome and the involved costs are significantly greater. In other words, energy efficiency is still far from realising its potential. Why? There is no single answer to this question. A meaningful response requires a major research and analytical effort, which is the objective of this report.

Why is energy efficiency an important issue?

The Kyoto Protocol objectives for the OECD countries and constraints on energy security for importing countries have raised the importance given to energy efficiency policies. In developing countries, energy efficiency can enable in addition to alleviate the financial burden of oil imports[5], reduce energy investment requirement, and make the best use of existing supply capacities to improve the access to energy.

Improving energy efficiency, for instance in electricity use, will have two benefits:

- Supply more consumers using the same electricity production capacity, which is often the main constraint in many countries of Africa and Asia.
- Slow down the electricity demand growth, and reduce the investment needed for the expansion of the electricity sector; this is especially important in countries with high growth of the electricity demand, such as China and many South East Asian countries.

Almost all OECD countries and an increasing number of non-OECD countries are implementing a wide range of policy measures on energy efficiency, in general tailored to their national circumstances. Even energy producing countries become concerned with energy efficiency as they realise that they maybe wasting valuable resources by not using them efficiently. Apart from a major role of market instruments (voluntary agreements, economic incentives, information dissemination etc), regulatory measures are increasingly implemented where the market fails to give the right signals (buildings, appliances etc).

The focus of this report is on the evaluation of energy efficiency policies and trends. This introduction will explain what is meant by energy efficiency, why are policies needed and why evaluation of the results is important.

Definition and Scope of Energy Efficiency

Energy efficiency improvements refer to a reduction in the energy used for a given service (heating, lighting, etc.) or level of activity. The

[4] Several studies point out to an economic potential around 30%, including the recent IEA Energy Technologies Perspectives report (31% saving in the Blue scenario at world level compared to baseline projection for 2050) (IEA, 2010). For the EU a recent study released by the European Commission estimates the economic potential at 23% in 2030 compared to an autonomous progress scenario (DG-TREN, 2009).

[5] Following the steep increase in oil price between 2003 and 2008 (more than a tripling from 29 to 97 US$/bbl for the Brent), the cost of oil imports has soared, with severe consequences for economic growth of the poorest countries).

reduction in the energy consumption is usually associated with technological changes, but not always since it can also result from better organisation and management or behavioural changes ("non-technical factors"). For instance, in the transport sector energy efficiency can improve through the diffusion of more efficient vehicles, from the shift of passengers and freight from cars and trucks to rail transport, from a better organisation of transport logistics (increased load factors and reduction of empty running for trucks) and from eco-driving of vehicles.

In some cases, because of financial constraints imposed by high energy prices, consumers may decrease their energy consumption through a reduction in their energy services (e.g. reduction of comfort temperature; in car mileage). Such reductions do not necessarily result in increased overall energy efficiency of the economy, and are easily reversible. They should not be associated with energy efficiency.

To economists, energy efficiency has a broader meaning: it encompasses all changes that result in decreasing the amount of energy used to produce one unit of economic activity (e.g. the energy used per unit of GDP or value added). In that case, energy efficiency is associated with economic efficiency and includes all kind of technological, behavioural and economic changes that reduce the amount of energy consumed per unit of GDP.

For energy efficiency experts, improving energy efficiency reflects the results of actions that aim at reducing the amount of energy used for a given level of services (e.g. lighting, heating, transportation): purchase of efficient equipment, retrofitting investments to reduce the consumption of existing buildings and facilities, or avoiding unnecessary consumption of energy.

Avoiding unnecessary consumption is certainly a matter of individual behaviour, but it is also, often, a matter of appropriate equipment: thermal control of room temperature, or automatic de-activation of lights in unoccupied hotel rooms are good examples of how equipment can reduce the influence of individual behaviour.

Energy Efficiency Policies and Measures

Any cost related decision concerning energy efficiency, at the individual level, is based on a trade-off between an immediate cost and a future decrease in energy expenses expected from increased efficiency. The higher the energy price, observed or expected, the more attractive are the energy efficient solutions.

Making a "good" investment decision, for domestic appliances or industrial devices, from the energy efficiency viewpoint, certainly relies on a sound economic rationale. Price signals are necessary.

In market economies, where most energy prices to final consumers are deregulated, prices should normally reflect fairly accurately the supply costs. However, for several reasons, they often reflect only a part of the overall costs of fuels and electricity. They include none, or just a few, environmental externalities and long-run marginal development costs.

As a result, decisions made by final consumers when purchasing equipment or making an energy efficient investment (e.g. retrofitting of dwelling) often do not reflect the drive towards the most cost effective solutions from the public interest viewpoint, creating a gap between the actual achievements in energy efficiency and what could be achieved through an accurate price system accounting for all costs involved.

Taxation is the usual means used by governments to reduce or suppress price distortions at the consumer level. In that sense, taxation is always complementary to energy efficiency policies and measures. It is hardly just a component of these policies and measures because of its much broader socio-economic aspects, but it certainly determines the effectiveness of policies and measures.

Clear price signals alone are not enough to achieve a rationalisation of energy use, as there are multiple market failures that prevent consumers from choosing the most cost effective solution and therefore there still exists a large potential for energy efficiency improvements.

Additional policy measures are necessary in market economies to reinforce the role of energy prices, firstly to create the appropriate market conditions for efficient equipment and secondly to drive consumer choice towards the most cost effective solutions.

The following major sources of failures in market mechanisms are often pinpointed to justify the implementation of policy measures:

- The information is either missing or partial, and cannot be improved at acceptable cost.
- The availability in the domestic market of efficient appliances and production devices is limited.
- There is a lack of technical, commercial and financial services.
- Decision-makers for energy efficiency investments (in buildings, appliances, equipment, etc.) are not always the final users who have to pay the heating or cooling bills: the overall cost of energy service is not transparent to the market.
- Financial constraints faced by individual consumers are often more severe than what is actually revealed by national discount rates or long-term interest rates, resulting in a preference for short term profitability. This often leads consumers to over-emphasise the immediate cost of equipment and devices, which usually does not benefit the selection of efficient equipment or devices. Implicit discount rates in industry are over 20% compared to less than 10% for public discount rates, and 4-6% for long-term interest rates.

The main objective of measures is to create the necessary conditions to speed up the development and the deployment of market efficient equipment, through:

- Information for and communication with final consumers.
- Economic support though subsidies or tax reduction.
- Deployment of specific financing mechanisms.
- Regulation for appliances, equipment and buildings.
- Regulation imposing energy savings requirements for consumers and for utilities.
- R&D and dissemination of expertise in the field of energy efficiency.

Energy efficiency policy is therefore considered here in a broad sense. It includes all public interventions ("policy measures") aimed at improving the energy efficiency of a country, through adequate pricing, institutional setting, regulation and economic or fiscal incentives.

Information and communication measures have two main targets:

- To increase the awareness of final consumers about the individual and national benefits of energy efficiency.
- To open the range of possible options for technical decisions to be made by final consumers and make the overall costs of all options transparent.

Economic support for the purchase of energy efficient equipment and devices can take several forms: loans, subsidies, tax credits, etc.

Introducing specific financing mechanisms aimed at reducing the market imbalance (due to financial constraints) between cost-effective solutions with high investment / low operating costs (energy efficient), on the one side, and low investment / high operating costs (less efficient) on the other side.

Regulations for appliances, equipment and buildings rely on the display of the energy efficiency performance through efficiency labels and in imposing minimum efficiency standards to remove from the market the least efficient equipment.

Regulations introducing requirements for the consumers aim at indirectly improving energy efficiency (e.g. maintenance, reporting, auditing).

Regulations imposing energy savings requirements for utilities consist mainly in obligation of energy savings with their customers.

Support to R&D and to dissemination of energy efficient technologies, equipment and devices aims at speeding up their penetration and decreasing their costs on the market.

Chapter 3 reviews various types of measures and discusses conditions for their implementation, as well as their use in the various world regions.

Energy Efficiency Policies Evaluation

Why is evaluation necessary?

Energy efficiency policies and measures are not free: whatever measures are taken, there is a cost to the taxpayer.

As a general rule, energy efficiency policies and measures are economically sound if the macro-economic benefits of increased energy efficiency achieved by these policies and measures outweigh the overall cost to the taxpayer. The bigger the difference between the benefit and the cost, the more attractive and effective are the policies and measures.

Evaluating energy efficiency policies and measures is necessary to ensure that public funds are well used. The evaluation can be done at two levels:

- From the taxpayer viewpoint: the public cost involved in the policies and measures.
- From the macro-economic viewpoint: the benefit resulting from the actual progress in energy efficiency achieved through the policies and measures.

Tracking energy efficiency at the macro level is not an easy task?

Insulating a house makes it obviously more energy efficient from an engineering point of view: less energy is consumed for the same comfort. However, this technical improvement at the micro-level may be not visible at the macro-level - the whole stock of dwellings - if, at the same time, more houses are built, dwellings get larger, more appliances are used and if the comfort is improved.

The same applies to industry: each factory can decrease its energy consumption per unit of output with more energy efficient technologies, but this may not be seen at the level of the industrial sector if there is at the same time an increase in the production or a higher growth in the production of energy intensive industries.

Energy efficiency is also a matter of efficient services: making a phone call instead of a personal visit, using public transport instead of a car, reducing heat at night, etc. result in a decrease in energy consumption for identical or similar services. Again, such improvements at the micro-level may not be directly visible at the macro-level.

Of course, assessing energy efficiency from a policy view point does not mean reviewing each particular dwelling or factory; but it means measuring how much all these improvements at the micro-level did contribute to the actual evolution of the energy consumption in the various sectors, and for the whole country.

Several difficulties emerge when assessing energy efficiency progress. First, from a conceptual viewpoint, energy efficiency is at the same time both a pure economic concept and a political concept (the result of energy efficiency policy); the boundary between these two concepts is never clear.

Secondly, from a methodological viewpoint, it is difficult to separate out the various causes behind observed energy efficiency improvements: more energy efficient economic structures, price setting, results of sectoral policy measures, etc. A good illustration is the example of cars. How to measure the energy efficiency of cars: in terms of technology, drivers' behaviour, or pattern of use?

Energy efficiency indicators used in this study aim at developing solutions to these difficulties, in three ways:

- Overall macro-economic indicators tend to reconcile the macro-economic and political concepts of energy efficiency, measuring separately the main components of the overall energy intensity of the GDP: those linked to the structure of the economy and those linked to sectoral energy efficiencies;
- Sectoral indicators aim first at reconciling the economic appraisal of energy efficiency in the sectors with the technical appraisal of efficiency improvements in dwellings, vehicles, industrial processes, etc., and second at relating these technical appraisals to the evaluation of actual energy savings, from which economic benefits can be estimated;
- Comparative country indicators, based on comparable data set, aim at allowing comparison across countries to highlight, in energy efficiency achievements, those which can be attributed to differences in policies and measures and to taxation and pricing policies.

2. Energy efficiency and CO_2 trends at world level

Introduction

This chapter reviews recent energy efficiency trends by world region on the basis of a set of homogeneous energy efficiency indicators covering the period 1980–2008, with a greater focus for the last eighteen years (1990-2008). As the year 2009 was marked by a deep recession all over the world, with specific trends, some comments will be given for the year 2009 based on preliminary data as available when writing the report. All indicators include biomass, as many OECD countries are now promoting the use of biomass to reduce greenhouse gases emissions and as it is still a dominant source of energy in many developing countries.

The data used for the calculation of the energy efficiency indicators were taken from ENERDATA world energy database[6]. This database relies on harmonised data from international organisations (International Energy Agency-IEA, Eurostat, World Bank, Asian Development Bank, IMF), from industry associations (Cedigaz for gas, IISI for steel, IRF for transport, for instance), as well as from national energy ministries and utilities. It provides a consistent coverage of the world energy consumption, split by main regions, and is kept up-to-date to take into account the most recent trends. Some more detailed indicators were taken for European Union (EU) countries from the ODYSSEE database[7].

The indicator trends are shown for various world regions. The world is divided into seven main regions. Because of its size and heterogeneity, Asia is split into 4 sub-regions and main countries:

- Europe (EU, Albania, Bosnia, Croatia, Iceland, Macedonia, Norway, Serbia, Switzerland, and Turkey)
- CIS[8]
- North America (USA, Canada)
- Latin America (including Mexico)
- Asia
    - China
    - India
    - Asia and Pacific OECD[9] (Japan, Korea, Australia, New Zealand)
    - Other Asia (ASEAN, other South Asia)
- Africa
- Middle East

This chapter is introduced by a presentation of the indicators at the level of the entire economy and at the level of economic sectors. Then a comparison of energy efficiency trends across

[6] For more information, see www.enerdata.fr

[7] The ODYSSEE database has been developed since 1990 at the EU level within a joint project between ADEME (coordinator), the Energy Intelligence for Europe programme of the European Commission and all EU energy efficiency agencies; EnR, the network of energy efficiency agencies, also supports the project. For more information, see www.odyssee-indicators.org.

[8] CIS (Community of Independent States): Azerbaijan, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan and Ukraine

[9] In the report, it is referred in short as “Asia OECD”.

the various world regions is presented: first the overall energy efficiency trends, then the trends by sector (industry, transport, households and services).

Particular attention is given to the relationship between, on the one hand, energy efficiency achievements (as assessed from the indicators) and, on the other hand, economic development (in particular the role of structural changes in the economy) and energy efficiency policies.

The energy efficiency indicators considered here are designed to monitor changes in energy efficiency and to allow cross-country comparisons of various energy efficiency situations. Three types of indicators are considered for the description of energy efficiency: economic ratios, techno-economic ratios and indicators of diffusion.

Economic ratios, referred to as energy intensities, are defined as ratios between energy consumption, measured in energy units - tonnes of oil equivalent/(toe) - and indicators of economic activity, measured in monetary units at constant prices (Gross Domestic Product, value added, etc).

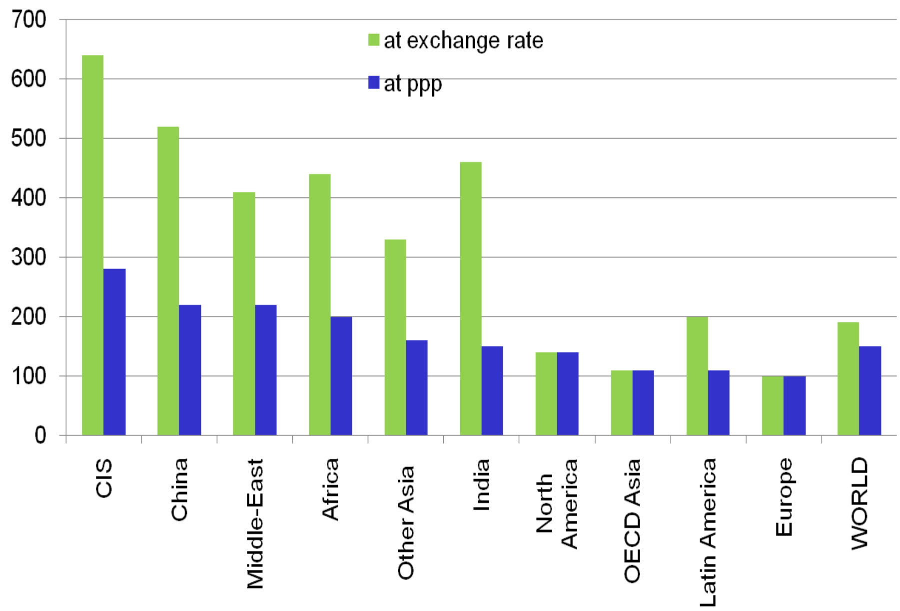
Intensities are used each time energy efficiency is measured at a high level of aggregation, i.e. at the level of the whole economy or of a sector.

To make these energy intensities more comparable, they are all converted to purchasing power parities at 2005 prices and parities **(see Box 2.1)**

Technico-economic ratios are calculated at a disaggregated level (by sub-sector or end-use) by relating energy consumption to an indicator of activity measured in physical terms (tonnes of steel, number of passenger-kilometres, etc.) or to a consumption unit (e.g. per vehicle, dwelling, etc.). These techno-economic ratios are called unit or specific energy consumption.

The indicators of diffusion aimed at monitoring the market penetration of energy efficient technologies (e.g., cogeneration, electric steel, solar water heaters) and practices (e.g. share of public transport). These energy efficiency indicators are complemented with CO_2 indicators linked to CO_2 emissions from energy combustion.

Figure 2.1: Primary energy intensity: purchasing power parities vs exchange rates



Source: ENERDATA.

Box 2.1: Energy intensities at purchasing power parities

GDP and value added data for all countries and regions are converted at purchasing power parities to reflect differences in general price levels[10]. Using purchasing power parities rates ("ppp" in short) instead of exchange rates increases the value of GDP in regions with a low cost of living, and therefore decreases their energy intensities[11] **(Figure 2.1)**.

Energy intensities at purchasing power parities are more relevant as they relate the energy consumption to the real level of economic activity. The use of purchasing power parities narrows the gap in energy intensities between countries and regions with different levels of economic development, compared to what would be shown with exchange rates. It therefore greatly improves the comparison[12].

To allow a meaningful comparison of energy efficiency between countries, these indicators are based on common definitions; in particular with respect to the definition of energy consumption and CO_2 emissions[13].

The indicators calculated in this study are available on the WEC web site[14], either in the form of data tables by WEC member country and for 10 world regions for 1980, 1990, 2000, 2008, or in the form of a data base that can be consulted through interactive queries; in that case, after selecting the indicator, its value in 2008 or its trend over the period 1990-2008 can be displayed for all countries under the form of world or regional maps[15].

Overall Energy Efficiency Performance

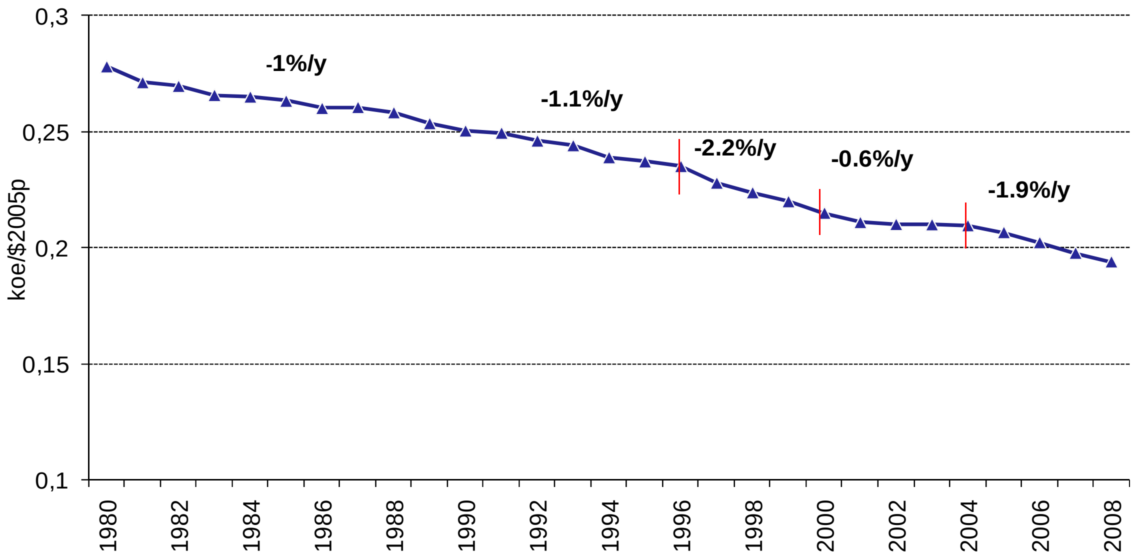
A general indication of energy efficiency performance is given by the primary energy intensity, which relates the total energy consumption of a region or country to its GDP. Primary energy intensity measures how much energy is required to generate one unit of GDP.

The energy intensity is generally considered to be a reliable indicator, as it is based on usual statistics, and easy to calculate and understand: therefore it is very commonly used. However, its interpretation is sometimes questionable for countries where part of their economic activity is informal (i.e. not accounted by the GDP) and where the use of traditional fuels is significant, as their consumption is usually not well monitored.

[10] National GDP at purchasing power parities are from the World Bank. The GDP of each region at purchasing power parities is then calculated as the sum of national GDPs of the region.
[11] On average, for non-OECD countries the GDP at purchasing power parties is 2.7 times higher than if it is expressed at exchange rates (factor 3 for CIS and 2.3 for China).
[12] As the intensities are measured at 2005 prices and parities, the use of purchasing power parities changes the magnitude of the indicators but does not affect the trends.
[13] Electricity is converted to toe according to the IEA methodology: 0.26 toe/ MWh (36 GJ) for nuclear; 0.086 toe/MWh (3.6 GJ) for hydro, wind and electricity consumption; 0.86 toe/MWh for geothermal. Biomass is included in energy consumption figures. Non-energy uses are excluded from final energy consumption.CO2 emissions are calculated by Enerdata based on UNFCCC definitions.

[14] http://www.worldenergy.org/work_programme/technical_programme/technical_committees/energy_efficiency_policies_and_indicators/default.asp.
[15] Examples of such maps are used to illustrated some of the indicators in this report.

Figure 2.2: Long-term trend in the primary energy intensity at world level
Tendance de long terme de l'intensité énergétique mondiale



The energy intensity is more an indicator of "energy productivity" than a true indicator of efficiency from a technical viewpoint, as it reflects the effect of many factors that are not directly linked to energy efficiency. Indeed, the energy intensity level is influenced by the nature of the economic activities (the "economic structure", i.e. the contribution of various sectors in the GDP), the primary energy mix (i.e. the share between coal, oil, gas, biomass, other renewables and nuclear), the climate, the level of development and lifestyles, the organisation of transport sector (in particular the importance of public transport), and the technical energy efficiency.

Trends in energy intensities are therefore influenced by changes in the economic and industrial activities of the country ("structural changes"), in the energy mix, in lifestyles, in transport infrastructures and in the end-use efficiency of equipment and buildings.

The amount of energy used per unit of GDP at world level is decreasing steadily: 1.4% p.a. between 1990 and 2008, with an acceleration since 2004 (1.9% p.a)

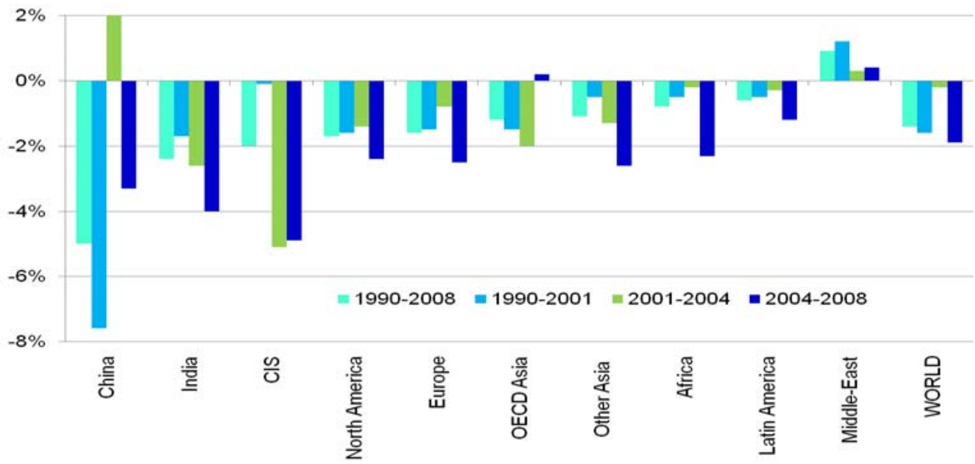
The primary energy intensity at world level has been decreasing by 1.3% p.a since 1980 and 1.4% p.a since 1990 (**Figure 2.2**). This trend is in net acceleration since 2004, reaching 1.9% p.a, following the sharp increase in oil price, from 38$/bl in 2004 to 97$/bl in 2008[16].

In most world regions the amount of energy used per unit GDP is also decreasing

The primary energy intensity demonstrates a decreasing trend in all regions, except The Middle East, where energy consumption has always been increasing faster than GDP, with however a net slow down since 2001 (Figure 2.3)[17]. This trend is the result of the combined effect of higher energy prices, energy efficiency programmes and more recently CO2 abatement policies, and other economic factors, such as the tertiarisation of the economies. Between 2004 and 2008, a net acceleration can be seen everywhere, reflecting the impact of oil price hikes. In 2009, in most countries, a net slow down or a reverse trend can be observed for the energy intensity[18].

[16] Brent spot price.
[17] Figures A 2.1 and A 2.2 in Annex displays the trends by world region and for G-20 countries.
[18] For instance, increase in the primary energy intensity in China and Germany; reduction twice slower in UK.

Figure 2.3: Variation of primary energy intensity by world region
Variation de l'intensité énergétique primaire par région du monde



Source: ENERDATA.

This phenomenon is due to the fact that part of the final energy consumption is not correlated with the GDP and remains stable regardless of the state of the economy.

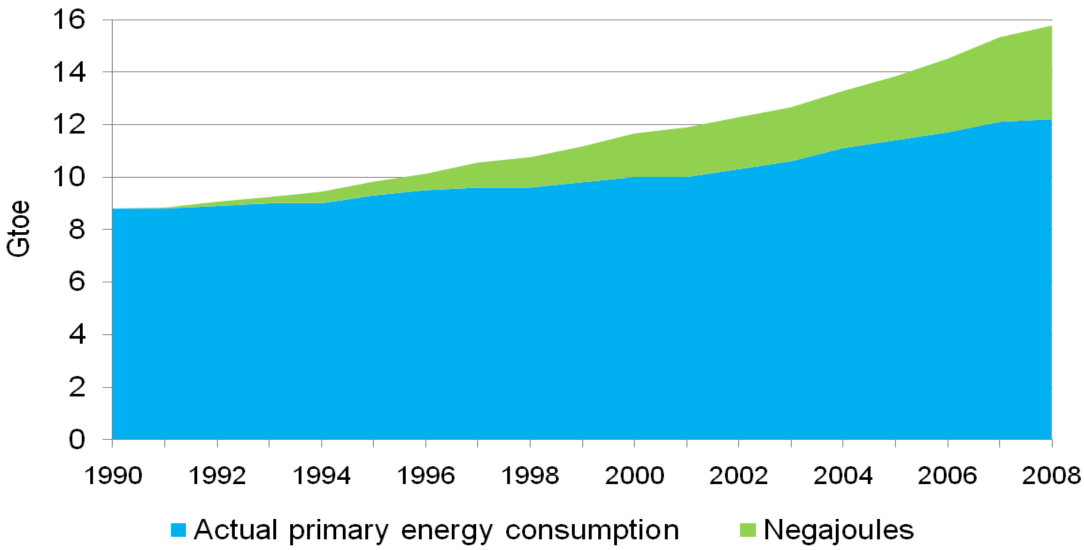
China experienced the strongest improvement in energy productivity, around 5% p.a. on average since 1990 (and even 7.6% p.a. between 1990 and 2001). This great improvement in China's energy productivity is the result of various factors: more efficient use of coal, switch from coal to oil, industry restructuring (rapid growth of equipment manufacturing industries) and higher energy prices. Their respective influences are however difficult to quantify. Between 2001 and 2004, the intensity has increased, partly because of the boom in energy intensive industries. From 2004 to 2008, the energy intensity was again decreasing; this trend stopped in 2009 with the economic crisis.

Higher GDP for less energy resulting in large energy savings at the world level

Energy productivity improvements in most regions resulted in large energy and CO2 emission savings. At 1990 energy intensity by main region (i.e. at constant technologies and economic structure of 1990), world energy consumption would have been 3.6 Gtoe higher in 2008. In other words, "energy savings" from energy productivity improvements ("Negajoules") reached 3.6 Gtoe in 2008 at world level, or almost 30% of the primary consumption (**Figure 2.4**). This avoided 8 Gt of CO2 emissions.

Almost 70% of the countries in the world (113 countries) have increased their energy productivity (i.e. decreased their energy intensity). For more than 80 countries, the energy intensity decreased by more than 1% p.a. and 30 countries have experienced a rapid decrease above 3% p.a. (**Figure 2.5**). In about 40 countries, on the other hand, the energy productivity is decreasing (mainly in the Middle East, South Europe, Africa and Latin America).

Figure 2.4: Energy savings from energy intensity decrease at world level
Economies d'énergie au niveau mondial

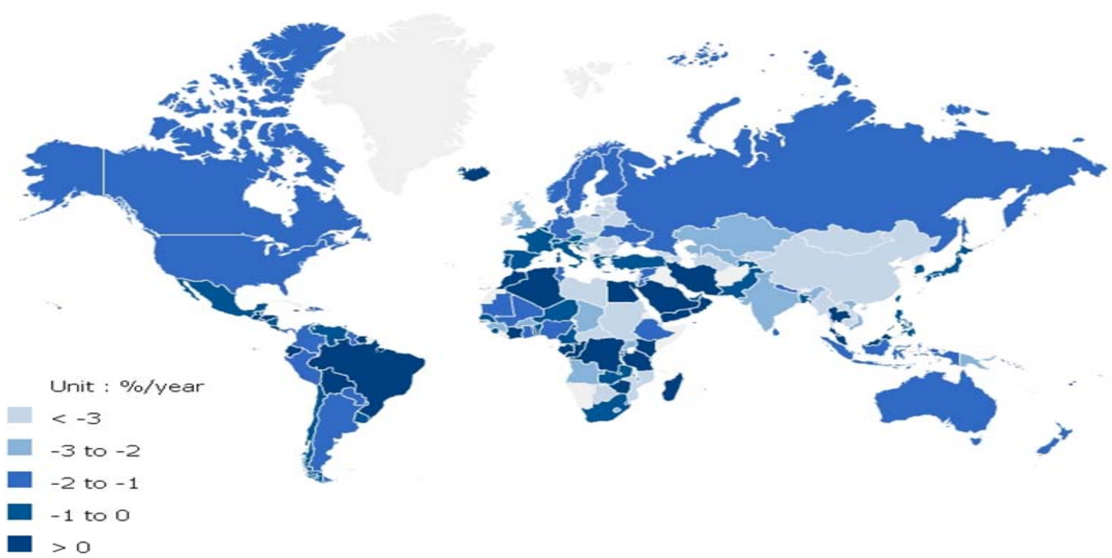


Source: ENERDATA

In developing regions, the energy intensity decrease is slower if biomass is excluded

If biomass is excluded, the decrease is weaker for developing regions and countries (e.g. Latin America, Other Asia, China, India and Africa).

Figure 2.5 : Primary energy intensity trends by country (1990-2008) (%/year)
Intensité énergétique primaire par pays



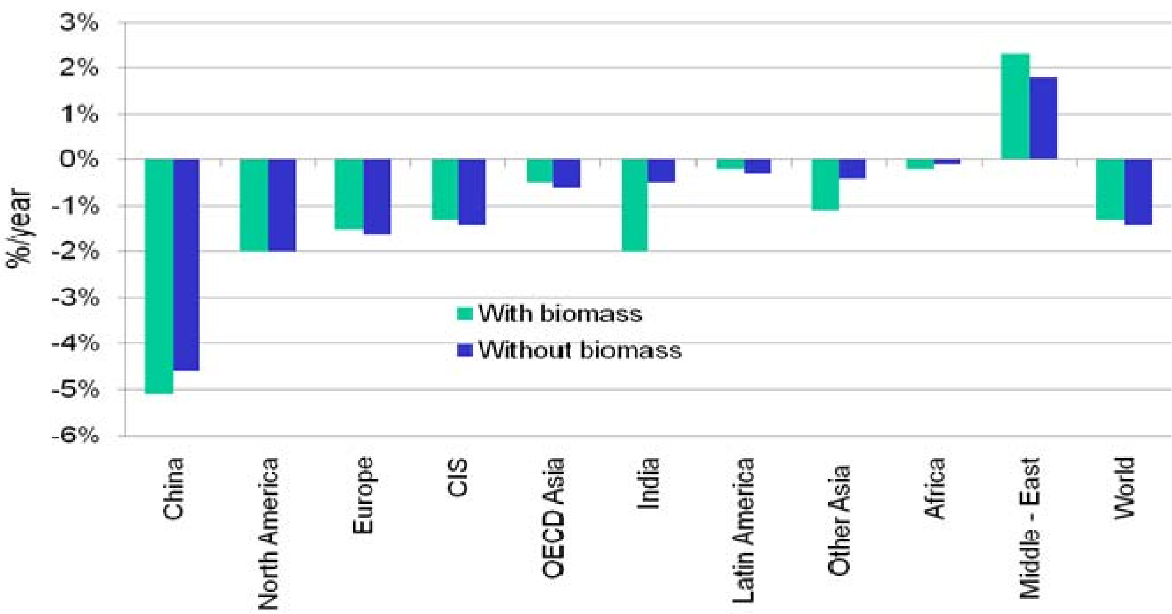
Source: ENERDATA

The total primary intensity (including biomass) always changes more rapidly than the primary intensity of conventional energies[19] because of the substitution of traditional fuels by modern energies (**Figure 2.6)**. For most developed regions (Europe, North America, CIS, Asia & Pacific OECD), a reverse trend can be observed: the primary intensity including biomass decreases less rapidly than the primary intensity of conventional energies, because of a broader use of biomass in these regions. At world level, these two opposite trends offset each other and both intensities experience almost the same decrease.

Large disparities in the amount of energy used per unit of GDP among regions

The CIS uses 2.7 times more primary energy per unit of GDP than Europe, the world region with the lowest energy intensity (**Figure 2.7**). OECD Asia & Pacific and Latin America are about 10% above the European level; North America, India and Other Asia stand at the same level as the world average with an energy intensity 50% higher than Europe. Finally, in China, Africa and Middle East, the energy intensity is twice higher than the average of Europe. High energy intensities in CIS, China and the Middle East can be attributed to various factors: dominant role of energy intensive industries and low energy prices.

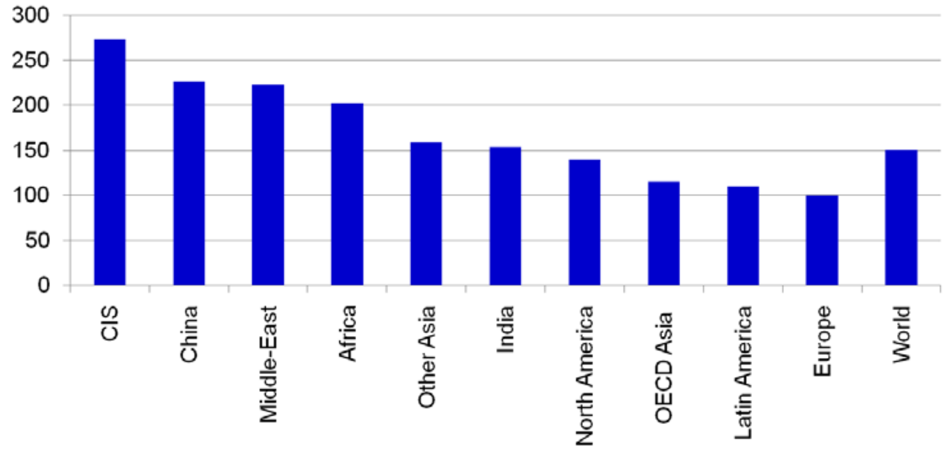
Figure 2.6: Primary energy intensity with and without biomass (1990-2008)
Intensité énergétique primaire (avec et sans biomasse)



Source: ENERDATA

[19] Oil, coal, gas and electricity.

Figure 2.7: Primary energy intensity levels by world region (2008)
I ntensité énergétique primaire par région du monde



Source: ENERDATA.

About 40 countries have a low energy intensity in the range of Europe or Latin America's averages (below 0.15 koe/$2005), among which 16 EU countries, including all the large ones, 7 Latin American countries (including Brazil and Mexico) and Japan **(Figure 2.8).** On the other extreme, 25 countries have a very high intensity (above 0.25 koe/$2005), among which China and many oil producing countries in the Middle East (e.g. Iran, Saudi Arabia), in the CIS (e.g. Russia and Kazakhstan) and in Africa (Nigeria).

Regions with the highest primary intensity experienced the largest reduction

It is not surprising that that countries or regions with the highest primary intensity in 1990 experienced the largest reduction over the period 1990-2008 (China, CIS, India) (**Figure 2.9**).

About 20% of end-use efficiency improvements are offset by higher conversion losses

Figure 2.8: Primary energy intensity levels by country (2008)
Intensité énergétique primaire par pays

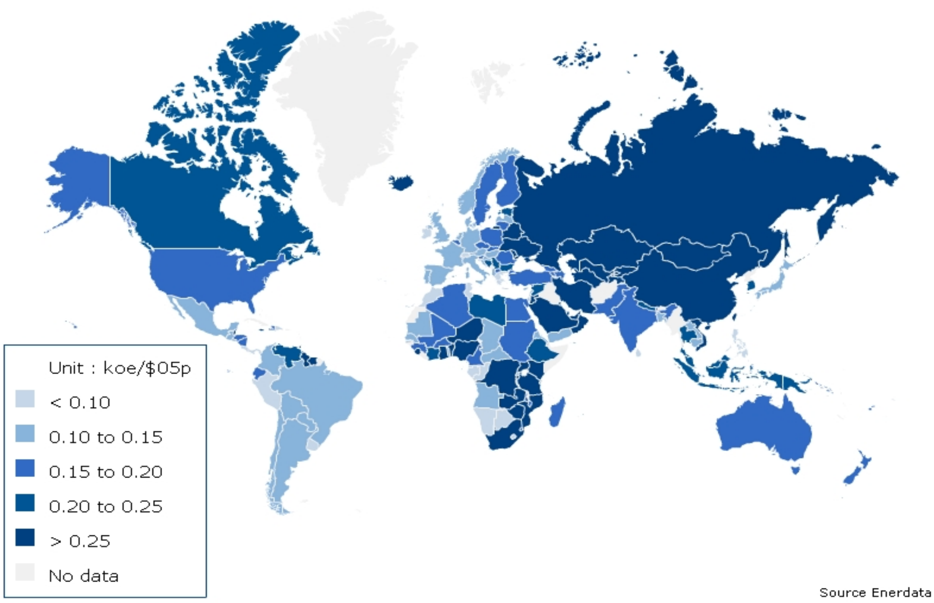
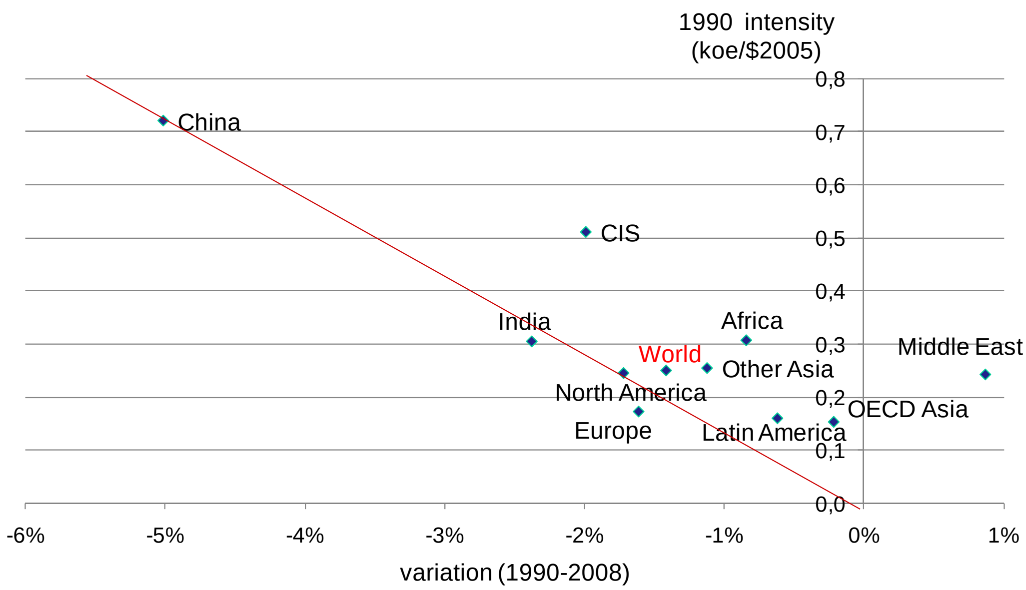


Figure 2.9: Primary energy intensity trends in relation to 1990 level



Source: ENERDATA.

The final energy intensity is a more appropriate indicator to assess energy efficiency at end-use level: it corresponds to the energy consumed per unit of GDP by final consumers for energy uses, excluding consumption and losses in energy conversion (power plants, refineries, etc.) and non-energy uses.

The final energy intensity at the world level decreases more rapidly than the primary energy intensity (1.8% p.a. against 1.4% p.a. between 1990 and 2008). This is also true in all world regions, except Europe (**Figure 2.10**). In other words energy productivity improved more rapidly at the level of final consumers that at the overall level. This trend is a result of growing losses in energy conversion. At the world level, 20% of the energy productivity gain at the final consumer level was offset by increasing losses in energy conversion (66% in OECD Asia, 33% in CIS, 36% in India).

The increasing losses in transformations are the result of two factors: on the one hand, the increasing use of electricity by final consumers[20] and, on the other hand, the fact that electricity is predominantly produced from thermal power plants[21] (i.e. with 60-70% losses).

In Europe, the primary energy intensity decreases slightly faster than the final intensity (1.6% p.a. against 1.5% p.a.). This trend is linked to three factors that reduced losses in energy transformations: the development of wind power, and the resulting reduction in the share of thermal power[22] (from 82.5% to 80.5%), the increase in the average efficiency of thermal power plants with the rapid penetration of gas combined cycles (from 32% in 1990 to 38% in 2008) and, finally, the development of cogeneration (from 14% in 1990 to 17% in 2008).

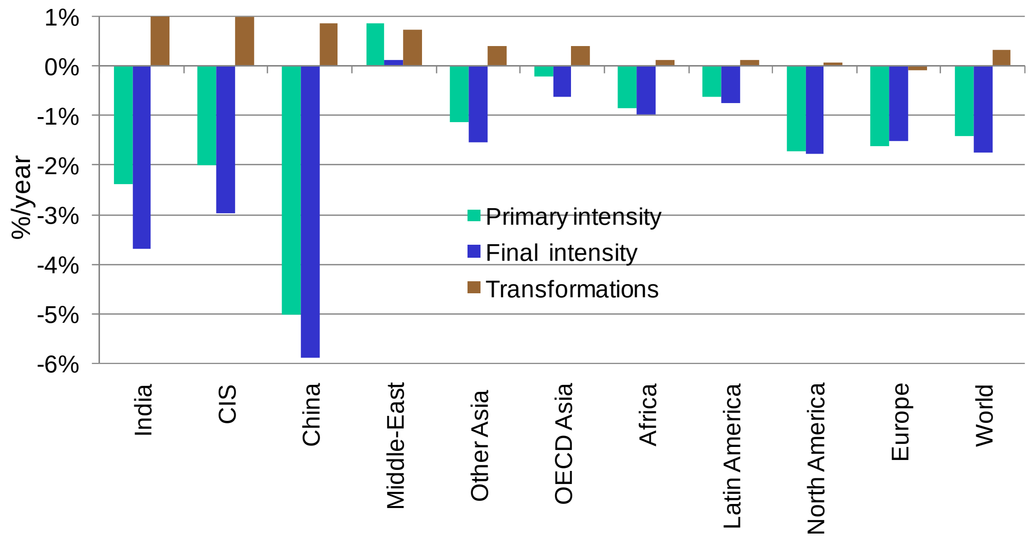
Energy efficiency of thermal power generation is improving slowly at world level

Energy efficiency of thermal power generation only improved by 2 points efficiency since 1990 at world level **(Figure 2.11)**, from 32% in 1990 to 34% in 2008: this is far from the EU average (40%) or the EU best practice (Spain with 46% due to a high penetration of gas combined cycle power plants).

[20] The share of electricity in the total final consumption increased from 13% in 1990 to 16% in 2008 at world level.

[21] The share of thermal, including nuclear, was 82% in 2008 at world level and 81% in 1990.
[22] The share of thermal power in Europe, including nuclear, decreased from 82.5% in 1990 to 80.5% in 2008.

Figure 2.10: Variation of primary and final energy intensity[1] (1990-2008)
Variation de l'intensité primaire et finale

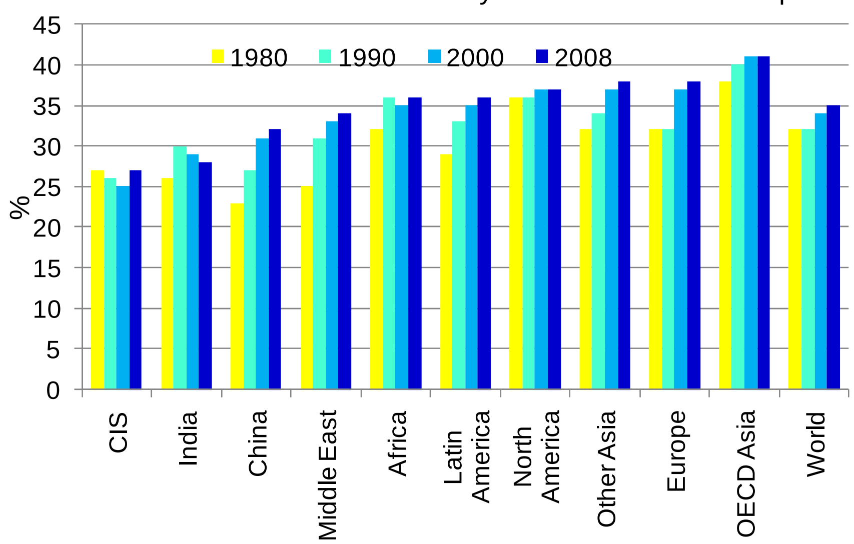


Source: ENERDATA

If all world regions had the same energy efficiency performance as the EU average, 420 Mtoe of fuels would have been saved in 2008, avoiding 1.3 Gt of CO2 emissions[23].

About 10 countries in the world have an average efficiency of thermal power generation above 43%, and about 30 countries are above 40% **(Figure 2.12).**

Figure 2.11: Trends in the average efficiency of thermal power production
Variation du rendement moyen des centrales thermiques

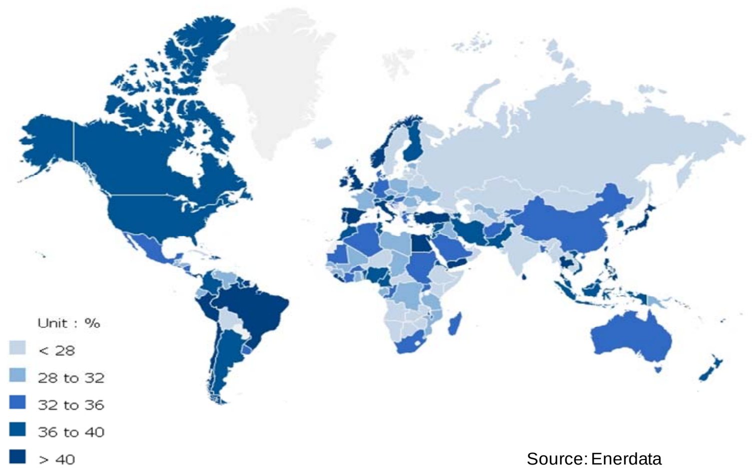


Source: ENERDATA

[23] Savings would even reach 770 Mtoe or 2.4 Gt CO2 if all thermal power plants had the Spanish performance.

industrial sector is clearly visible in industrialised countries.

Figure 2.12: Average efficiency of thermal power production by country (%) (2008)
Rendement moyen des centrales thermiques



Source: Enerdata

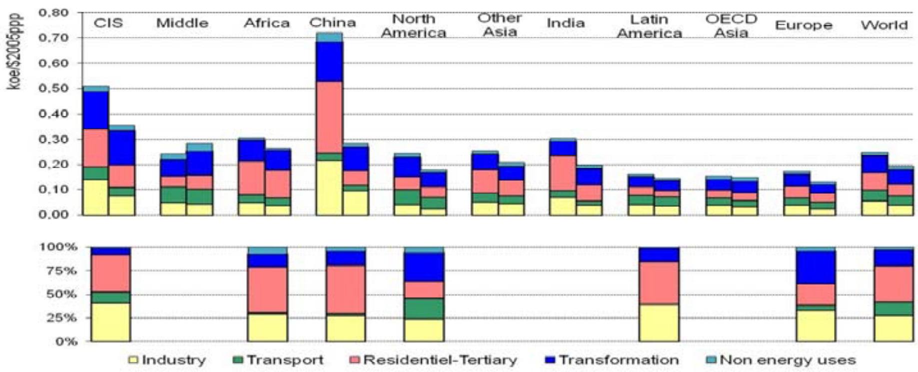
The sectors behind the decrease in the primary energy intensity vary across regions

In emerging countries and regions, households are driving the reduction in energy intensity, because of the substitutions of traditional fuels by more efficient fuels (e.g. LPG). In the Middle East, the transformation sector explains most of the increase in the energy intensity due to the rapid development of electricity uses (e.g. air conditioning) and the fact that electricity production is 100% thermal.

At the world level, the residential/tertiary sector and industry account for two thirds of the reduction of the energy intensity (38 and 28%, respectively). Surprisingly, transport has had a lower influence on energy intensity trends, probably because of the large increase in the price of motor fuels in recent years that have slowed down its consumption growth and brought it in line with the GDP growth. The share of the transformation sector in the primary energy intensity is increasing everywhere.

There are significant discrepancies in final energy intensity at same level of economic development

Figure 2.13: Primary energy intensity by sector (1990 and 2008)[1]
Intensité primaire par secteur



Source: ENERDATA

Energy importing OECD countries demonstrate the lowest final energy intensity (**Figure 2.14**). Oil or coal producing countries have the highest intensities.

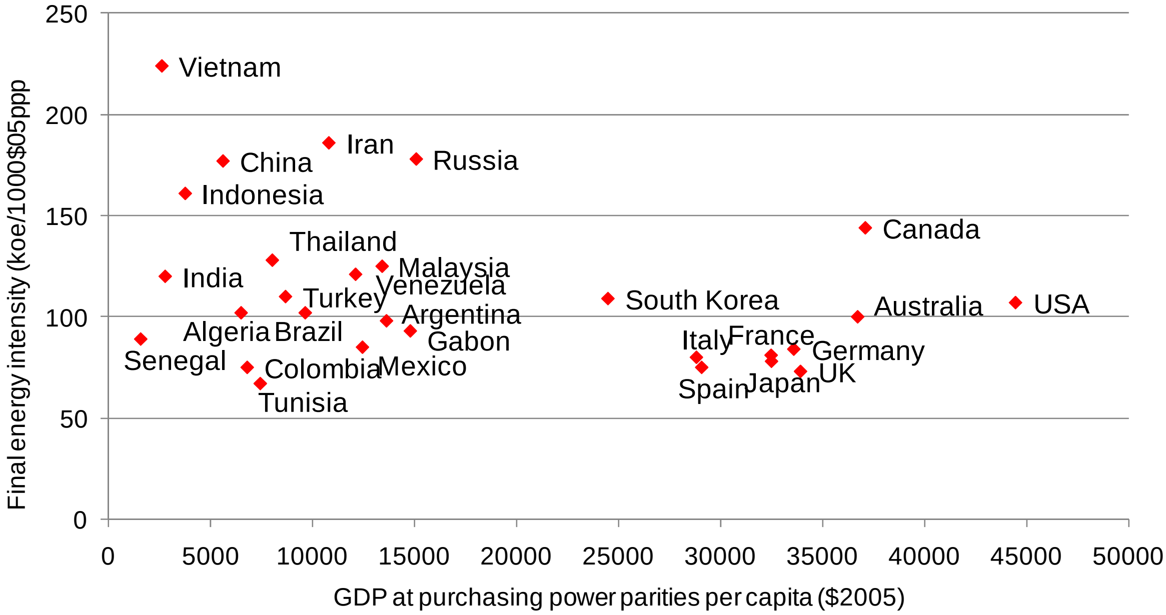
For a given level of economic development, final energy intensities vary significantly**:** up to 2 times for energy importing countries and up to 3 times if large energy producers are included (e.g. Russia, China, Indonesia or Iran). For energy importing countries, several factors explain such large discrepancies: different price levels, difference in the structure of the economic activity, importance of energy efficiency policies etc. In particular, former centrally planned economies in Europe and the CIS, that historically had low and subsidised energy prices, usually have high energy intensities, because of low efficiency of buildings and end-use equipment.

with significant energy resources (e.g. USA, Canada, Australia) (**Figure 2.15**).

In a long-term trend, energy intensities follow a “bell curve”, generally with developing countries to the left, with increasing intensities, and developed countries on the right side, with decreasing and converging values.

Figure 2.14: Final energy intensity and GDP per capita (2008)

Intensité finale et PIB par habitant

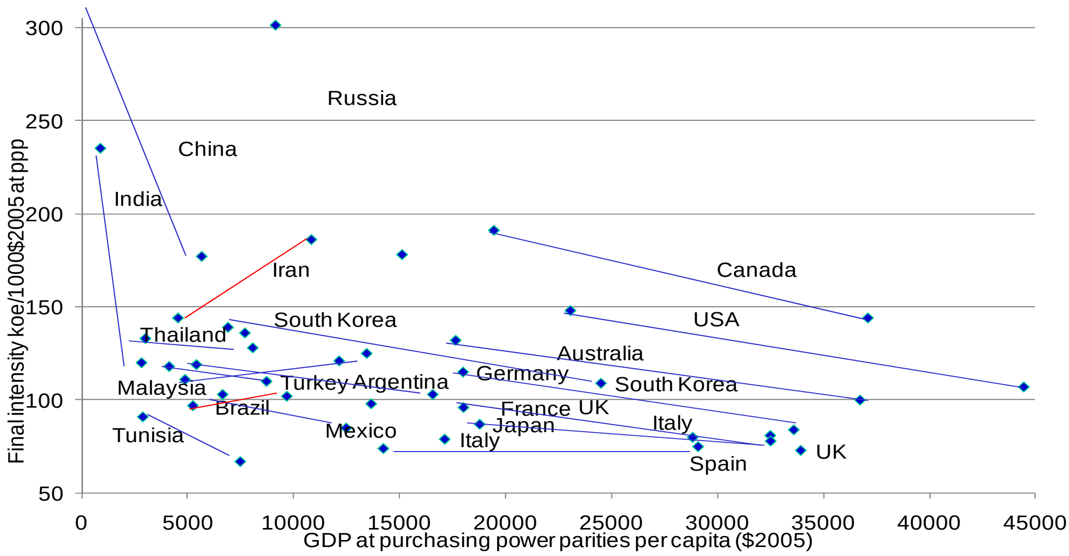


Source: ENERDATA

Final intensities are generally decreasing with economic development and converging

Final energy intensities are decreasing in energy importing countries, as well as in OECD countries

Figure 2.15: Trends in final energy intensity (1990-2008) and GDP per capita (2008)
Variations de l'intensité finale et PIB par habitant



Source: ENERDATA

Overall energy intensities, whether primary or final, capture all the factors that contribute to changes in the amount of energy required to produce one unit of GDP, including technical, managerial and economic factors. In this sense, changes in the economic structure contribute to variations in overall energy intensities, although they are not generally the result of energy efficiency policies. For example, all things being equal, the tertiarisation of the economy will decrease total energy intensities, as the energy intensity of industry is six times higher than that of the service sector at world level. In other words, it requires six times more energy to produce one unit of activity in industry compared to the service sector. In OECD countries, the difference in these intensities is around 4.5 to 6 depending on the region. In non-OECD countries it is even higher, around or above 10.

The effect of structural changes is especially important in countries with rapid economic growth. The share of industry in the GDP varies from 20% in North America, to 25% in Europe, India and Africa, around 30% for the world average, Latin America, OECD Asia and Pacific and around 60% in China.

The share of services is about 20% in China, around 50% in Latin around 50% in Latin America, CIS, India, and at world level, 60% in Europe and OECD Asia & Pacific and 75% in North America [24].

In order to monitor energy efficiency trends in relation to energy pricing and energy efficiency policies, it is more relevant to exclude the influence of structural changes. This is achieved by calculating an energy intensity at constant GDP structure, i.e. assuming a constant share of agriculture, industry and services in the GDP as well as a constant share of the private consumption in the GDP (for households)[25].

The intensity at constant GDP structure is a better indicator to capture trends in energy productivity than the usual energy intensity.

[24] See figure A 2.5 in Annex.
[25] The final energy intensity at constant GDP structure is calculated assuming that the GDP structure by main sector (agriculture, industry, services) as well as the private consumption share in the GDP are unchanged from 1990, only taking into account the actual variation in the energy intensity of each sector (i.e. consumption per unit of value added for agriculture, industry and services and of private consumption for households).

The difference between the actual evolution of the final energy intensity with that at constant economic structure shows the influence of structural changes in the economy **(Figure 2.16)**. For most regions the final intensity at constant structure decreased less than the final energy intensity. This means that part of the energy productivity improvement was due to an increasing share of services in the GDP, the less energy intensive sector. Changes in the GDP structure explain around 8% of the final energy intensity decrease at world level, 12% for Europe, 60% for OECD Asia and 80% for Africa. In China and the CIS, there was an opposite but marginal trend: as a result, the actual energy productivity improvement reduction is slightly higher than shown previously.

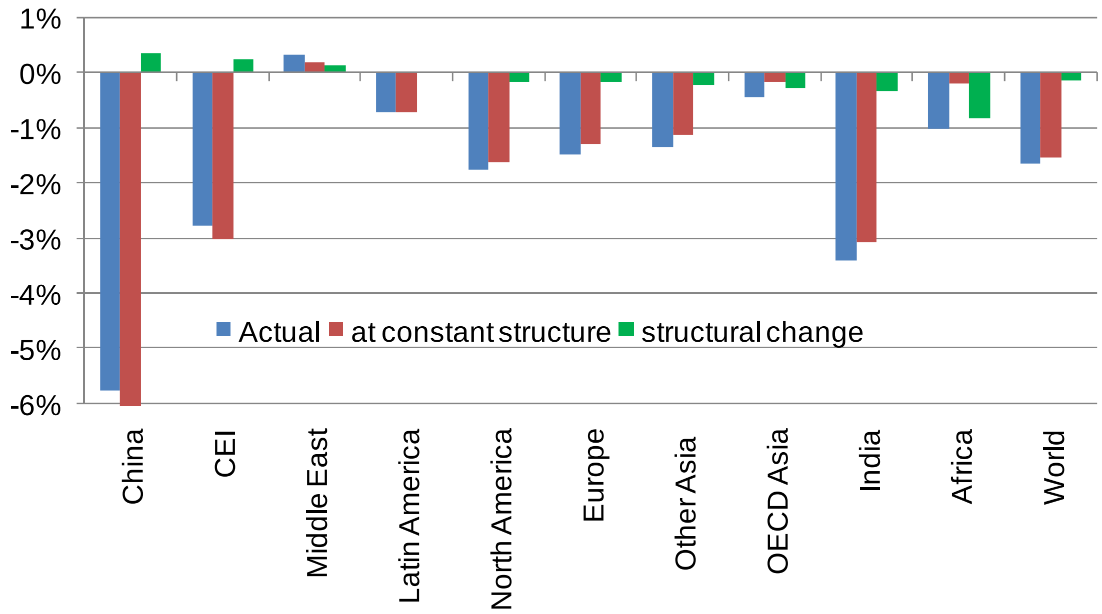
Energy intensity should be compared at the same GDP structure

Differences in GDP structure among countries and regions will affect their relative energy intensity levels. For instance, a region with a high share of industry in its GDP, all other things being equal, will have a higher energy intensity than other regions. To improve the comparisons, final energy intensities should be compared with the same GDP structure.

In The Middle East 40% of the increase in the energy intensity is due to structural changes.

In most regions, the most important economic restructuring was in industry and has not been measured in this study because of a lack of data by industrial branch (probably most important in China) [26].

Figure 2.16: Role of structural changes in the GDP (1990-2008)
Rôle des changements structurels dans le PIB



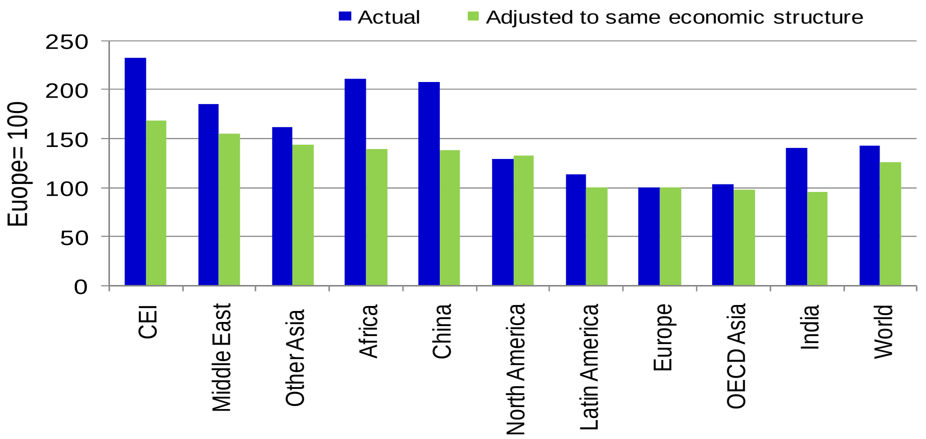
Source: ENERDATA

[26] In ODYSSEE, the calculation for European countries also considers a constant structure between industrial sub-sectors, which was not possible in this study due to data limitations on energy consumption and value added by industry sub-sector (http://www.odyssee-indicators.org/database/definition_odex.pdf.

After adjustment to the same economic structure (Europe), final energy intensities are lower than their observed level except for North America and Europe (**Figure 2.17**)[27].

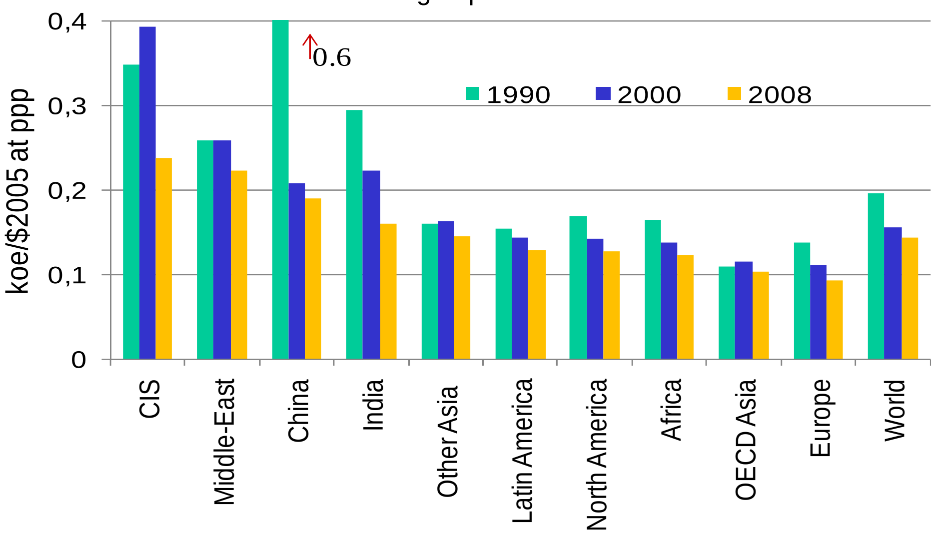
The adjustment is particularly significant in non-OECD countries with a high contribution of industry to the GDP. After adjustment, Europe is no longer leading and four regions have almost the same final intensity level: Europe, Latin America, OECD Asia and India.

Figure 2.17: Final energy intensity adjusted at the same economic structure (2008)
Intensité finale ajustée à la même structure économiq



Source: ENERDATA

Figure 2.18: Energy intensity of industry
Intensité énergétique de l'industrie



Source: ENERDATA.

[27] The average GDP structure of Europe was taken as a reference. This choice does not affect the relative adjustment of countries and regions.

Industry

The energy intensity of industry decreased significantly in OECD countries and China

Since 1990, the general trend in industry in Europe, OECD Asia & Pacific, North America, China and India is towards a decrease in the energy required per unit of value added (industrial intensity) (**Figure 2.18**). The energy intensity levels are converging because of the globalisation of industrial activities.

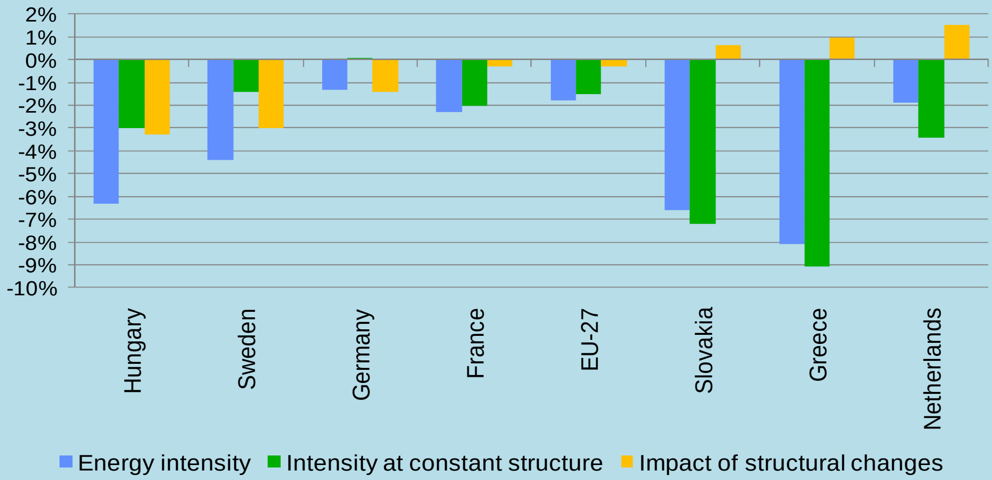
Trends in industrial energy intensities are influenced by energy productivity improvements at the level of each individual branch (e.g. steel, chemicals, non metallic minerals), but also by changes in the structure of the industrial value added: in countries or regions with a growing importance of energy intensive industries (e.g. Middle East), such a trend will, all thing being equal, contribute to increase the energy intensity of industry; on the opposite, a greater specialisation on less intensive branches, such as the production of electrical equipment or textiles, will lower the energy intensity.

Because of a lack of detailed data by branch, the effect of changes in the structure of industry has not been considered here. **Box 2.2** indicates what was the magnitude of these structural changes in selected EU countries, based on the EU project ODYSSEE-MURE.

Box 2.2: Influence of structural changes in industry in selected EU countries

In most EU countries, especially Hungary, Sweden and Germany, there has been a shift of industrial activities towards less energy intensive industries (e.g. electronic goods, light chemicals). As a result, part of the decrease in the energy intensity of industry is due to these structural changes. In other words, the intensity decrease overstates the actual improvement in energy productivity. In countries that have experienced an increasing role of energy intensive sub-sectors (e.g. steel, cement), such as The Netherlands, Greece or Slovakia, the actual improvement in energy productivity, as measured by the energy intensity at constant structure, is greater than the decrease in the intensity of industry

Energy intensity trends in the EU industry: role of structural changes Intensité énergétique de l'industrie de l'UE: impact des changements de structure



Source: ODYSSEE

Convergence in specific energy consumption for energy intensive products

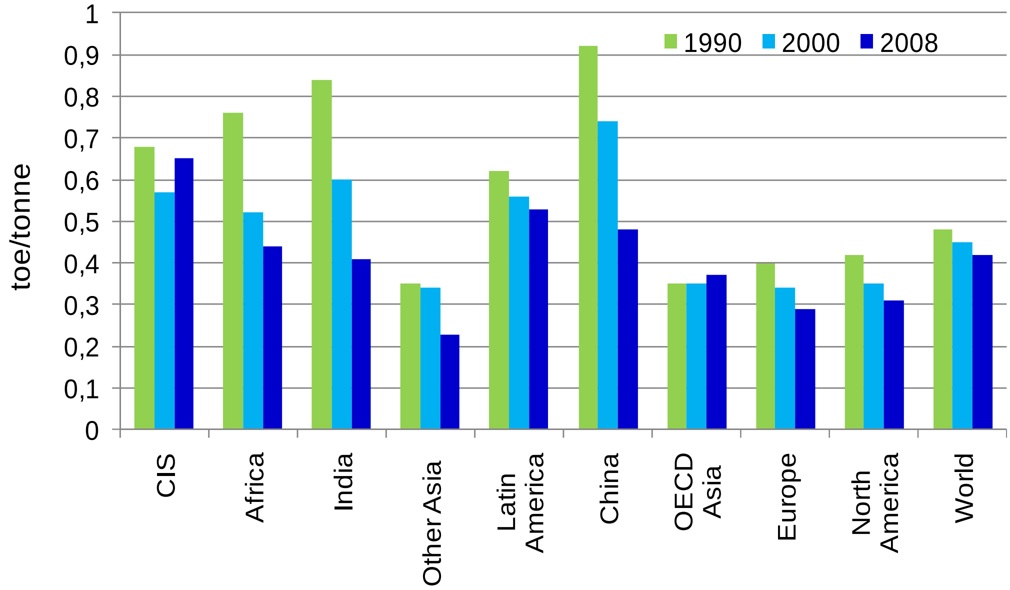
In energy intensive industries, the general trend points towards a reduction in the energy consumption per tonne of output, as observed for steel, cement/clinker and aluminium [28]. Given the importance of steel and cement in the energy balance of industry, this trend partly explains the overall improvement in energy productivity outlined above. There is a convergence in the most developed countries, whereas, in other countries, the situation is more diverse, due to differences in the mix of production process and product.

For steel, Europe and North America have the lowest average specific consumption (around 0.30 toe/t of crude steel) (**Figure 2.19**).

In the CIS, this specific consumption is twice higher and in emerging countries about 60-70% higher, but the progress is generally greater in these countries.

The rapid reduction in the energy consumption per ton of steel is the result of two factors: energy efficiency improvements and an increasing share of electric steel, the least energy intensive process compared to the oxygen/ blast furnace process: at world level, 38% of the steel was produced through the electric process in 2008, up from 28% in 1990. In Other Asia, the share of electric steel even reaches 2/3 of the production, which explains its low value. In some countries, negotiated agreements between industry associations and the government on targets for energy efficiency improvements explain part of the results.

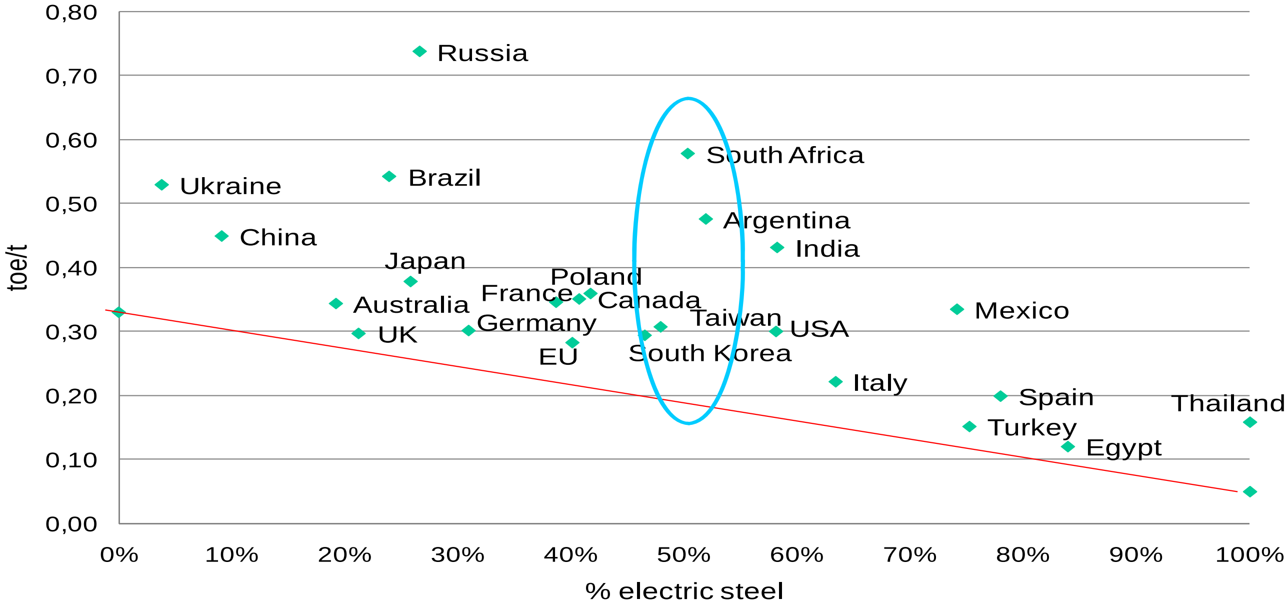
Figure 2.19: Variation of the energy consumption per tonne of steel
Variation de la consommation unitaire moyenne de l'acier



Source: ENERDATA

[28] See for aluminum Figure A 2.6 in Annex 1.

Figure 2.20: Energy consumption per ton of steel as a function of process mix
Consommation unitaire par tonne d'acier en fonction de la part des procédés



Source: Enerdata

To really compare the countries' energy efficiency performance in steel production, it is necessary to account for the differences in the process mix: countries with 100% production from electricity will have, all things being equal, a much lower specific energy consumption than countries with a large proportion of steel produced with the energy intensive oxygen process.

Figure **2.20** indicates for a selection of countries the average consumption per ton of steel in relation to the share of the electric process: only groups of countries with a similar process mix can be compared: for instance, South Africa, Argentina, India, Korea and Taiwan, with Korea turning out to have the best performance, or else Russia, Brazil, Japan, Australia and UK, with UK with the lowest specific consumption. The graph also displays the best practice (red line): the distance of each country to this best practice gives an estimate of the potential of energy efficiency improvement that can be achieved with the existing process mix. An additional potential of reduction of the specific consumption could be achieved by increasing the share of the electric process.

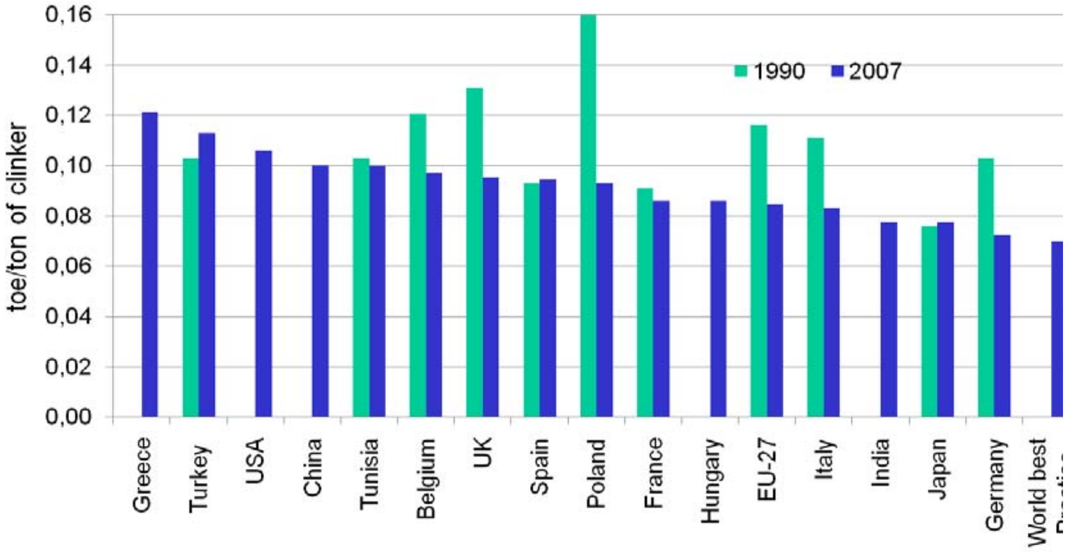
Distance to the red line (best practice) indicates the potential of energy savings. Again, only countries with a similar ratio clinker/cement can be compared: for instance for countries with a ratio around 90%: Greece, USA, Belgium, Sweden, Poland, China and Japan, with Japan having the best performance.

For cement most of the energy consumption (more than 80%) goes to the fabrication of clinker[29]. As for steel, the specific energy consumption per tonne of clinker is decreasing everywhere **(Figure 2.21)**. For several countries, the energy performance of clinker production is far from the world best practice.

The energy performance of cement production is linked to the share of clinker produced in the country in relation to cement production: the lower this ratio the lower the specific consumption is[30]. Figure **2.22** displays the specific energy consumption of cement as a function of the ratio clinker/cement. Distance to the red line (best practice) indicates the potential

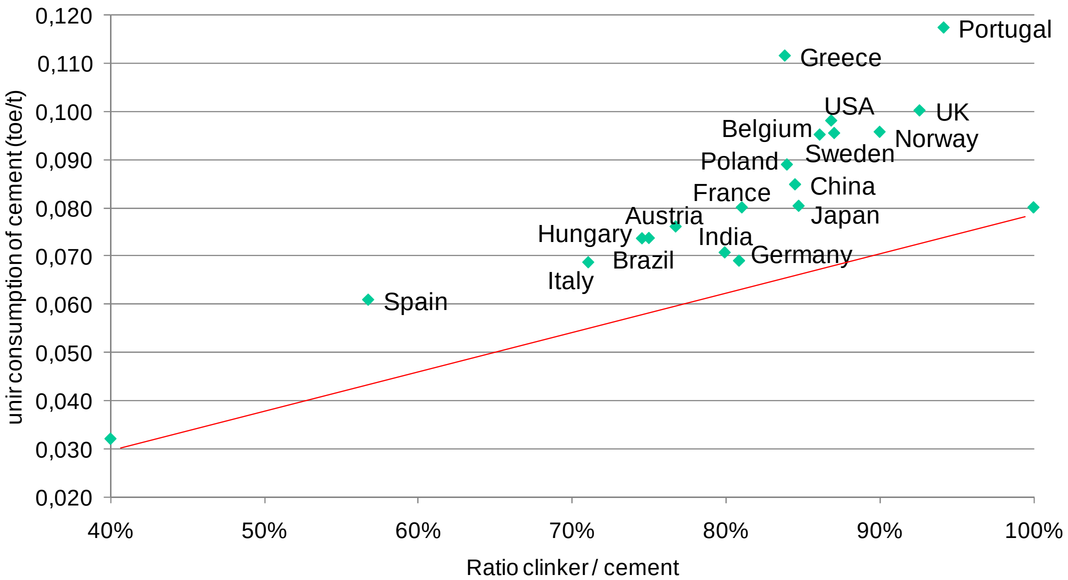
[29]Cement is a mix of clinker and additives, such as ashes. Clinker is produced in high temperature kilns. Cement is obtained by grinding clinker and additives.
[30] Differences among countries in the ratio clinker/cement can be due to the percentage of additives and to imports of clinker. Countries with a high proportion of additives and/or importing part of the clinker will, all things being equal, reduce the energy consumption per ton of cement.

Figure 2.21: Variation of the energy consumption per tonne of clinker
Variation de la consommation unitaire moyenne du clinker



Source: Enerdata, based on ODYSSEE database, IEA and national sources

Figure 2.22: Energy consumption per ton of cement
Consommation unitaire par tonne de ciment



Source: Enerdata, based on ODYSSEE database, IEA

Transport

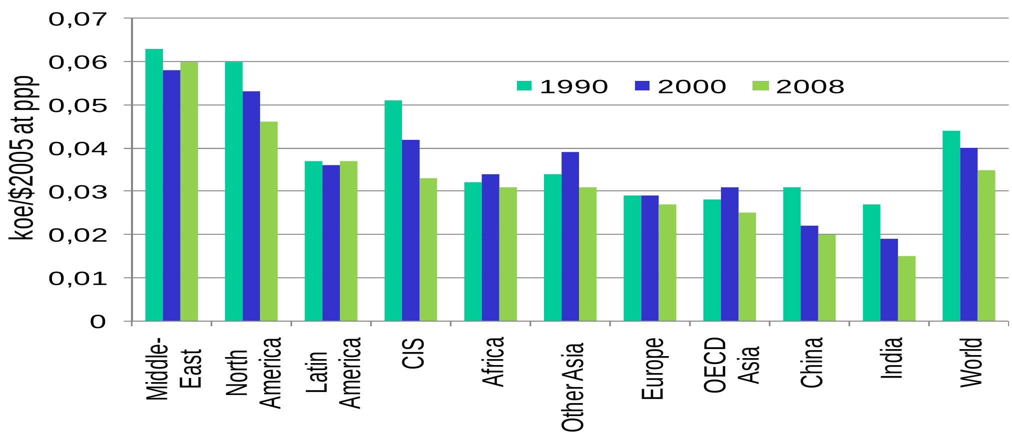
In transport great disparities exist among regions in the energy intensity trends; with a stabilisation or even a reduction of transport energy use in some OECD countries

The energy intensity of the transport sector[31] appears to be quite similar in Europe, OECD Asia and Pacific and other Asia, while North America stands at a level 75% higher (**Figure 2.23**). In China and India, because of the still low car ownership and the dominant role of rail transport for the transport of goods, the energy intensity is low compared to the other regions.

In most regions and at world level, this energy intensity is decreasing, which means that the energy consumption of transport is growing much slower than the GDP.

In Latin America, Africa and Other Asia, the energy intensity of transport has been increasing until 2000, because of the increasing ownership of cars and motorcycles, and the use of roads to transport goods instead of water or rail. Higher oil prices have, however, reversed that trend everywhere in recent years.

Figure 2.23: Energy intensity of transport
Intensité énergétique du transport



Source: ENERDATA

New cars are more and more efficient

The reduction in the energy intensity of transport in OECD countries is due to the combination of two main drivers: lower growth of car ownership and traffic, due to saturation, and improvement of the energy efficiency of new cars linked to the policy measures implemented. In the EU and Japan, the specific consumption of new cars has decreased regularly since 1995 (by about 20%), due to the agreement between the association of

[31] There is no good indicator to reflect the overall efficiency trends in the transport sector, mainly because of the difficulty of separating out the energy used by different modes of transport, especially for road transport. The most common indicator is the energy consumed in transport per unit of GDP, as transport activities take place in all sectors. In the ODYSSEE project for Europe, an alternative indicator is used, combining in a single index the energy efficiency trends by mode (ODEX) (see www.odyssee.indicators.org).

car manufacturers (ACEA, JAMA, KAMA) and the European Commission in the EU and the top-runner programme in Japan (**Figure 2.24**). In the US, the reduction was significant in the 80's because of the CAFE standards but there has been little progress over the 90's.

Since 2000, some OECD countries even demonstrated a stabilisation in the energy consumption of the transport sector (e.g. France) or even a decrease (Japan or Germany)[32].

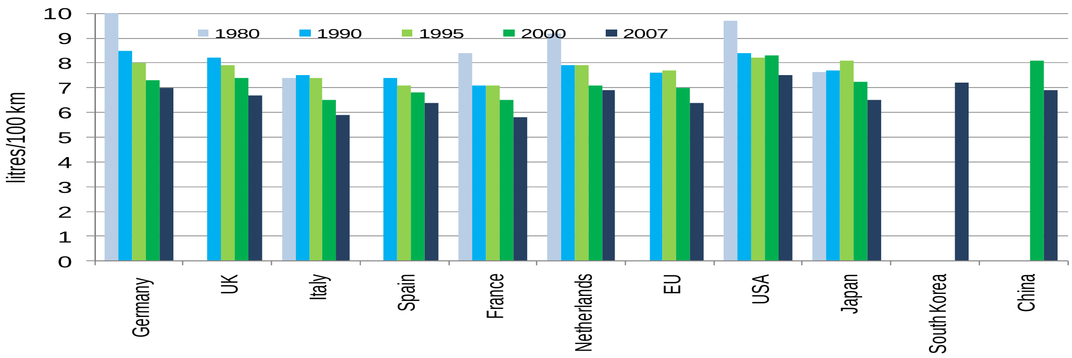
Household and Service[33]

Very different levels of electricity consumption per household

It varies from a value of around 4000 kWh/household for European countries[34] to around 6000 kWh in OECD Asia & Pacific, and is around 12500 kWh in North America, i.e. twice the value for Europe. .

Developing regions have much lower values of specific consumption as part of the population does not have access to electricity[35] and the ownership of large appliances (e.g. refrigerators, washing machines, air conditioning) is less common: per household consumption is 7 times lower in India than in Europe (around 600 kWh), 5 times lower in Africa (900 kWh) and 4 times lower in China and Other Asia (around 1000 kWh).

Figure 2.24: Specific consumption of new cars (litres/100km)[1]
Consommation spécifique des automobiles neuves



Source: Odyssee

The average consumption of electricity per household is very diverse in developed regions depending on the level of ownership of electrical appliances and the importance of electric space heating **(Figure 2.25)**.

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household is more relevant if thermal uses (mainly space heating) are excluded for OECD countries and if the consumption is related to the number of electrified households in developing and emerging regions **(Figure 2.26)**[36].

[32] Reduction of 10% for the transport consumption between 2000 and 2008 (11% for road transport alone)

[33] The diverse patterns among world regions of energy consumption for space heating and for the fuel mix for cooking make any comparison of the total energy consumption between regions fairly meaningless. The following evaluation of energy trends in these sectors will therefore mainly focus on electricity.

[34] In EU new member countries from the Baltic region and Central and Eastern Europe, the average is twice lower than the average for Europe.

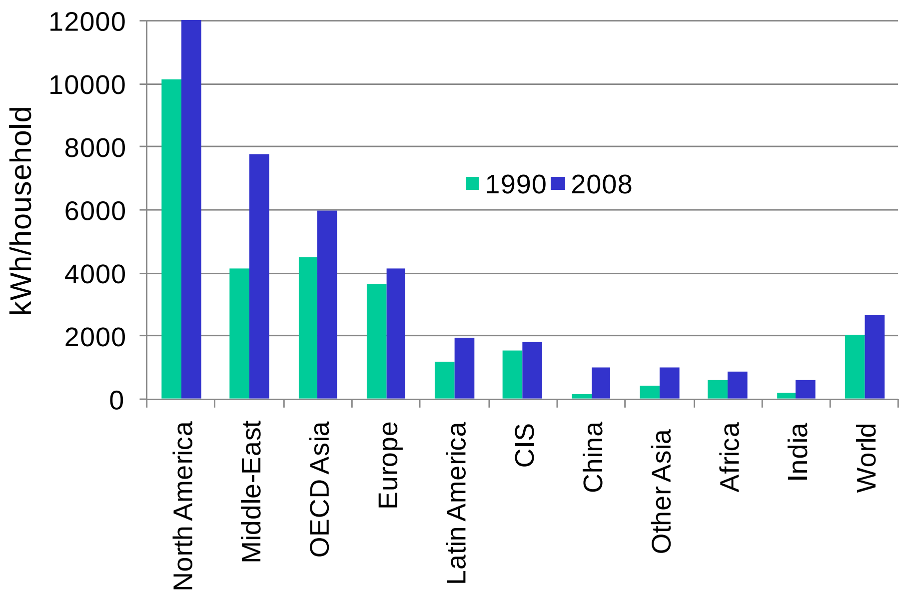
[35] Around 60% in India and 40% in Africa in 2009 (source Enerdata).

[36] In Annex, a comparison on OECD countries is done by excluding in addition use of electricity for cooking and water heating, restricting the consumption to the captive uses of electricity, such as refrigerators, TV, washing machines or lighting (Figure A 2.7).

The differences between regions are narrower with this new indicator. The average consumption per electrified household of India and China are now very close (around 900-1000 kWh) and only 3.5 times lower than in Europe; for Africa and Latin America, this consumption is 1.5 times lower than the European level (around 2000 kWh).

In all regions, household electricity consumption per capita is increasing. The growth is the most rapid in Asia: above 10% p.a. in China and in the range 5-6% p.a. in India and other Asia between 1990 and 2008. It is more moderate in Europe (0.7% p.a , with even a slow down to 0.5% p.a since 2000). In North America and OECD Asia & Pacific, the progression is still sustained for highly developed regions, between 1 and 2% p.a, given the fact there is a saturation in appliance ownership. **(Figure 2.27)**.

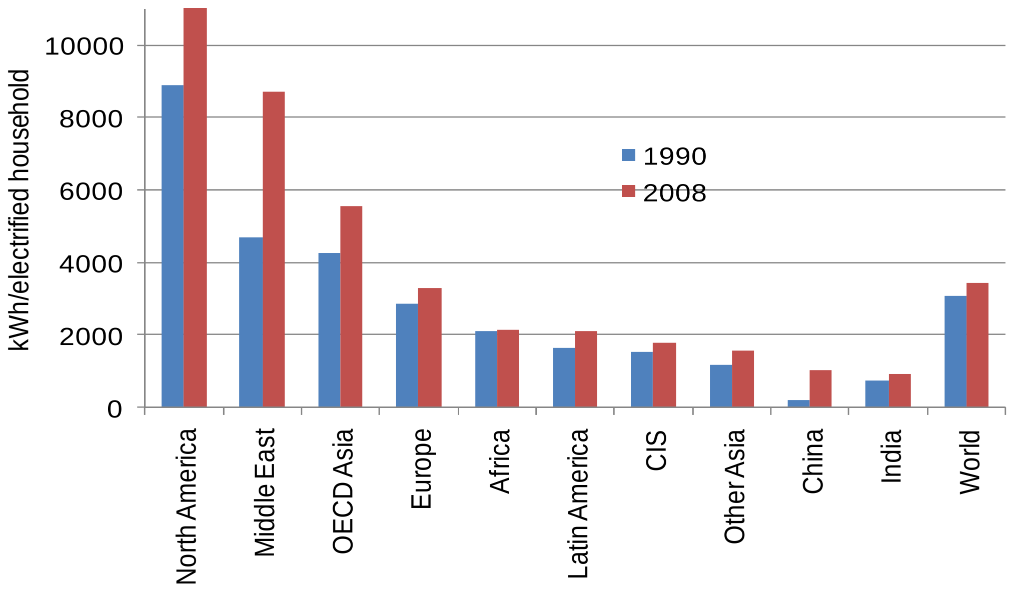
Figure 2.25: Electricity consumption per household
Consommation d'électricité par ménage



Source: ENERDATA

The household electricity consumption per capita is rising slower since 2000

Figure 2.26: Electricity consumption per electrified household excluding heating
Consommation d'électricité par ménage électrifié (hors chauffage)



Source: ENERDATA

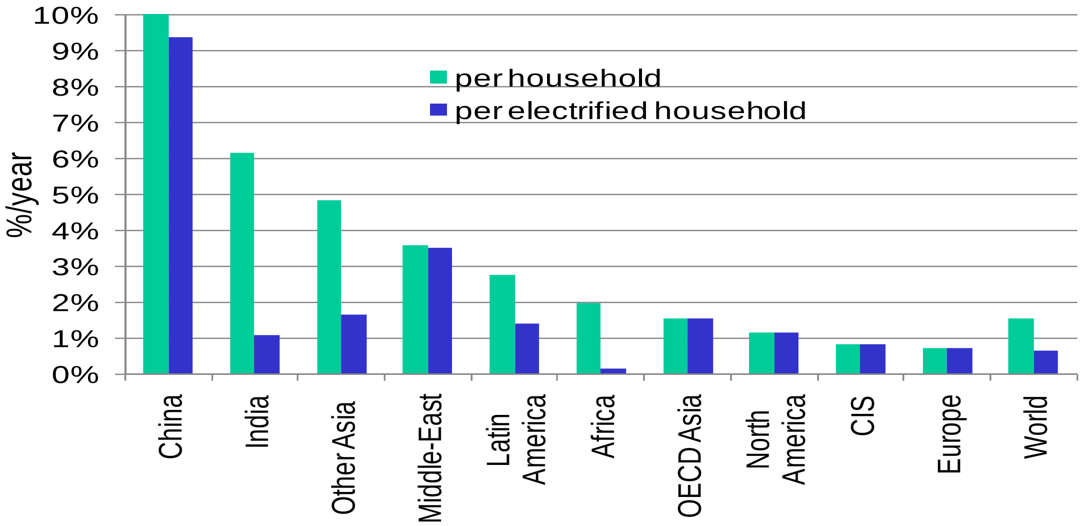
The progression is slower in developing countries, especially in Africa and India, if the electricity consumption is related to the number of electrified households, as part of the growth came from the increase in the number of electrified households[37]. These trends are slowing down in some regions or countries since 2000 (e.g. Europe, India, Other Asia), probably, as the result of the policies implemented to improve the energy efficiency performance of electrical appliances (labelling, minimum efficiency standards).

The electricity intensity of the service sector is increasing

In developing countries, the main source of energy used in the services sector (public administration, commerce and other service activities) is electricity. Therefore, as for households, the focus will be here on electricity. The quantity of electricity required to generate one unit of value added (the electricity intensity) is increasing in most regions, especially in less industrialised regions in which the service sector is expanding rapidly, and in countries with air conditioning requirements (e.g. China, India, Other Asia) **(Figure 2.28)**. In North America, region with a high energy intensity level, the ratio is rather stable. This may be due to the growing numbers of new appliances, such as IT devices, linked to the development of internet and of new telecommunications device, as well as a spread of air conditioning in Europe.

[37] The percentage of electrified households increased from less than 30% to 60% in India between 1990 and 2008 and from 30% to 40% in Africa.

Figure 2.27: Variation of the electricity consumption per household
Variation de la consommation d'électricité par ménage



Source: ENERDATA

The diffusion of solar water heaters is still very disparate among regions

The diffusion of solar water heaters represents a great potential of energy savings in many regions, either to substitute present uses of electricity or fossil fuels (namely gas and LPG), or to reduce the energy demand in the future in developing regions where this use is still not well established. Its diffusion is still very disparate, mainly because of unequal priorities given to its promotion **(Figure 2.29**). Indeed the climatic conditions explain little the differences observed, as very different penetration of solar water heaters can be found in countries with similar sunshine (e.g. Cyprus or Israel, the two leading countries, compared to Greece or Lebanon in terms of installed m2 per inhabitant), and some countries with limited sunshine have a large utilisation of solar water heaters (e.g. Austria).

The top 3 in the world are Cyprus, Israel (700-800 m2/ 1000 inhabitants) and Austria (~500), which are far ahead from China (~100) or the European average (70 m2/ 1000 inhabitants) are is a very rapid progression since 2000 in all regions (by a factor 3 at world level, a factor 5 in China and a factor 2 in Europe and North America).

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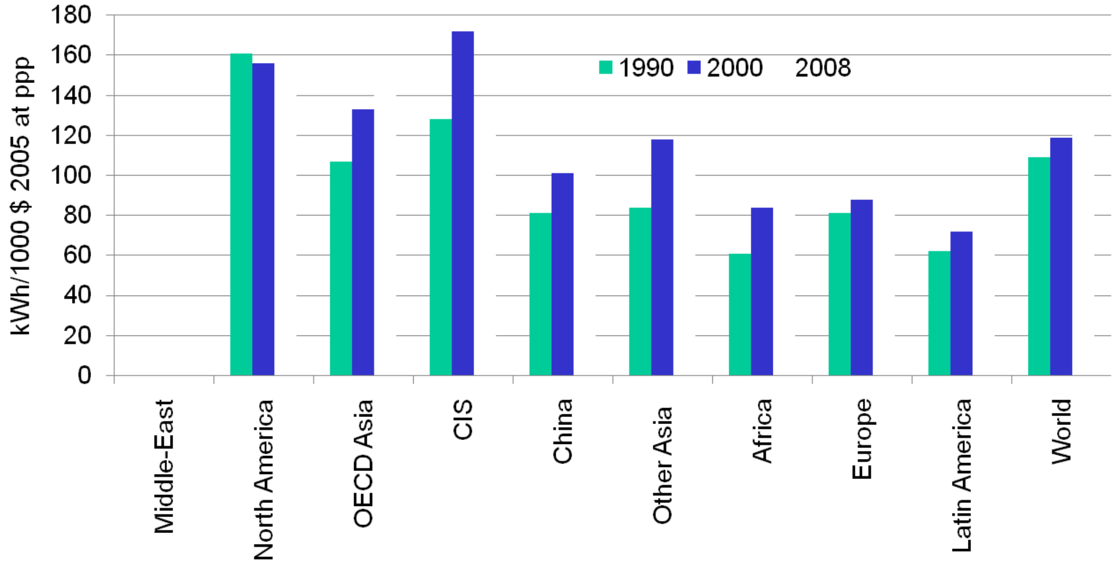
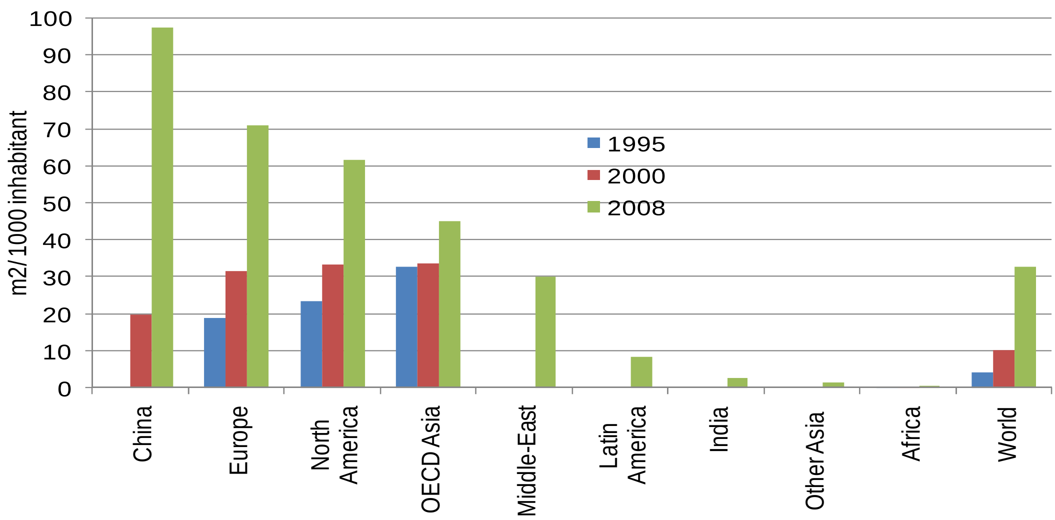
Figure 2.28: Electricity intensity in the service sector
Intensité électrique des services



Source: ENERDATA

Figure 2.29: Installed solar water heaters
Surface installée de capteurs solaire



Source Enerdata from ObservEr, IEA

CO2 Emissions from Energy Combustion

One fifth of the world's population accounts for more than half of world CO_2 emissions

Ten countries account for two thirds of world emissions

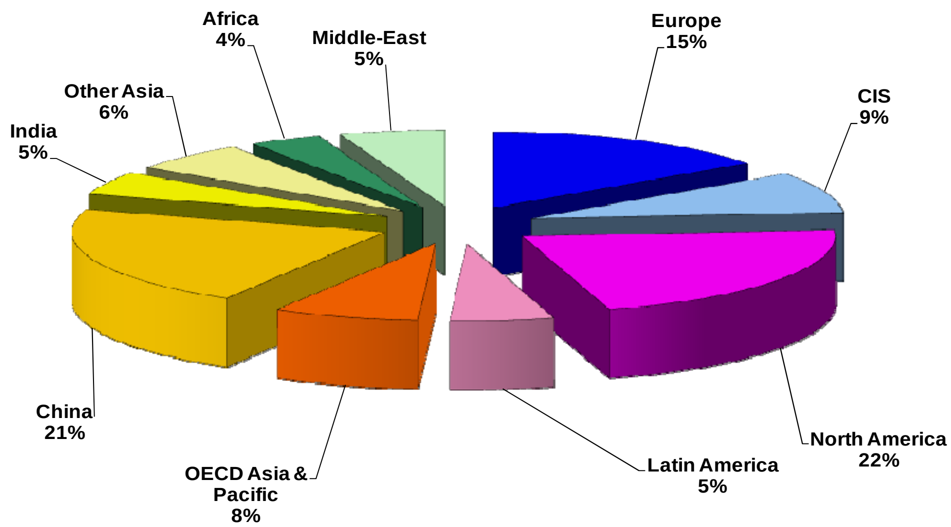
North America, Europe, CIS, Asia & Pacific OECD together still account for more than half of total world CO2 emissions from energy combustion in 2008 whereas they only represent one fifth of the population **(Figure 2.30)**. However, their role is decreasing rapidly, from almost three fourth of total emissions in 1990 to 65% in 2000 and 54% in 2008. Since 2008, China has become the largest emitter in front of the United States with 21% of total emissions, up from 11% in 1990. The top 5 emitters of energy related CO2 emissions, China, USA, Russia, India and Japan, represented 56% of world emissions in 2008.

The top ten emitters, including in addition Germany, UK, South Korea, South Africa, and Italy made up two thirds of world emissions that year.

Strong increase of CO_2 emissions in non OECD Asia and the Middle East

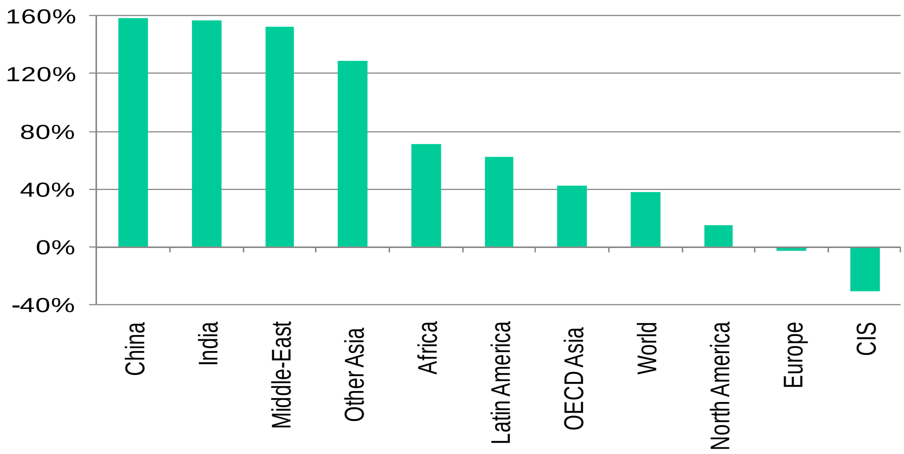
Trends in CO_2 emissions vary significantly between countries (**Figure 2.31**). Developing countries with high economic growth have registered a very rapid increase in their emissions (by around 160% in China, India and The Middle East). On the opposite, there is no progression in Europe where these emissions are in 2008 back to their 1990 level because of strong climate change policies. North America and OECD Asia & Pacific experienced a progression in their emissions (38% and 17% respectively), as climate policies have been weaker in some of the countries (e.g. USA and Australia). The decrease in emissions in the CIS is due to the sharp contraction of their economies in the 90's; since 1998, their emissions are however increasing (+ 14%). As a result of these trends, world CO2 emissions from energy use were 40% higher in 2008 than in 1990 and two third of this growth took place since 2000.

Figure 2.30: Distribution of world CO_2 emissions from energy use (2008)
Répartition des émissions de CO_2 mondiales liées à la combustion de l'énergie



Source: ENERDATA

Figure 2.31: Variation of CO_2 emissions from energy use (1990-2008)
Variation des émissions de CO_2 liées à la combustion de l'énergie



Source: ENERDATA

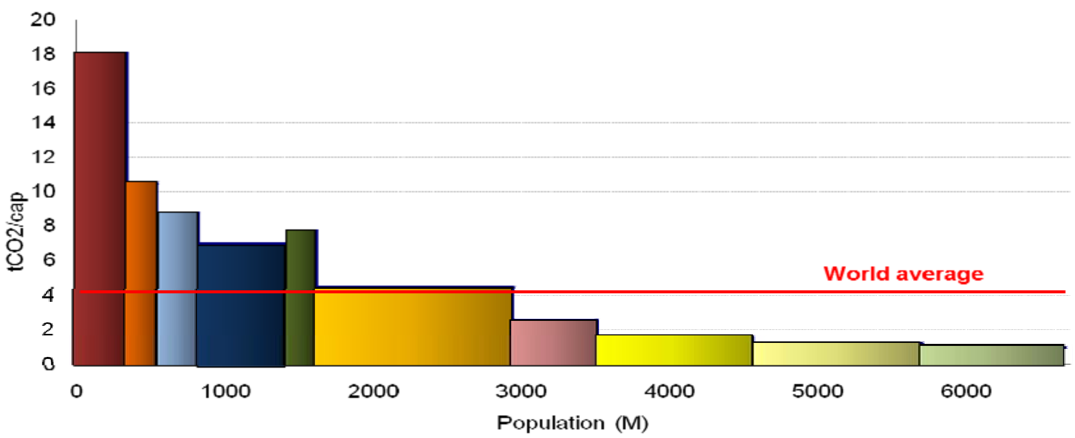
CO₂ emissions per capita vary greatly among countries

CO2 emissions per capita are very diverse: around 1t CO2/cap in the less developed regions (Africa and India), 1.5 t in other Asia; slightly under 4.4 t in China, 7t for Europe, 8t for The Middle East and 9 t for the CIS, and the Middle East, 10,5 t in Asia & Pacific OECD and near 18 t in North America **(Figure 2.32)**.

About 50 countries in the world have a level of emission per capita above the world average, i.e. 4.2 t CO2/cap. About 20 countries have low emissions, below 1.2 t, of which 10 sub-Saharan African countries.

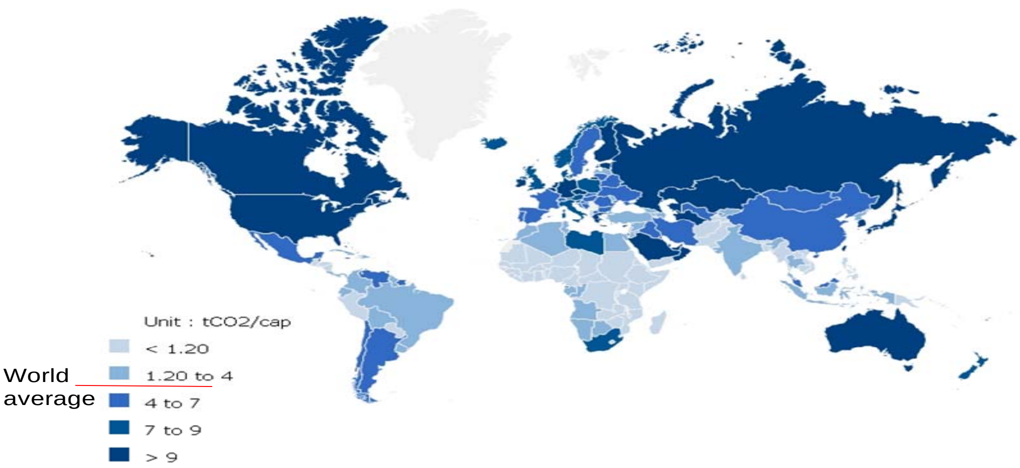
Slightly less than 40 countries are above 7 t, the European average. In total, 24 countries have high emissions, above 9 t (the CIS average), of which 9 with very high emissions, above 15t CO2/cap, including mostly countries with abundant energy resources, such as Saudi Arabia, Canada, USA and Australia **(Figure 2.33)**.

Figure 2.32: CO_2 emissions per capita from energy combustion[1]
Emissions de CO_2-énergie par habitant



Source: ENERDATA

Figure 2.33: CO_2 emissions per capita from energy combustion (2008)
Emissions de CO_2-énergie par habitant

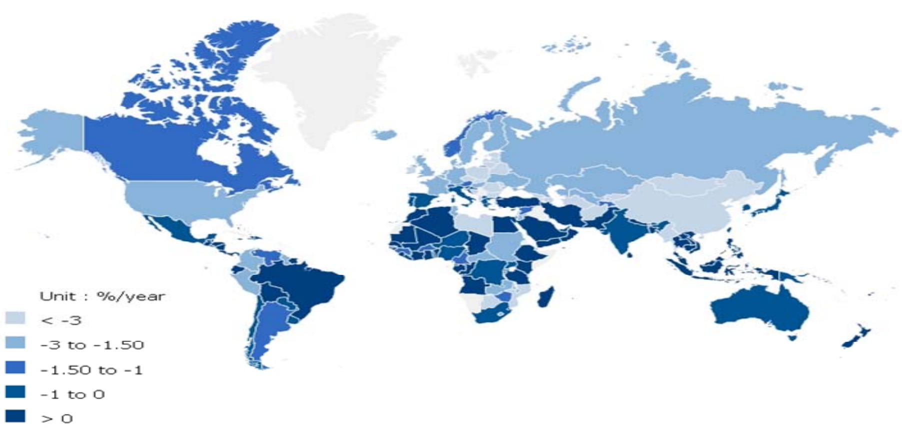


Source: ENERDATA

At world level, in CO_2 emissions per capita increased only moderately (+9% since 1990). There was even a slight decrease between 1990 and 2000, followed by a progression by 14% between 2000 and 2008. This is the result of two opposite trends: a rise of in CO_2 emissions per capita in most regions, on the one hand, and a decrease in Europe, CIS (until 1998) and North America (since 2000), on the other hand. The largest progression took place in China and India (multiplied by a factor 2) and the Middle East (+75%), due to the high economic growth **(see Figure A 2.8 in Annex)**.

CO_2 emissions generally increased less rapidly than the economic activity

Figure 2.34: Variation in CO_2 intensity (1990-2008) (%/year)
Variation de l'intensité en CO_2



Source: ENERDATA

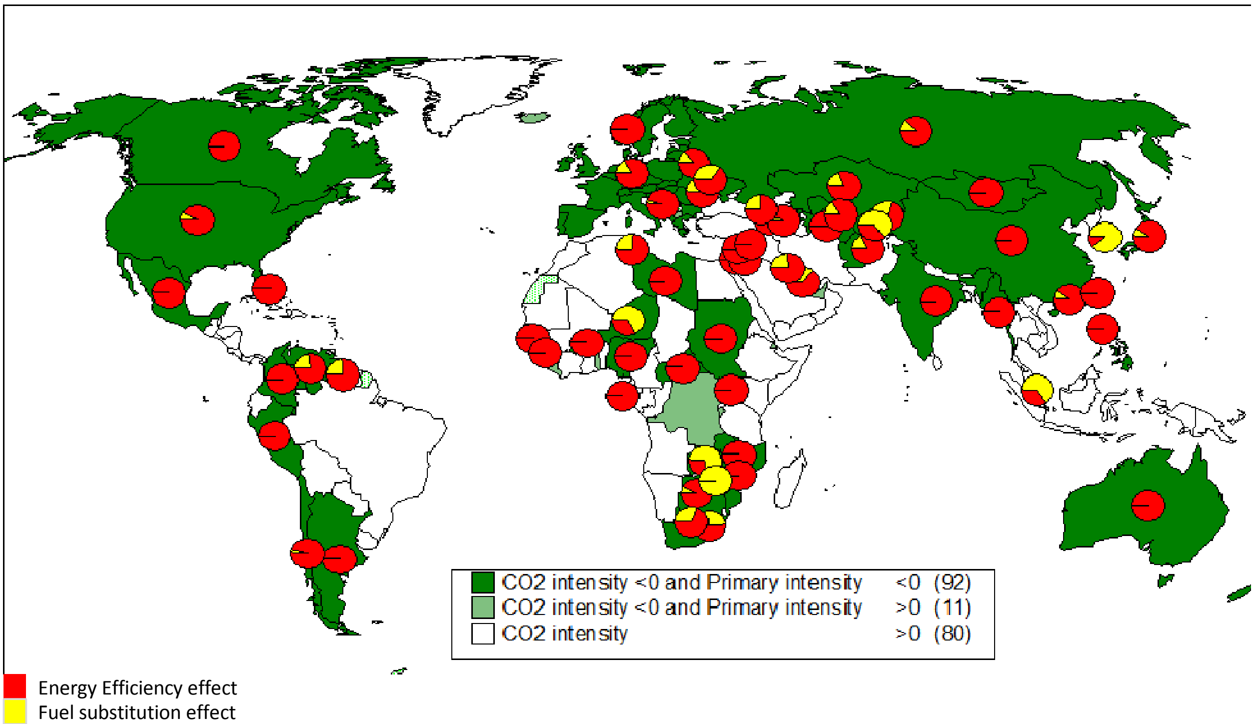
in in CO_2 emissions from energy use increased slower than economic activity in about three fourth of the countries in the world **(Figure 2.34)** and in all world regions **(Figure A2-9. in Annex**).

Energy productivity improvements: main driver of reduction in CO_2 intensities

Two main factors contribute to decrease the in CO_2 intensity of the GDP: energy productivity improvement on the one hand, and a shift to energy sources with lower in CO_2 emission factors (e.g. gas, renewables, nuclear).

In about half of the countries, both the in CO_2 intensity and primary energy intensity are decreasing and most of the reduction in the in CO_2 intensity is driven by energy productivity improvements, i.e. mostly energy efficiency (e.g. 3/4 at EU level) (Figure 2.34). Fuel substitution only had an impact in a few countries (dominant yellow part) (e.g. Korea with 75% of the reduction). Fuel substitutions often offset part of the energy intensity reduction (e.g. North Africa and world level). At world level, all the reduction is due to energy productivity improvements.

Figure 2.35: Impact of fuel substitutions on the CO_2 intensity variation[1]
Effet des substitutions d'énergie sur la variation de l'intensité enCO2



Source ENERDATA, variation over 1990-2008

3. Evaluation of Energy Efficiency Policies and Measures

This evaluation covers the impact of selected energy efficiency policy measures around the world to find answers to the following questions. What is the importance of energy efficiency measures? What are the priorities? What are the trends? What measures are being favoured? What are the innovative measures? What are the results? Which measures are cost effective?

Based on a comprehensive global survey and case studies, the evaluation also draws on six in-depth case studies prepared by experts. The following measures were selected as they correspond to new concerns or areas of actions for policy makers in charge of energy efficiency and the set of measures already evaluated in previous reports[38]:

- Innovative communication/information tools from utilities or energy agencies
- Good practices in the public sector
- Successful financial tools for households
- Energy efficiency measures for low income households
- Obligation of energy savings (white certificates.):
- Regulation and compliance.
- Smart meters

Experts were requested to carry out a comprehensive evaluation of these six types of instruments. Each of the experts prepared a core report of between 10 and 50 pages, completed with concrete examples of country experiences ("country case studies"). These reports have been harmonised and shortened to be included in this chapter in the review of the different measures[39]. The full set of country case studies is included in Annex 1 of this report.

The survey[40] of energy efficiency policy measures covers a total of 88 countries, representative of all world regions (Figure 3.1):

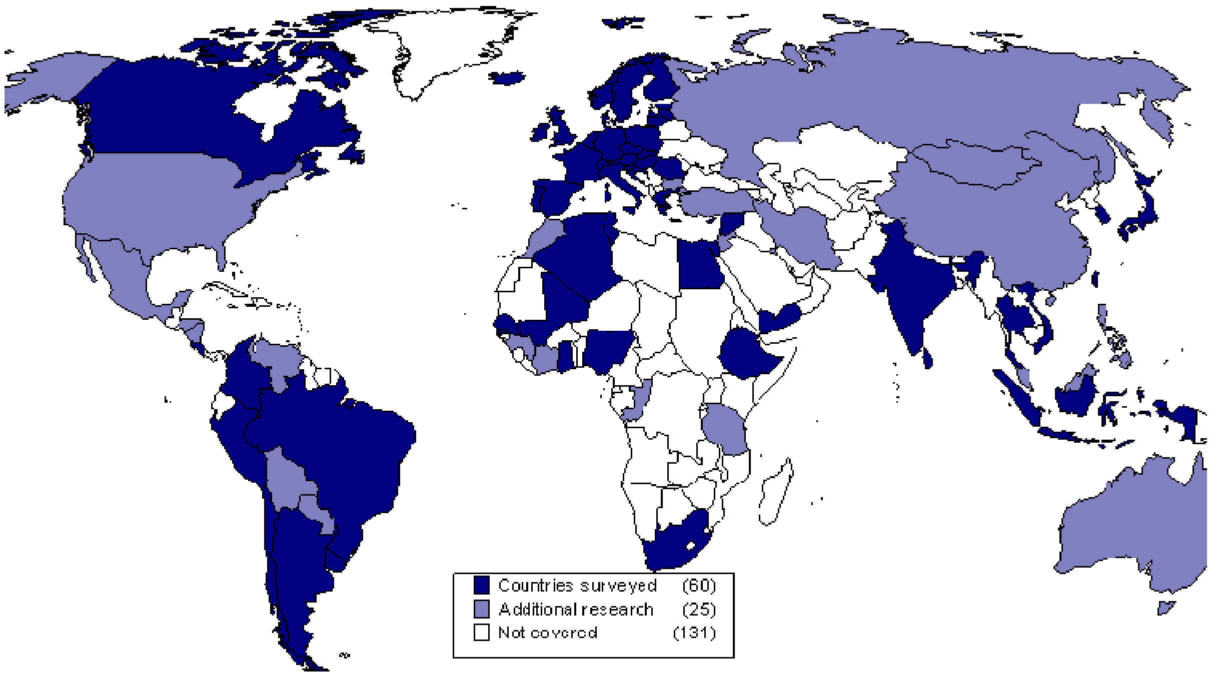
- **34 from Europe:** 27 countries from the European Union (EU), Croatia, Iceland, Norway, Russia, Serbia, Switzerland and Turkey;
- **15 from America:** Argentina, Brazil, Canada, Chile, Colombia, Mexico, Peru, the United States, Venezuela, Paraguay, Uruguay, Costa Rica, Bolivia, El Salvador;

[38] The following measures have already been evaluated in the previous reports: building codes, energy audits, labelling and standards of electrical appliances, incentives for cars, voluntary/sectoral agreements, local energy information centres, new energy efficiency financing schemes, packages of P&M 's., Energy Service Companies (ESCO's), energy efficiency obligation for energy utilities, measures for solar water heaters.

[39] The full reports of the experts are available on the WEC web site: http://www.worldenergy.org/wec-geis/wec_info/work_programme2004/tech/seep/reports.asp

[40] The survey is based on a questionnaire designed by ADEME and Enerdata and sent in 2009 to all WEC national committees and additional contacts from the ADEME's network of energy efficiency agencies in the EU, in North Africa, and in some OECD countries. In total 100 countries were contacted, 60 countries answered directly and 25 countries were completed by Enerdata from the previous survey of 2006 and from literature research.

Figure 3.1: Countries covered by the WEC survey on energy efficiency policies
Pays couverts par l'enquête CME sur les politiques d'efficacité énergétique



- **17 from Asia and the Pacific:** Australia, China, Hong Kong China, India, Indonesia, Japan, Malaysia, Mongolia, Myanmar, New Zealand, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Vietnam;

- **15 from Africa:** Algeria, Botswana, Cote d'Ivoire, Egypt, Ethiopia, Ghana, Guinea, Guinea Bissau, Kenya, Mali, Mauritania, Morocco, Nigeria, Senegal, South Africa, Tunisia;

- **7 from the Middle East:** Iran, Israel, Jordan, Kuwait, Lebanon, Syria, Yemen.

The surveyed countries represent altogether about 90% of the world energy consumption (100% for North America and Western Europe, 95% for Asia, 90% for Latin America, 75% for Africa and 50% for the Middle East).

In the sample, almost 70% of countries do not belong to OECD: this sample therefore gives a good representation of non-OECD countries. There is still a limited coverage of Africa but more countries are included this time (15 compared to 12 in 2006); there is a much better coverage of Latin America (13 compared to 7). Among the 29 OECD countries, 7 countries are outside Europe (in America, Asia & Pacific).

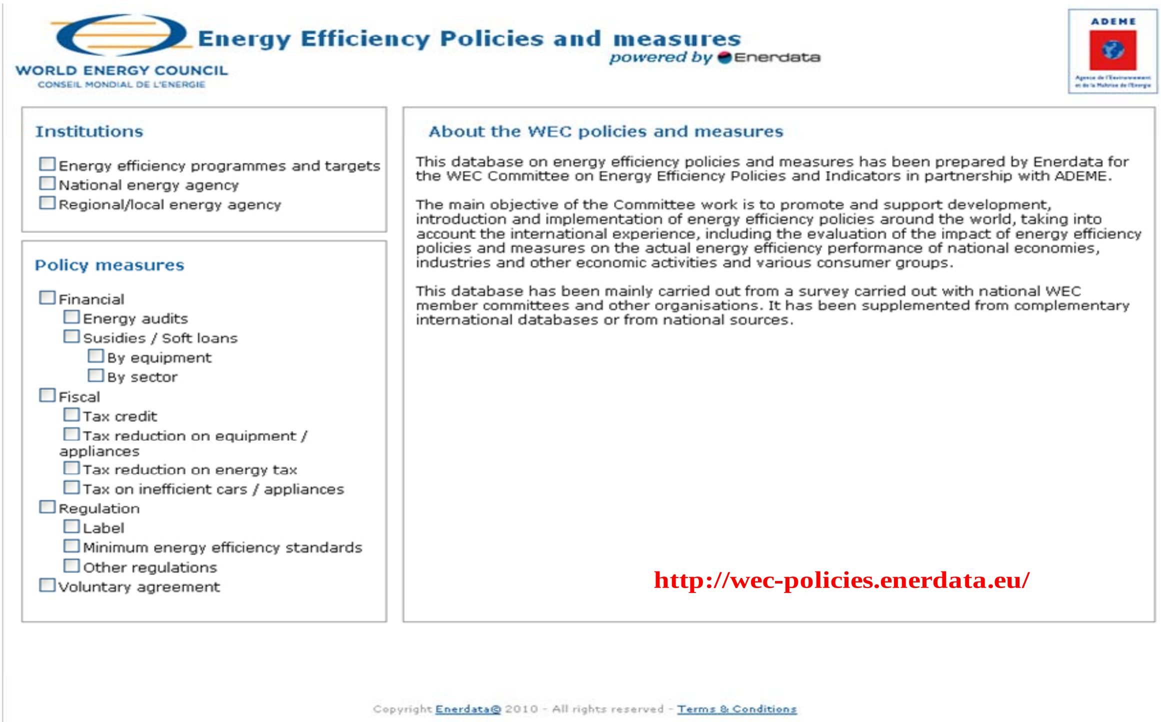
The survey covers institutional aspects, as well as existing regulations and financial measures. It also covers with a greater focus the selected energy efficiency policy measures mentioned above. The measures considered in the survey are organised as follows[41]:

Institutions and programmes

- Institutions: agencies (national, regional and local), Ministry department;
- National programmes of energy efficiency with quantitative targets and laws;

41 Measures to promote renewable energies and fuel substitution were not included. R&D activities, although important in the long term, are also excluded from the survey, as they are less important in developing countries.

Box 3.1: Interactive WEC data base on energy



Regulations

- Minimum efficiency standards and labels for electrical appliances (refrigerators, washing machines, AC, lamps, water heaters, motors), cars and buildings (new and existing)

- Other regulations for designated consumers: mandatory energy managers, mandatory energy consumption reporting, mandatory energy saving and mandatory maintenance

- Obligation of energy savings for energy companies at consumers premises;

Financial and fiscal measures

- Subsidies for audits by sector (industry, commercial, public, households, low income households transport)

- Subsidies or soft loans **(**i.e. loans with subsidised interest rates) for energy efficiency investment and equipment by sector

- Fiscal measures:
  - tax credit,
  - accelerate depreciation,
  - tax reduction for efficiency investment, by type of tax (import, VAT, purchase, annual car registration) and by type of equipment (appliances, cars, lamps,)
  -

Cross-cutting measures

- Innovative communication tools
- Voluntary agreements

The results of the survey are summarised in this report in different graphs, which show the degree of implementation of the measures in six world regions: Europe[42], North America and OECD Asia & Pacific[43], Latin America, Non OECD Asia, Africa and Middle East[44]. The results of the survey can be queried by type of measure, by target (i.e. sector, type of appliance) and by country from an interactive data base at http//wec-policies.enerdata.eu[45].

Although energy pricing is an important component of energy efficiency policies, this issue was not addressed in the survey, as there exist different international data base that enable to monitor price level and trends[46].

Adequate pricing is a necessary condition for promoting energy efficiency: this means establishing consumer energy prices that reflect the cost of energy supply, at least the present cost but better to future costs: the long-term marginal cost for electricity or the long-term price of oil products on international markets for fossil fuels.

The first step of any energy efficiency policy should be to adjust energy prices to the energy supply cost in order to give correct signals to consumers, to give them incentives to change their behaviour or to acquire energy efficient equipment and technology. Energy producing countries often maintain very low domestic price, which leads to intensive energy uses, as was seen previously by the high and increasing energy intensities in these countries. A reduction in the subsidies could save energy that could be sold at a much higher price on the international market and bring benefits to these economies. Many importing non OECD countries are also protecting their consumers from increase in the oil price by maintaining subsidised price for some fuels, which has a negative impact on public budgets, especially in the recent years with the soaring oil price. Subsidies on energy price can provide a significant disincentive for energy efficiency investments and limit the scope and profitability of energy service companies (ESCOs).

Taxation of energy may further contribute to internalizing the externalities (such as social cost, opportunity cost and scarcity cost) in the energy price, contributing thus to the realisation of the measures proposed in mandatory audits. Although most energy planners agree with such objectives, they often face reluctance and opposition from decision-makers outside the energy sector, who fear public resistance and the impact of energy price corrections on the consumer price index.

[42] Including Russia
[43] USA, Canada, Japan, Australia, South Korea, New Zealand.
[44] The percentages shown in the different graphs only apply to the countries that have responded to the survey: they are not an exact average of each region, except for Europe where the rate of answers was quite good. The countries are in addition not weighted according to their energy consumption.
[45] Synthetic tables are also given with all the detail by country/economy in various tables in Annex 2.
[46] For instance GTZ monitors motor fuel prices for all countries in the world in its publication: "International Fuel Prices", www.gtz.de/fuelprices ; (last update 2009). IEA provide quarterly energy prices for all OECD countries and a selection of non OECD countries.

Also, energy is a basic good for which a low price is a condition for access for low-income households. This makes actual price adjustments very slow or non-existent in many developing countries, especially in the household sector.

This part of the report is organised in different sections as follows:

1. Institutions and programmes;
2. Regulations;
3. Financial and fiscal incentives;
4. Energy savings obligations;
5. Role and importance of compliance for regulations;
6. Good practices in the public sector
7. Evaluation of smart meters policies
8. Energy efficiency measures for low income households
9. Innovative communication/information tools from utilities or energy agencies

Institutions and Programmes

There are three main questions related to institutional aspects of energy efficiency policies and their implementation. Firstly, what are the institutions supporting the implementation of programmes in the different countries? Secondly, what are the countries with national and regional energy efficiency agencies? Thirdly, are such agencies necessary to sustain national efforts to improve energy efficiency?

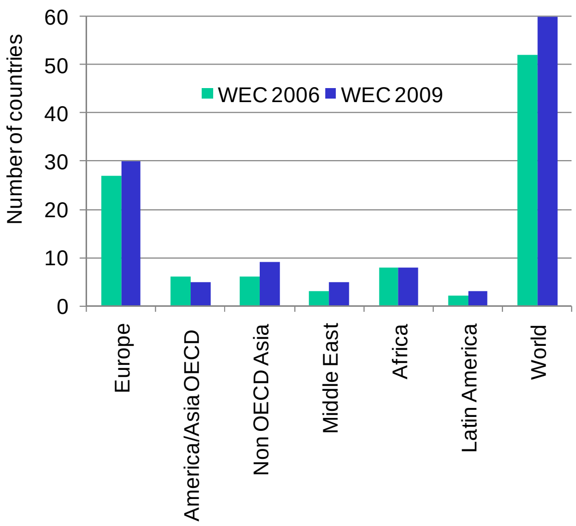
In addition, countries are increasingly setting up quantitative targets to be achieved in the framework of their energy efficiency programmes, which shows a stronger commitment to energy efficiency. Therefore the analysis of programmes will assess the degree of institutionalisation of energy efficiency measures, through an energy efficiency law or a national programme approved by the parliament.

Energy efficiency agency

Two thirds of the surveyed countries have set up a national energy efficiency agency

Energy efficiency programmes implementation almost always requires a dedicated technical body able to reach scattered and multiple energy consumers. Some measures, such as energy pricing or transposing international standards may however be implemented without a specific energy efficiency institution. About two thirds of the surveyed countries have a national energy efficiency agency and over 90% a Ministry department dedicated to energy efficiency (**Figure 3.2**). The number of countries with an energy efficiency agency is increasing over time, from 50 in 2006 to 60 in 2009.

Figure 3.2: Countries with an energy efficiency agency[47]
Pays avec une agence d'efficacité énergétique



Source: WEC/ADEME survey

An energy efficiency agency is defined here as a body with strong technical skills, dedicated to implementing the national energy efficiency policy, as well as in some cases the environmental policy. Such agencies are usually separated from ministries, but may be part of a Ministry, as in Denmark, Canada, the US or the Philippines. In Europe, most of the countries have a national energy efficiency agency; several countries have created a new agency since 2000, such as Germany, Norway and Estonia. In some countries, these agencies also cover environmental issues (e.g. France, the Netherlands). Energy efficiency agencies are increasingly recognised in the EU as necessary instruments to foster energy efficiency policies. The European Commission has recently set up a new agency dealing with the management of EU programmes on energy efficiency and renewables, the Intelligent Energy Executive Agency (IEEA).

Energy efficiency agencies have the mission and capabilities, first of all, to design, implement and evaluate programmes and measures, to contract a range of stakeholders, such as companies, local authorities, or NGOs and, finally, to ensure coordination with higher or lower levels of authorities (international, national, regional and local).

These agencies are usually public institutions funded by the State budget, and in developing countries are often supported by overseas technical assistance funds. In an increasing number of countries, part of the budget is based on a tax on energy (e.g. Norway, Spain, Switzerland, Thailand, Tunisia) and some countries have set up agencies with private sector participation (e.g. Morocco, Portugal), whilst others are expecting their agency to operate as a partially private body that has to earn income.

In countries with a federal or decentralised structure, such as Spain, Germany, Belgium, the US, Canada, China or India energy efficiency agencies have been set up by regional administrations. In addition, many countries have

[47] Based on the sample of countries surveyed; Mexico is included in America/Asia OECD. Europe includes Russia and Turkey.

set up local or regional agencies[48], especially in EU countries[49] have set up local agencies or regional agencies. In 2009, about 60% of the countries had regional or local agencies, compared to 50% in 2006: it is estimated from the survey that there exist now about 1300 of local and regional agencies at world level, of which about 900 in Europe (against 600 in previous survey). These regional and local agencies aim at providing more targeted measures, as they are closer to consumers and better able to take into account regional circumstances (climate, energy resources, etc.). They are complemented in this action by local information centres that many countries have set up. EU now accounts for about 800 information centres and agencies dealing with energy efficiency. At world level, half of the countries have local or regional agencies.

The primary objective of all these institutions is to provide technical expertise to governments and consumers, something that cannot always be found in existing institutions. As often, the lack of quality of energy efficiency equipment and services is often seen as an obstacle to their good diffusion, energy agencies can play a role in that field by certifying those which have the required quality. Government ministries do not, in general, have the required expertise to carry out all the activities of energy agencies.

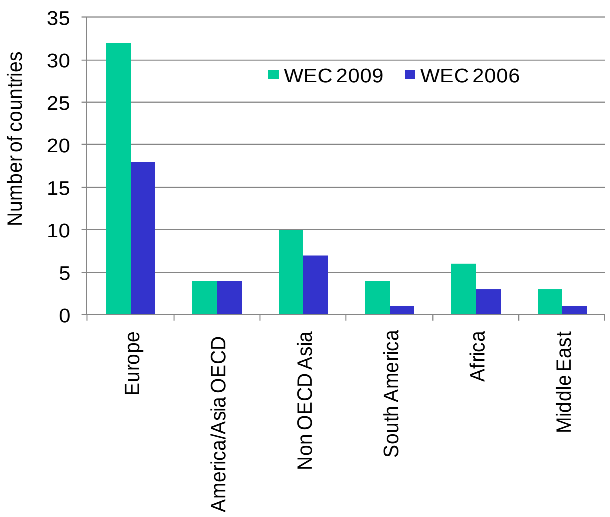
Another important function of energy efficiency agencies is to act as a promoter of energy efficiency in front of energy companies. Electric utilities, although very active in some countries, remain above all in the business of selling electricity and thus do not necessarily have a strong enough interest in energy efficiency over the long-term, especially in the context of a growing competition. There is, therefore, a need for agencies to deal with energy efficiency on a long-term basis. Yet another function of energy efficiency agencies is to act as a coordinator of all governmental initiatives in the field of energy efficiency to avoid scattered and uncoordinated actions by different ministries. In particular, the existence of such agencies has proved very useful in negotiating sectoral agreements with groups of consumers or equipment producers to reach specific targets for efficiency improvements.

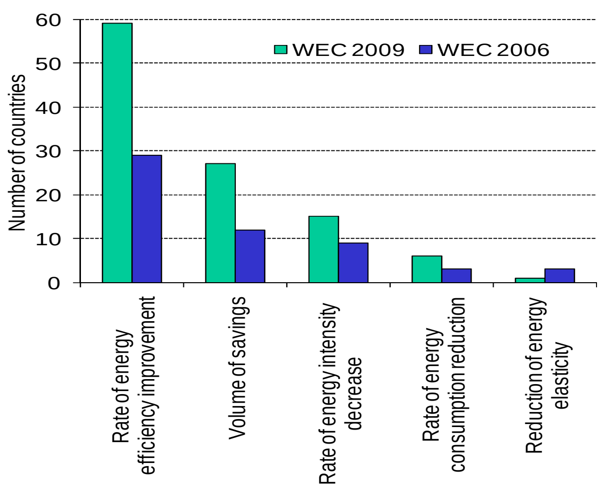
In countries that receive aid from international development assistance programmes, such agencies can in addition act as the national counterpart with whom donors negotiate the implementation of financial packages for energy efficiency. More generally, such agencies can be the counterpart to financial institutions to develop new funding schemes.

The fact that most countries have set up an energy efficiency agency is in a way an empirical justification of their usefulness.

[48] In some countries with a national energy agency, regional offices have been set up (e.g. ADEME in France with 28 offices or ARCE in Romania with 16 branches).
[49] Very often with the support of the Energy Intelligence for Europe programme of the European Commission that provides funding to the agencies

Figure 3.3: Countries with quantitative target and mode of expression of the targets[1]
Pays avec des objectifs quantifiés et mode d'expression des objectifs





Source: WEC/ADEME surveys

3.5.3 National energy efficiency programmes and laws with quantitative targets

Twice more countries than in 2006 have now set quantitative targets in their energy efficiency programmes

Increasingly, countries adopt national energy efficiency programme with quantitative targets: this is now the case of 70% of the countries surveyed in 2009, with 60 countries, which represents almost a doubling compared to 2006 (35) (left part of **Figure 3.3).** The progression can be observed in all regions, and especially in Europe in relation to the EU Directive on End-use Efficiency and Energy Services that imposes to all member countries a rate of energy savings of 9% over the period 2008-2016[50]. This reflects more ambitious policies. In the EU exist monitoring and reporting obligations[51].

In some countries, such as Bolivia, Brazil, China, Colombia, India, Mexico, the Philippines and Peru, an energy efficiency law has been adopted only recently (since 2000). Such laws and programmes ensure a certain continuity of public efforts and a better co-ordination of the various actions and measures taken.

The targets are expressed in very different ways depending on the country. The target may refer first of all to a rate of energy savings or efficiency improvement, which is the most popular target used in about 60 countries (compared to 30 in 2006) (**Figure 3.3**)[52]. This is the case of all EU countries with the Energy Service Directive, New Zealand, Japan, Vietnam.

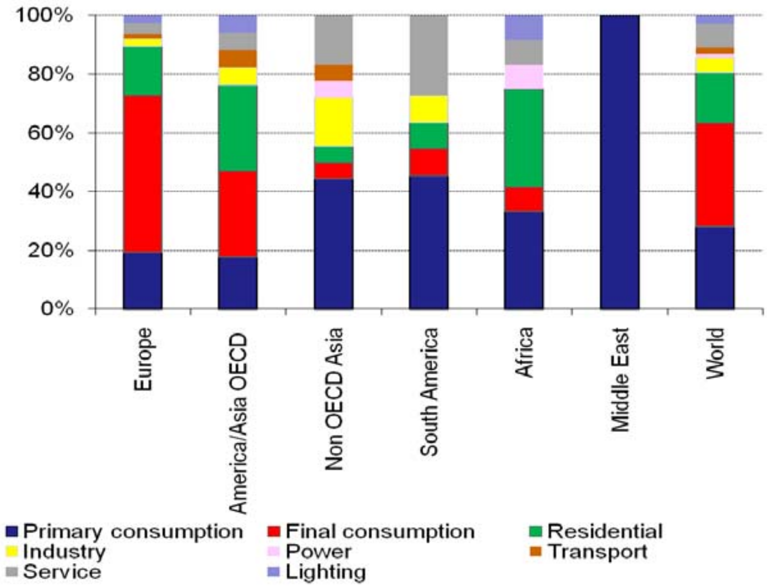
The second type of target considered by some countries is to aim at achieving a specified volume of energy savings (in GWh or Mtoe). This is the case for instance of Belgium, Denmark, Spain,

[50] This target of 9% has to be calculated in relation to the average final energy consumption over a 5 years period preceding the start of the Directive.

[51] In the EU countries must submit an energy efficiency plan, called NEEAP and must report regularly the achievements to the European Commission.

[52] The number of countries is different from the left part as some countries have several targets (i.e. a target on energy savings and one on the energy intensity, as in Tunisia for instance).

Figure 3.4: Targets of energy efficiency programmes by sector
Objectifs des programmes par secteur



France, Ireland, Poland, Italy, UK, Norway, Brazil, Uruguay, China, India, Iran, Sri Lanka, Philippines, Thailand, Algeria, New Zealand, and Tunisia[53].

About two-thirds of targets on total energy consumption (final or primary) and one third of sectoral targets.

At world level, one third of programmes have a target on the final energy consumption and slightly less than 1/3 on the primary energy consumption (**Figure 3.4**). About one fourth of the targets relate to the household and service sector (17% for households and 8% for services). The focus of the targets are quite different according to world regions: final consumers are the primary target in Europe while other regions give a priority to the primary energy consumption[54].

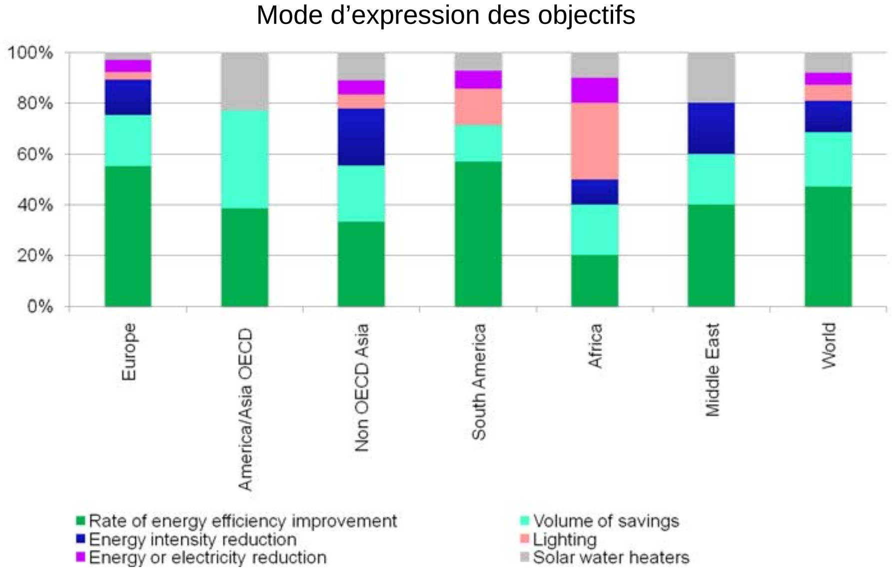
In all regions, except Africa, there is a predominance of target on energy efficiency improvements or energy savings (about 60-80%); in America/Asia OECD, there are more targets on volume of savings (**Figure 3.5**). Targets on energy intensity reduction (i.e. in terms of energy productivity progress), which used to be the main mode of expression of policy target are no longer popular. Some countries have chosen to achieve a rate of reduction in the energy consumption (%) (e.g. Finland, Switzerland, Korea). Slightly over one third of the countries have multiple targets (of which 2/3 are in Europe).

In addition to these targets on energy efficiency many countries have targets for renewables and, for Annex 1 countries of the Kyoto Protocol, targets on GHG emissions.

[53] Some of these targets include the energy savings obligations imposed to energy companies (see below the section devoted to such obligations) (e.g. France, Italy, UK). Targets in terms of rate of energy savings can usually be expressed in a volume of energy savings if they are calculated in relation to a fixed consumption; this is the case of EU countries where the 9% savings in 2016 translate into a volume of energy savings; in the graphs, these targets have been included under rate of energy savings as it was the original mode of expression of the target in the Directive.

[54] The difference is that a target on final energy consumers will give a higher priority to end-use sectors (i.e. industry, transport and household and services) whereas a target on primary energy consumption will also include savings in the transformation sector, mainly in the power sector, which may come from various actions, including the use of renewables.

Figure 3.5: Mode of expression of policy targets by region



Source: WEC ADEME survey, 2009

3.1 Regulations

Regulations are widely used as they have been proven effective in lowering energy consumption of specific appliances and equipment and in speeding up the diffusion of energy efficient equipment, energy savings investments and practices.

Regulations are mainly used in the residential and service sectors (80% of all regulations in Europe, of which 50% for households) (**Figure 3.6**). This is not surprising as regulations are more powerful than traditional incentives to transform the market in these sectors by limiting the choice of consumers; indeed the impact of incentives depends on the effective changes of behaviours of millions of consumers that lack information and resources to act.

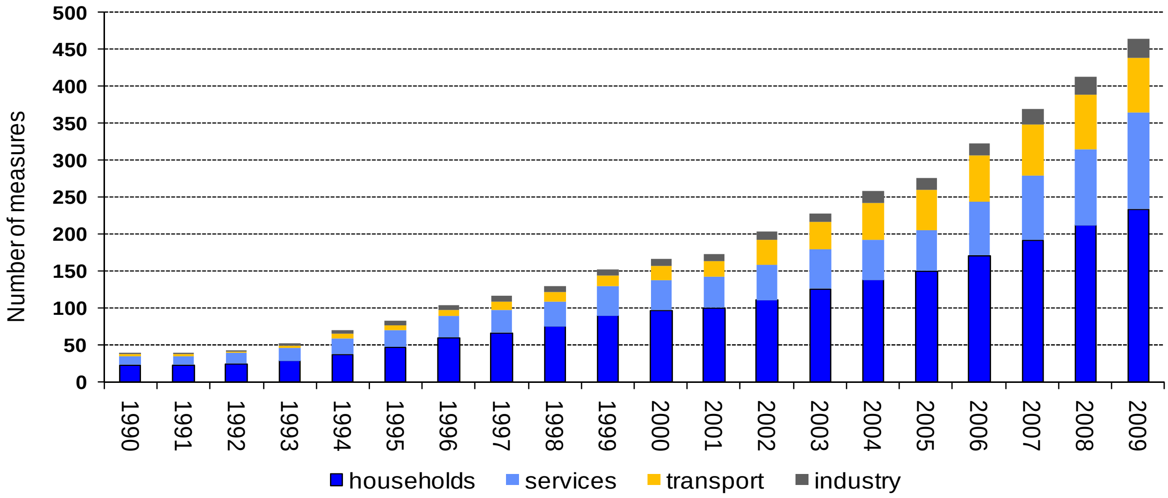
In general, regulations aim either to impose minimum efficiency standards by law and/or governmental decree, or to impose energy efficient practices, as well as to provide systematic information to consumers (e.g. energy audits, labels). Regulations and standards can therefore be classified into 3 main categories[55]:

- Mandatory labelling for new appliances, new cars and buildings[56]
- Minimum energy efficiency standards (MEPS) for new appliances and lamps[57], new cars, new buildings and more recently existing building[58]

Other regulations, such as obligation of maintenance (e.g. boilers, air conditioners, cars), obligation for designated consumers (mainly in industry and for large buildings) of energy managers, energy consumption reporting, of energy audits, of energy saving plans and finally, obligation for energy utilities to make energy savings with their consumers ("energy savings obligation").

[55] There are also regulations which are not specifically targeted at energy efficiency, but which can nonetheless influence energy efficiency (e.g. speed limits, maximum weight of trucks).
[56] For buildings they are often called energy efficiency certificates.
[57] The interdiction of incandescent lamps falls into that category.
[58] Usually they refer to maximum specific consumption for existing buildings (linked or not to renovation).

Figure 3.6: Number of regulations per sector in EU countries
Nombre de réglementations par secteur

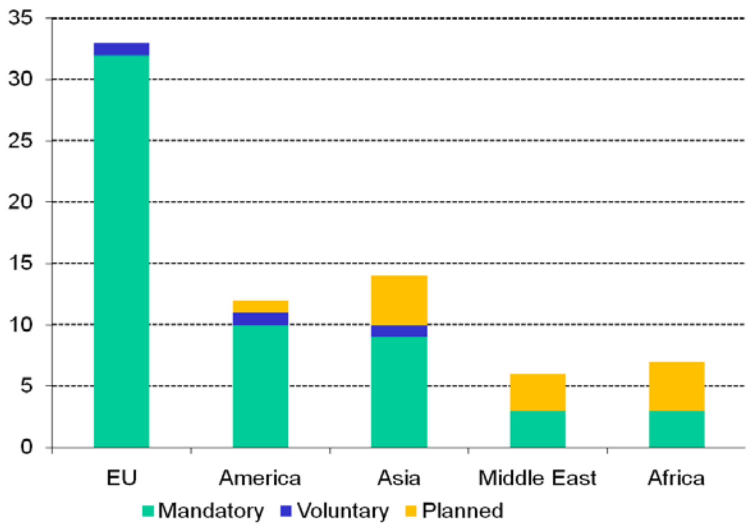


Source: MURE data base www.mure2.com

In Europe, most of the regulations relate to energy efficiency standards (about 70% in Europe). In developing and emerging countries, labelling is more frequent and is often among the first measures to be introduced, generally for refrigerators. Labelling aims at encouraging consumers to purchase more efficient appliances and manufacturers to remove inefficient appliances from the market. Labels are now extended from new electrical appliances to cars and buildings to point out their energy efficiency performance (or CO2 emissions).

Around 60 of the surveyed countries have label schemes **(Figure 3.7)**.Ten more countries have already planned the introduction of labels. These labels are mandatory in most countries (90% of countries); some countries however have favoured a voluntary approach which is usually just a transition phase before making them mandatory. Labelling is well developed for refrigerators in Latin America. In Africa and The Middle East, labelling is not yet well spread but often planned.

Figure 3.7: Number of countries with labels [59]
Nombre de pays avec des étiquettes énergie

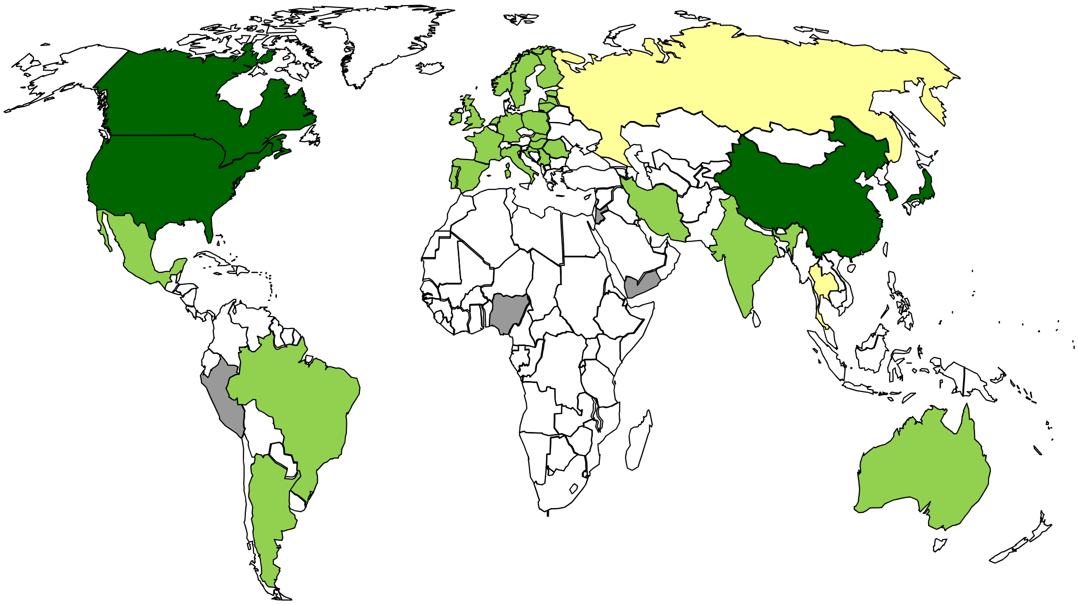


Source: WEC ADEME survey, 2009

Regulations can be set at the national level, at the level of a group of countries (e.g. the case of Directives in the EU), or at the level of a sub-national region inside a federal country (e.g. California in the US).

[59] Labels are implemented for electrical appliances, buildings, dwellings, cars.

Figure 3.8: Diffusion of labels on electrical appliances
Diffusion des étiquettes énergie pour les appareils électroménagers



3.2.1 Labelling and Efficiency Standards for Household Electrical Appliances

To slow down or even reverse the trend in the electricity consumption of households, as described in the previous chapter, many countries have introduced labelling programmes and minimum energy performance standards for a selection of electrical appliances. Labelling programmes are designed to provide consumers with information, which enables them to compare the energy efficiency of the different appliances on sale. They aim at modifying the selection criteria of consumers by drawing their attention to the energy consumption of household appliances. Labelling also acts as an incentive for manufacturers to differentiate themselves from their competitors and stimulates the introduction of new, more efficient models

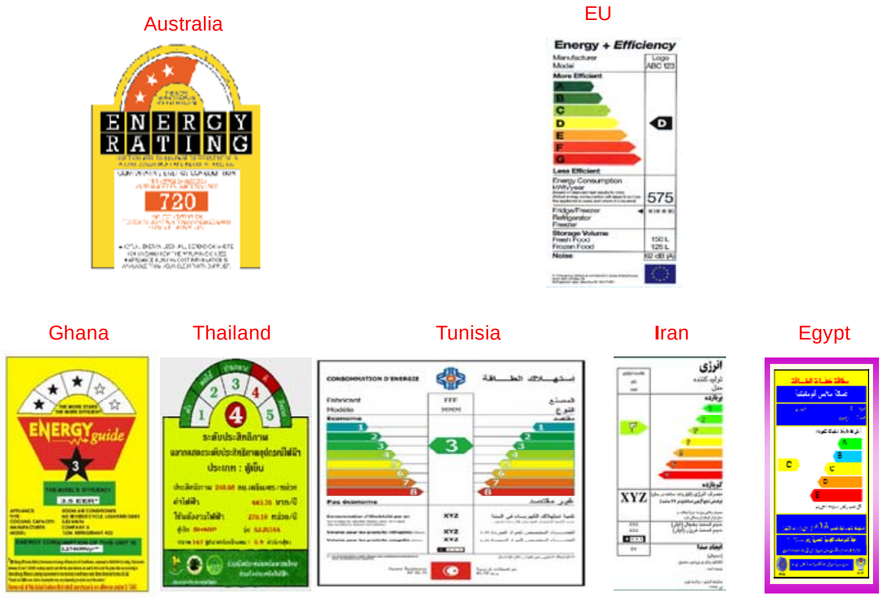
Mandatory labelling of electrical appliances exists in 54 of the surveyed countries (**Figure 3.8**). Five countries have in addition voluntary labels [60]and 9 countries are planning their introduction[61], which means that about 70 countries should have a label scheme end of 2010. Most countries first focused on refrigerators, along with air conditioners in certain countries, since they account for a large part of the household electricity consumption. Now labels cover a greater number of equipment: lamps and lamp ballasts, washing machines, dryers, dishwashers, water heaters, boilers, computers, rice cookers, tyres, glazing...Some countries have labels for a large number of appliances: 5 countries have mandatory labels for more than 10 appliances (Canada, Japan, China, South Korea, USA) and 34 for more than 5 appliances[62]. In EU countries as well as in OECD Asia and America, all of the countries have labels for refrigerators; in Africa, the Middle East and non OECD Asia, labels are not widespread: they exist for refrigerators in less than 20% of the surveyed countries.

Mandatory labels have proven more effective than voluntary labels since they require manufacturers to put labels on all appliances and not just on the most energy efficient ones. In most developing countries, second hand appliances take a large market share of the appliances sold, which reduces

[60] Voluntary labels in Russia, Peru, Uruguay, Indonesia, Taiwan, depending on appliances and sectors
[61] Labels are planning in countries such as Columbia, Thailand, Vietnam, Algeria, South Africa, etc

[62] This is the case of EU countries, where there exist mandatory labels for 9 electrical appliances based on the same regulations (EU Directives): they include refrigerators, freezers (and their combinations), washing machines, dryers (and their combinations), dishwashers, water heaters and hot-water storage appliances, air conditioners, lamps, and ovens.

Figure 3.9: Examples of energy labels



Exemples d'étiquettes énergie

the impact of a labelling restricted to new appliances.

Labelling programmes introduced in developing countries are based on the experience of OECD countries and use models that have already been proven: for instance, the European label has been used as a model in Brazil, Tunisia, Egypt, China or Iran, while labels introduced in Thailand, Ghana or the Korean Republic are based on the Australian model[63] (**Figure 3.9**).

Labelling programmes cannot alone transform the market and are usually completed by minimum performance standards in the great majority of countries. The aim of performance standards is to improve the energy efficiency of new appliances either by imposing a minimum energy efficiency rating to remove the least efficient products from the market - Minimum Energy Performance Standards (MEPS) - or by requiring sales-weighted average energy efficiency improvements ("target values") (e.g. "Top Runner Programme" in Japan)[64]. Target values are more flexible as they allow the sale of less efficient equipment provided other models with a higher efficiency rating are also offered for sale.

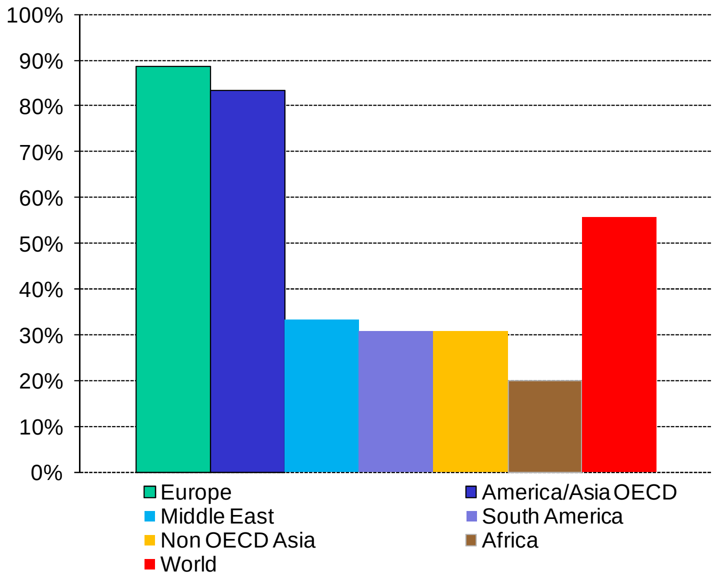
As an alternative to the regulatory process, also exist agreements with appliance manufacturers, which also aim to improve the energy efficiency of appliances (e.g. agreements with CECED for washing machines in the EU[65]). Some countries even moved from unsuccessful voluntary agreements to MEPS (e.g. Brazil). Voluntary agreements can be an effective alternative to minimum energy efficiency standards. Since they have the support of manufacturers, they can be implemented more rapidly than regulations. Nevertheless, their effectiveness is still dependent on the possibility of imposing precise requirements

[63] The Energy Rating Label is mandatory for all appliances sold in Australia. There are labels for refrigerators and freezers, clothes washers and dryers, dishwashers, air conditioners and televisions.

[64] The Top Runner Program sets target standard values for the energy efficiency of equipment: the manufacturers are obliged to surpass a weighted average value for all their products for each target year.

[65] Commitment by CECED (European Committee of Domestic Equipment Manufacturers) to reduce by 20% the average consumption of washing machine over 1994-2000 (from 0.30 to 0.24 kWh/kg), followed by a second commitment for 12% additional savings by 2008 (33% total savings compared to 1994). Similar agreements have also been signed in the EU for dishwashers, electric water heaters, TVs and VCRs in standby mode.

Figure 3.10: Diffusion of Minimum Energy Performance Standards for new refrigerators
Diffusion des normes d'efficacité pour les réfrigérateurs



Source: WEC Survey

corresponding to genuine additional efforts from industry.

Standards are necessary to remove certain inefficient but inexpensive products from the market, which labelling programmes alone cannot do. They are also needed in areas where the selection criteria of consumers totally exclude energy efficiency (television sets for example), or when the economic stakes for the consumer are very limited. Basically, labelling stimulates technological innovation and the introduction of new more efficient products, while standards organise the gradual removal from the market of the least energy efficient appliances.

In OECD countries (Europe, America and Asia), standards for refrigerators exist in almost 90% of the countries (**Figure 3.10**). In developing and emerging countries, MEPS for refrigerators are not yet well spread: about one third of the countries surveyed in Latin America, Asia and The Middle East and 20% in Africa. For some countries, MEPS are voluntary for refrigerators (e.g. Russia, Columbia, Venezuela, Peru, Japan and Lebanon).[66]

In OECD America and Asia, as well as in China and more recently in the EU, MEPS are imposed on a large number of appliances (more than 40 in Canada[67] and 25 in China[68]). In Japan and Russia, MEPS are voluntary for appliances. In EU countries, MEPS existed for refrigerators, freezers and water heaters since 1996. With the Eco-design directive adopted in 2005, minimum efficiency standards will be extended for up to 40 products in all sectors[69] . MEPS for 9 of these product groups have already been published[70].

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[66] MEPS for new refrigerators are planned in some African countries such as Senegal, Ghana, Ethiopia, or in Vietnam, Sri Lanka or Brazil.
[67] The number of appliance with standards increased from: 2 in 2001, 6 in 2003, 12 in 2004, 22 in 2006, 34 in 2008 and 44 end of 2009, of which about 30 in the residential sector. Following a new amendment, new products will be concerned in 2010 raising the total number of products with standards to almost 60 covering 80% of the energy used in homes and businesses.
[68] China has had various standards and labels since 1989 when China first adopted MEPS. Currently there are MEPS for 25 appliances and 50 products with a voluntary endorsement label (based on the US Energy Star).
[69] http://www.eceee.org/Eco_design/products
[70] Among which, lighting ,with the implicit phasing-out of incandescent light bulbs, stand-by of IT appliances, electric motors, pumps etc.

Labelling programmes and performance standards are effective instruments, which enable authorities to obtain energy savings at a low-cost for the public budget, consumers to spend less on electricity and manufacturers to improve their products and become more competitive against imported, less efficient products. As shown by various studies, the increased diffusion of more efficient appliances did not result in a price increase for the consumers, as producers were able to adapt and to benefit from the increased sales ("learning effect") and as at the beginning there was no correlation between the price of appliance and their energy rating.

The European and Australian programmes are considered successful. In the EU for instance, there was a rapid increase in the market share of the most energy efficient appliances: sales of refrigerator in the most efficient classes (A and above) increased from less than 5% of total sales in 1995 to 23 % in 2000 and 86% in 2007; with 19% of refrigerators sold in 2007 in the two new more efficient class (A+ and A++). For washing machines, the progression was even more rapid (1% in 1996, 38% in 2000 and 97% in 2007, with 40% of class A+ in 2007). This successful market transformation that can be attributed to several complementary factors: the increased interest of consumers in energy efficiency, changes in the models made available by manufacturers, and other accompanying measures (rebates, information campaigns[71]). The effect of labelling was reinforced by the progressive introduction of MEPS for refrigerators and by the agreement with CECED for washing machines. In anticipation of standards, manufacturers withdrew their less efficient models that had become hard to sell and introduced new more efficient models to meet new demand and to differentiate themselves from their direct competitors. The average energy consumption of refrigerators fell from 370 kWh/year in 1990 to around 300 kWh/yr now[72].

In the US, minimum performance standards on the energy efficiency of household appliances also had a large impact[73]. For instance, the average consumption for cold appliances has decreased from 1726 kWh/year in 1972 to 490 kWh today. In Australia, there was a 40% drop in the average specific energy consumption of refrigerators since 1993.In Japan, the top-runner programme resulted in a reduction of the specific consumption of refrigerators and freezers from 946 to 232 kWh/year between 1991 and 2003 (75% saving at a rate of more than 10%/year)[74].

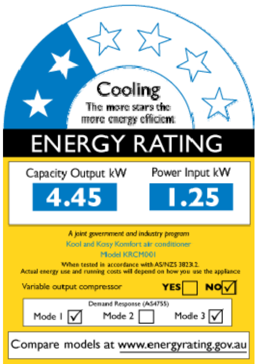
[71] The different penetration of level A, A+ appliances among EU countries is to a large extent due to the existence of accompanying measures, with the Netherlands, Germany or Sweden recording a penetration much higher than the EU average.

[72] Source Odyssee project www.odyssee-indicators.org

[73] The progress is more spectacular than in Europe, since appliances were less efficient at the outset and regulations older.

[74] Source ECCJ, What is the top-runner programme? http://www.asiaeec-col.eccj.or.jp/top_runner/index.html

Figure 3.11: New labels in Australia and in the EU
Nouvelles étiquettes en Australie et dans l'UE



Labels and standards need to be changed regularly

To be effective, labelling programmes and performance standards must be regularly revised and upgraded. In the US, changes in the energy efficiency of cold appliances clearly show that energy efficiency improves as a result of new standards but then stabilizes[75]. Faced with new standards, manufacturers adapt the appliances available on the market so that they meet the new minimum requirements, but there are no incentives for them to go beyond what is required if no stricter standards have been planned for the future. In the same way, for labels, there is no longer any incentive to innovate when all the models are in the best efficiency classes or when most of the models on the market have been endorsed with a label (Energy Star programme in the US). Therefore it is essential to reinforce labels and standards at regular intervals as a way of stimulating technical progress and ensuring a steady improvement in energy efficiency.

For instance, in the EU, in front of the success of the labelling for refrigerators and freezers with a great majority of new appliances corresponding to the most efficient class A, the EU split class A in 3 classes in July 2004, A, A+ and A++. A new revision applying to all appliances will take effect in January 2011. Under the new system, appliances better than A-rated would be classified as A-20% and A-40%, for products using 20% and 40% less power than A. In Australia, a new label came into force in April 2010 to better reflect the size of refrigerators (**Figure 3.11**).

Table 3.1 illustrates in the case of EU countries, Canada and Australia this dynamic adaptation of MEPS. In general, changes are announced in advance so as to provide the right signals to the manufacturers. In the EU, changes in MEPS are now directly linked to label class, which reinforces complementarities between labels and MEPS. In the case of Australia, the way the standards are stated has changed over time.

[75] The periods during which energy efficiency ratings improved the most correspond to periods when new or reinforced standards were introduced while little or no improvement was observed for the periods in between: after the introduction of minimum energy performance standards (MEPS) in 1993 and 2001, specific energy consumption dropped 20 % each time.

Table 3.1: Change in minimum efficiency standards for appliance: a dynamic approach

	Refrigerators & freezers	Washing machines
EU	1999 (removing above D)	
EU	2010 (removing classes B and C)	2010 (removing classes B and C)
EU	2012 (removing class A)	2013 (removing class A)
EU		Removing class A
Canada	2001	2004
Canada	2006	2008
Canada	2009	
Australia	1999	
Australia	2005 (revision: model average)	
Australia	2010 (maximum permitted specific consumption)	

Evolution des normes d'efficacité pour les équipements : approche dynamique

The "Top Runner" programme has been designed so as to integrate the dynamic aspect of regulations. It has the particular advantage of making easier the definition of new targets. As the most efficient appliances on the market at a given time are used to set the future standards, there is no need for extensive market or techno-economic analysis to set the minimum energy efficiency standards. With this type of approach, the preparatory work may be shortened and the negotiations between manufacturers and public authorities facilitated as the target corresponds to existing appliances that are already available on the market. Presently, the top-runner programme cover 18 energy intensive products, of which the main household appliances and passenger cars. The savings achieved for new appliances are impressive: for instance 68% for air conditioners, 55% for refrigerators (between 1997 and 2004), 26% for TV. The expected energy efficiency improvement for 2010 is 21.0% for refrigerators and 22% for air conditioners compared to 2005[76].

Labelling and Standards for Buildings

Mandatory efficiency standards for new buildings very well spread in Europe

Most European countries have set up mandatory energy efficiency standards for new dwellings and service sector buildings. In almost all the other OECD countries in Asia and America, there exit mandatory standards[77]; for Canada, South Korea, the standards for buildings or dwellings are voluntary (**Figure 3.12**). Some non-OECD countries outside Europe have recently established mandatory or voluntary standards for service buildings: Singapore and the Philippines were among the first, followed by Algeria, Tunisia, Taiwan, Malaysia, Egypt or Syria for instance[78]. In most countries, standards exist for both dwellings and service sector buildings, except in Africa and in Asia where most often standards only apply to non-residential buildings[79]. The situation in these two regions is explained by the fact that commercial buildings account for the largest share of energy consumption. Altogether, about 50% of the countries surveyed had mandatory or voluntary standards for new non-residential buildings.

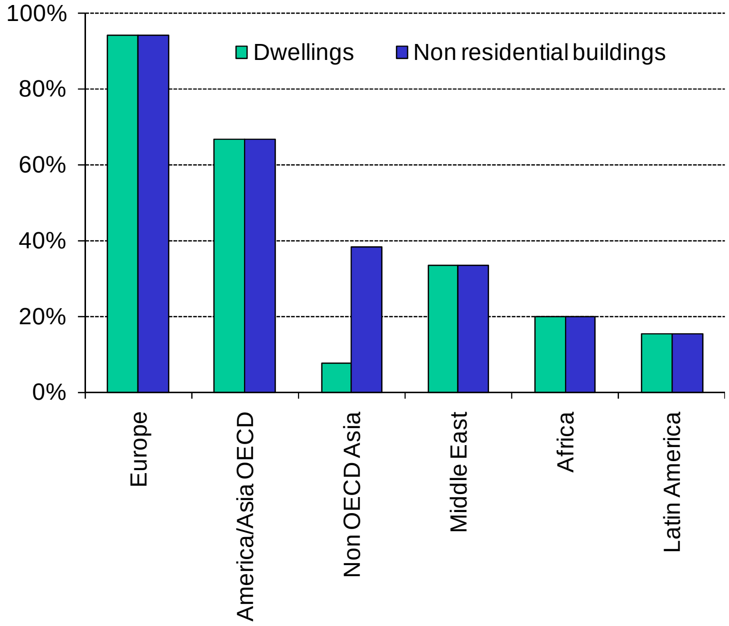
[76] Source: ECCCJ, http://www.eccj.or.jp/top_runner/index_contents_e.html

[77] In the United States, in 2009 the US House of Representatives passed the **American Clean Energy and Security Act of 2009 (ACES), which mandates a new national building energy code** and provides for federal enforcement in state and local jurisdictions that cannot or will not comply

[78] Voluntary standards for South Africa, India, Indonesia, for instance.

[79] There are of course some exceptions, such as China, Egypt and Algeria, which have also have implemented standards for dwellings.

Figure 3.12: Countries with efficiency standards on new buildings
Pays ayant des normes sur les bâtiments neufs



Source: WEC/ADEME Survey

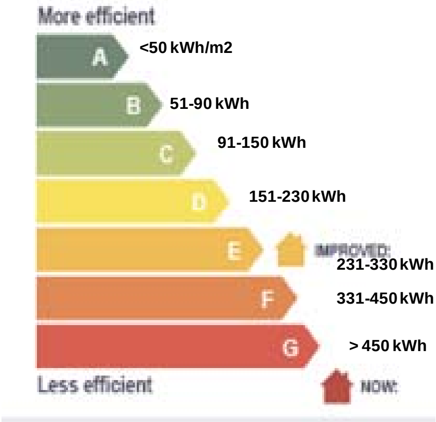
Thermal building codes have been changing over time from simple standards on building components to more complex standards, including for the most advanced countries energy performance standard[80]. These performance standards consider the whole building as a system and integrate also building equipment such as heating and air conditioning systems, ventilation, water heaters, and even in some countries pumps and elevators (maximum energy consumption per m^3 or m^2/year). Most building codes now are performance based (e.g. present standards in California, all EU countries with the Energy Performance Building Directive EBPD). These types of standards can 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.

Revisions in thermal building codes have become increasingly regular. For instance, over the past 30 years, standards have been reinforced three to four times in most EU-15 countries and independent from the oil price level. Most EU countries have reinforced their standards since the year 2000, with the implementation of the EPBD Directive. In addition, this directive has for the first time provided for a mandatory revision every five years.

Relatively few countries have carried out evaluations of their building codes. According to the few studies available, it seems that the actual energy performance of new buildings are below what could be expected from the building regulations. Such a situation can be explained by behavioural factors (such as higher heating temperatures, more rooms heated, or longer heating period over the year) and by a non-compliance with the building regulation. Only a few countries have estimated the additional costs that

[80] Building standards can be basically classified in four categories (see 2001 WEC report on energy efficiency):
i) maximum heat transfer through individual building components (e.g. walls, roof, windows) (k or U values in terms of W/m^2K); ii) limit on the overall heat transfer through the building envelope; iii) limitation of heating/cooling demand (taking into account the contribution from ventilation losses, passive solar gains and internal heat sources) (maximum demand per m3 or m2); iv) energy performance standards

Figure 3.13: Energy efficiency certificate for buildings: case of France
Certificats d'efficacité énergétique pour les bâtiments : cas de la france



each round of new building codes has caused. Nevertheless, from the few results available, the additional costs are limited to a few percentage points, if any at all.

Measures on buildings focused so far on new buildings. As new buildings represent a small share of the existing stock[81], buildings standards can only have a slow impact on the short term, which is however significant on the long-term. A more recent trend is to extend regulations to existing buildings and impose minimum standards in case of renovation (e.g. in the EU in 2006/ 2007 with the Directive on Buildings) and the production of energy efficiency certificates for existing buildings, each time there is a change of occupant or a sale. These certificates enable consumers to obtain information about the energy consumption of the dwelling they are going to buy or rent (**Figure 3.13).** Such a measure may be powerful if the information provided is accurate and effectively displayed

Car labels for fuel consumption and CO_2 emission

Introducing labels for new cars, which display information on fuel consumption and/or CO_2 emission, is a relatively simple measure, provided that most car manufacturers on the global market have such information already available and standardised test cycles (like those established in the European Union) are being applied. It is advisable to promote such labelling schemes with adequate information campaigns and eventually promote low-consumption cars through fiscal or financial incentives. Fuel efficiency and CO_2 labelling schemes exist now in all EU member countries following a European Directive. They are also effective in around 10 other countries such as Australia, Brazil, Canada, USA, India, South Africa, New Zealand, South Korea, Japan, China.

The EU Directive (1999/94/EC) obliges car manufacturers and distributors to display information on fuel consumption and CO_2 emissions of new passenger cars in showrooms and within any marketing activity. It also makes it mandatory to publish annual guides on fuel economy and CO_2 emissions for all new car models available on the market.

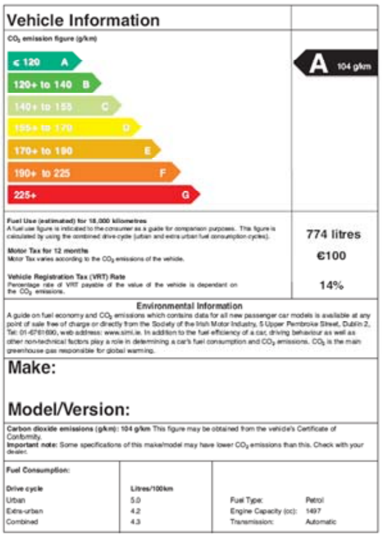
The labels include mandatory data on CO_2 emissions (g/km), fuel consumption (l/100km and /or km/l)[82]. The EU directive did not require the standardisation of the presentation of the labels, as was the case for electrical appliances, for instance. As a result, around 80% of the countries used comparative colour-coded labels with efficiency class A, B, C, similar to those for electrical appliances, and 20% imposed the minimum requirement only, in other words, a simple

[81] New dwellings represent around 1%of the stock in industrialised countries, more in emerging countries.

[82] In some countries, additional data like noise, emission standards, tax data are included.

Figure 3.14: Examples of car labels in the EU/
exemples d'étiquettes pour les voitures dans l'UE

Absolute labels (Ireland)



Relative label (Spain)

indication of the value of the emissions (so without coloured tags). Among the countries using the comparative colour-coded labels, two approaches were followed (**Figure 3.14**):

- absolute labels[83], type A, B, C, with a band of fixed CO_2 emission values; that emission band can vary from one country to the next[84];
- relative labels, on which the bands are defined in relation to fleet average[85];

CO_2 labelling is a practical method to inform consumers about the fuel economy and environmental standards of the new cars. But as the buying decisions are strongly influenced by costs, size, power, manufacturer and safety of the car, the impact on the consumer decision of labels is quite low. For this reason relative comparison labels are more favourable, as they are interested in the fuel economy of a certain car with respect to other cars. However, it is difficult to develop a consistent and fair method for a relative labels, which is accepted by all involved parties, especially the car manufacturing industry. In that respect, the absolute system is simpler to handle, as it avoids the arbitrary and contentious issues of defining the categories of classes. The impact of CO_2 labelling can be reinforced in combination with tax incentives, as this has been observed in several EU countries that have implement green taxation for new cars.

CO_2 labelling on used cars being imported in developing countries could inform consumers about the fuel economy and environmental standards of the used cars and thus influence the decision for buying the car. Nevertheless, the fuel price in relation to the personal income in those countries importing used cars plays an important, even crucial role, which might have a higher impact on the decision of buying a car.

MEPS for cars have been applied for new cars in the US in the eighties (CAFE). China has more recently set up MEPS for new cars. In Japan, the "Top Runner Program" fixes standards for new cars, by category of vehicles and fuel[86]. South Korea enacted fuel economy standards in 2006 for domestic cars and in 2009 for imported cars with sales of less than 10,000

83 About half of the EU countries finally implemented the absolute comparative label, i.e. the type similar to the label used for electrical appliances.

84 For instance, in France Class A covers cars with CO_2 emissions below 100 g/km, whereas in Ireland it covers cars with CO_2 emissions below 120 g/km.

85 In Spain, for example, a car is labelled Class A if emissions are 25% below the market average.

86 http://www.eccj.or.jp/top_runner/index.html

vehicles. Companies manufacturing or importing more than 10,000 vehicles per year are subject to US CAFE standards[87].

In the EU, the approach was to go with voluntary agreements signed with three car manufacturers' associations (ACEA, JAMA and KAMA)[88], fixing a target of 140 g of CO_2/km for the average emissions of all new cars sold in 2008 at EU level by all the members of those association.

Since that target was not reached, the Commission decided to go for a mandatory standard: thus, in 2008 the European Parliament adopted a regulation on mandatory CO_2 emissions for new cars fixing a limit for each manufacturer of 130 g CO_2 per km for the average of its sales to be achieved in 2015[89]. The Directive specifies a long-term target of 95 g/km for the year 2020.

Fuel economy standards in *Canada* have been set by Transport *Canada* under a voluntary Motor Vehicle Fuel Consumption Standards (MVFCS) Program.[90]

Other regulations

The most common other regulations implemented in some countries are mandatory requirements for designated consumers, such as energy audits, mandatory energy consumption reporting, mandatory energy managers, mandatory energy saving plans. These designated consumers are usually large consumers, identified from energy consumption thresholds, in selected sectors (e.g. steel, cement, public sector, large commercial buildings)[91].

Other regulations include mandatory maintenance, mandatory installation of solar water heaters and obligation of energy savings imposed on utilities. Energy savings obligations are analysed in detail in another section of the report. Some other regulation, not directly linked to energy efficiency, and that can also have a significant impact on the energy use (e.g. speed limit), are not included in this review.

Mandatory energy audits

Energy audits, either in the form of walk-through audits[92] or detailed energy audits are necessary to have a better understanding of the current status of energy use and to identify potential actions for energy savings. Mandatory energy audits are more popular in OECD countries (**Figure 3.15**). In Europe, there is a greater focus on public and residential buildings, with about half of the countries with audits schemes (respectively 55% and 45% of countries), compared to 40% for industry and commercial buildings. In Asia, audits are imposed in several countries, mainly in industry (in 60% of countries including the largest countries) and to a lesser extent in commercial buildings (in 40% of countries).

87 South Korea plans to raise the fuel economy of locally-made vehicles to surpass future requirements being by the US and Japan, according to the Ministry of Knowledge Economy (MKE). Korea's fuel efficiency standards are already slated to increase 16.5% in 2012 from the current levels.

88 ACEA, European Automobile Manufacturers Association; JAMA, Japan Automobile Manufacturers Association; KAMA, Korean Automobile Manufacturers Association.

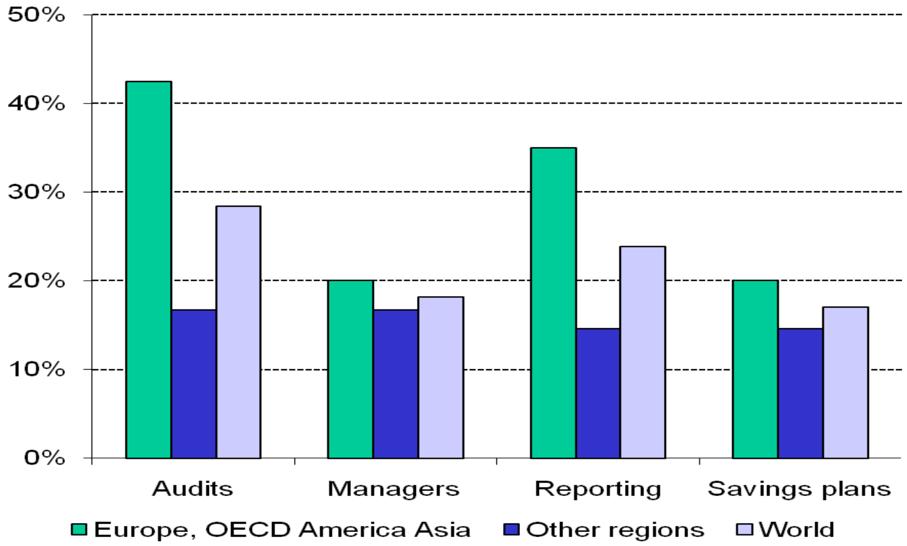
89 Directive 443/2009. The regulation sets intermediate targets: in 2012, 65% of each manufacturer's newly registered cars must comply with the limit value. This will rise to 75% in 2013 and 80% in 2014. Penalty payments for excess emissions are to be paid by the manufacturers for each car registered: €5 for the first g/km in excess, €15 for the second g/km, €25 for the third g/km, and €95 for each subsequent g/km. As of 2019, the penalty will be increased to €95 for the first g/km of excess.

90 A new revision of efficiency standards has been decided in April 2010, fixing new targets for vehicles from 2012. By model year 2016 vehicles must get an average of 35.5 miles per gallon. The requirements will add as much as $985 to a vehicle's initial cost, according to EPA estimates, but buyers will save about $4,000 on fuel over the life of the car

91 In India, under the Energy Conservation Act, 2001, units in 9 sectors (power, fertilizer, iron & steel, cement, pulp & paper, aluminium, chlor-alkali, textile and railways) have been notified as " designated consumers" with mandatory requirements (on reporting, audits, energy managers).

92 A walk-through audit is a basic and cost-effective exercise to identify opportunities for energy cost saving.

Figure 3.15: Regulations for designated consumers
Réglementations pour les consommateurs désignés



Source: WEC ADEME survey 2009

Mandatory energy audits for buildings, especially in the residential sector, are most widely spread and exist many countries and regions. In Africa and The Middle East Mandatory, few countries require mandatory energy audits and they apply to all large consumers in all sectors (Algeria, Tunisia and Syria). The industrial sector appears to be quite frequently concerned by audits in Asian countries[93]. Mandatory energy audits in the transport sector are less common and aim at fleet owners (e.g. Tunisia and Algeria). However, even in those countries mandatory audits in the transport sector are in a very early stage.

Compared to voluntary audits, mandatory audits allow to reach rapidly a substantial fraction of consumers (e.g. case of India). However, the mandatory nature of the instruments implies inherently that a variety of consumers are not yet convinced by its benefits and consider the procedure an administrative burden rather than a process that helps them to save costs or to make their company more competitive: there is a risk that they will not comply with the regulation or comply formally but will not take into account the conclusions of the audits.

[93] India, Taiwan, Thailand with, however notable exceptions such as China or Japan

Mandatory audits suppose a certain quality and number of the auditors as well as of the staff responsible for energy management in the companies (energy managers). This can be assured by the certification of the auditors and by the training of energy managers. In reality, however, especially in the early phases of the establishment of such a system, too little qualified staff is available as compared to the large number of units to be audited rapidly when the instrument is mandatory. One possible way out of the dilemma is to include issues around audits in the curricula of the higher education levels implying therefore that the hoped rapid impact of mandatory audits may take time to materialise unless the qualification process receives. If the participation is voluntary the number of auditors may build up more slowly leaving more time for the establishment of qualified auditors.

In addition to the qualification problem, frequently the financial means foreseen may not be enough to carry out detailed audits, which is an obstacle in industrial companies where the processes are heterogeneous and complex.

Non-compliance with the regulation may be sanctioned, although there is no evidence that sanctions are really applied. In general, a co-operative approach is preferred. The implementation of the measures recommended in the audits is most commonly not mandatory; however often they entitle to subsidies.

Energy audits do not lead to energy savings per se: the realisation of the measures proposed during the audits is another critical point, unless there was a legal requirement to carry out the measures found. Quite frequently, the mandatory audits are therefore accompanied by supporting measures such as subsidies for the audits or for all or certain types of investments[94]; training measures and seminars for the auditors and the staff of companies (both management and technical staff). Measures to accompany the audits with the development of a market for energy service companies was also considered (e.g. in Taiwan) but not systematically undertaken. In the Ivory Coast, an Energy Efficiency Fund was set up with the aim to support the realisation of the measure proposed by audits (which were however, not mandatory).

Energy audits and the realisation of subsequent measures led to savings of 5-10% for the participating companies. Equally important is the cultural change that mandatory audits also try to initiate in companies by making energy efficiency a regular target at all levels of the company. Experiences in Australia show that an "external view" on energy use in a company from an energy auditor often also brings additional value[95].

Frequently, government agencies are involved in the administration of the process via a central database on the audits carried out. The main obstacle is the insufficient response of administrations to the information collected (feedback on the quality of the reports and on the results to the consumers) due to an understaffing of the involved government bodies or government agencies.

In summary, there are various approaches also within the instrument of mandatory audits, reaching from the softer, process-based Australian approach to more regulative approaches with stronger requirements also on the results to be achieved such as in India, Taiwan or Bulgaria. Both approaches have attractive features which are not necessarily mutually excluding. The comprehensive approach of "cultural change" in the attitude of companies towards energy efficiency and energy audits is fully compatible (and necessary) for a more regulative approach, while it may depend on the culture of a country how much mandatory elements are introduced into the frame of mandatory audits. In any case, the qualification of auditors, company and government staff as well as a suitable mix of accompanying measures including the development of a market for energy

[94] For instance, measures that are not economic under current conditions but appear as reasonably close.

[95] Australia considers in its Energy Efficiency Opportunities programme the introduction of mandatory audit as a "cultural process" with six key elements for a comprehensive assessment of energy efficiency: leadership; management; quality of data and analysis; skills of a wide range of people; decision making; communicating outcomes.

services appears as an important aspect in the realisation of the measures found in the audits.

Energy consumption reporting

Some countries have set up regulations requiring designated or large consumers to report their energy consumption, either directly to the government or in their annual report. This measure is seen as an incentive to companies to monitor closely their energy performance. Such measures exist in about one fourth of the surveyed countries and are more frequent in Europe and other OECD countries than in the other regions (**Figure 3.15**). This measure is mainly applied in industry and public buildings. This measure exists for CO_2 emissions for all large consumers in the EU[96].

Mandatory energy managers

In about 20% of the countries covered, there is a regulation requiring the nomination of an energy manager in companies above a certain size. This measure usually applies to large consumers in industry (13 countries) and in the service sector (8 countries) (e.g. in Denmark for the public sector). In some countries, transport companies are also included (e.g. Italy, Portugal, and Romania).

Mandatory energy saving plans

Slightly less than 20% of the surveyed countries have set up regulations on the preparation of energy savings plans for consumers, generally in industry (20% in OECD and 15% for non-OECD countries). This measure exists for several sectors, including in some countries municipalities (e.g. Portugal, Italy, Poland, Romania, Russia, Japan, Korea, Thailand, Turkey, Algeria, Tunisia, and Iran[97]).

Maintenance

Maintenance of energy-consuming equipment is another important field of regulation. The concern is that without a proper maintenance of energy consumers' equipment (e.g. boilers, vehicles), their efficiency will decrease over time: the objective of the regulation is to maintain as long as possible the initial efficiency of the equipment. This measure concerns mainly countries in Europe. With the new Directive on buildings, the maintenance of heating boilers is now mandatory in all EU countries. This measure existed before in Denmark, Italy and Germany. In a few countries (Italy, Romania), regulations on maintenance exist for the transport sector. The mandatory technical controls for cars that exist in many countries may to some extent contribute to save energy, depending on the items that have to be controlled.

Mandatory installation of solar water heaters

Even in fairly mature markets, solar water heating systems are not used each time they are cost effective. The reasons are well known: lack of trust in new technologies, long payback times and preference for immediate savings, insufficient information, lack of motivation and awareness on the part of decision-makers, high transaction costs,

[96] In the EU, this measure is part of the Emission Trading Directive that sets a quota of emissions to large consumers and impose to participants to report their emissions to the European Commission,

[97] See Annex 2.

problems with owners / tenants, and so on. In such circumstances, regulations making the use of solar heaters mandatory provide a way of expanding diffusion.

Israel was the first country to make mandatory in 1980 the use of solar water heaters, followed recently by Spain (first in 1999 in Barcelona City and in March 2006 in the rest of the country with a new Building Code)[98].

Regulatory measures result in a much larger market for the technology and can thereby help improve performance (reliability/cost). Nevertheless, minimum quality levels must be imposed to prevent the solar energy obligation from encouraging the use of inexpensive but inefficient equipment. Standards and quality labels can ensure that such minimum requirements are met.

Regulation on quality standards (norms)

The real or perceived quality of systems is an important driver or obstacle to enlarge the dissemination of efficient equipment, such as solar water heaters or CFL. For solar for instance, the low quality of equipment and installation, and the lack of adequate maintenance is a clear barrier to the development of solar water heating. At the opposite, the high perceived quality of solar products and installations can be a key element for consumer confidence and an important driver for the dissemination of solar water heating (e.g. in Austria). The quality issue does not concern the manufacturer (the collectors) alone but also the installer (the solar system including the backup) and often first the after sales and maintenance network.

The aim of standards is to guarantee or improve quality. Technical standards are drawn up with reference to a given set of specifications and guarantee a specific level of quality. In addition to product standards, there are standards relating to the installation of equipment. For instance in Europe, the "Keymark" certification scheme developed for solar heaters by European manufacturers with ESTIF is now recognised and facilitates the movement of products between countries and makes it easier to get financial incentives[99]. China intends to develop its own national technical standards on the basis of this label. Consumer access to subsidies or loans is now very often conditional on certification of the product or contractor.

In addition to standards, special contractual approaches have also been developed aimed at guaranteeing or improving the quality of solar water heating systems. For example, the "Guarantee of Solar Results" project[100] has been implemented on an experimental basis in certain countries such as France and Spain. Applicable to large installations, its aim is to check that the real performance of a system corresponds to the advertised performance, and to compensate users if this is not the case. The risk related to poor performance is no longer borne by the user but by manufacturers and

[98] In Spain, the new Building Code stipulates that in all new or renovated buildings, 60% of hot water demand must be met by solar.

[99] www.keymark.org

[100] http://www.tecsol.fr/st_uk/garant0-uk.htm

installation contractors, who are thus strongly encouraged to supply high quality equipment.

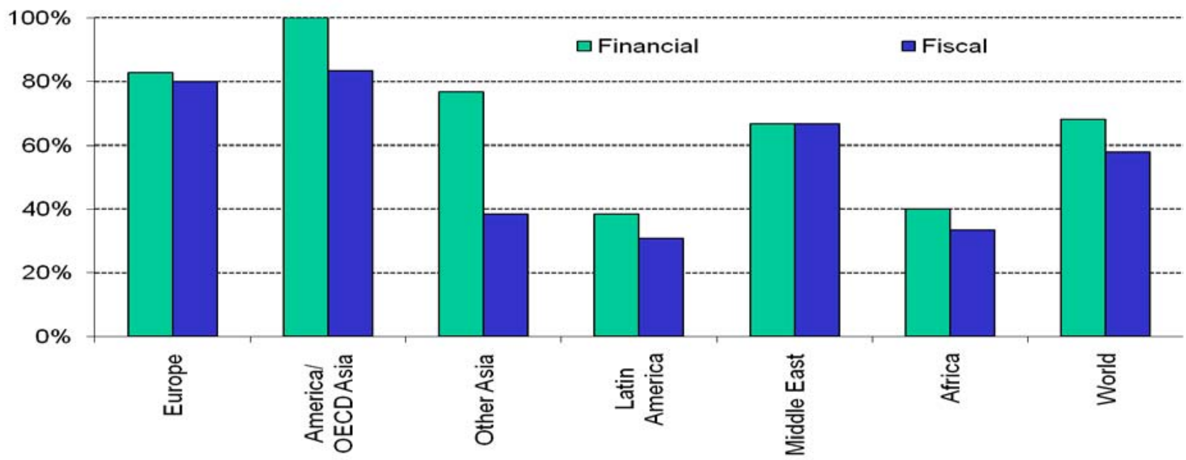
Anyway, setting standards is not enough. It is also necessary to make sure that these standards are effectively enforced. Without certification facilities, it may be difficult or impossible for most countries to check the compliance of imported products with national standards; it may also be impossible to adapt or strengthen the national standards so as to follow the technical change in state of the art technology. A national or regional testing and certification centre that can verify the compliance of marketed products with the national law (technical standards) is a key element for the implementation of policies intended to promote efficient appliances and of solar water heaters.

Financial and Fiscal Incentives

Economic instruments include financial incentives to promote energy efficiency (e.g. subsidies for energy audits or investment, soft loans), as well as fiscal measures. Economic incentives aimed at encouraging investment in energy efficient equipment and processes by reducing the investment cost, either directly (economic incentives) or indirectly (fiscal incentives). Two thirds of countries have economic measures (**Figure 3.16**). In all regions, financial incentives are more popular than fiscal measures, which are mainly used in OECD countries. Financial and fiscal incentives exist in more than 80% of OECD countries.

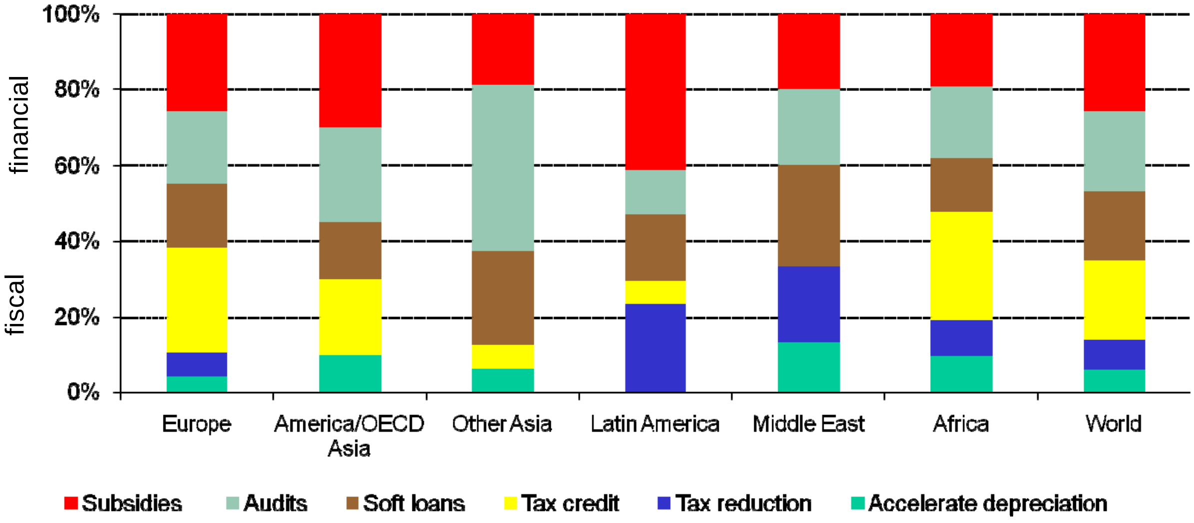
Figure 3.16: Countries with economic incentives

Pays avec incitations économiques



Source WEC ADEME survey

Figure 3.17: Countries with economic and fiscal incentives by type of incentive
Pays avec incitations économiques par type d'incitations



Source: WEC/ADEME Survey

Investment subsidies represented about one fourth of all financial and fiscal measures in the surveyed countries (and up to 40%) in Latin America (**Figure 3.17**). Audit subsidies are the most popular measure in non OECD Asia.

Economic incentives are increasingly conditional upon quality label as a way of to promote the use of high quality equipment. In practical terms, this means that economic incentives are granted only for equipment that has an approved quality label[101]. In the same way these incentives can be granted to encourage the use of qualified installation contractors[102]

To be effective, financial and fiscal incentives need to be combined with public information and awareness campaigns to stimulate public interest in energy efficient equipment. Where regulations have been introduced, additional economic or fiscal incentives may be necessary to ensure that the initial extra costs involved (at least during the early stages) do not give rise to increased construction costs and make home ownership more difficult for lower-income families.

Economic Incentives

Economic incentives fall into three broad categories: subsidies for audits, investment subsidies and soft loans.

- **Investment subsidies**

Investment subsidies are intended to reduce the investment cost to retrofit existing buildings or dwellings or industrial facilities, and thus to shorten the payback time. They are also used to lower the price of efficient equipment that are more expensive than the market average price (e.g. CFL, efficient motors or boilers, solar water heaters). Subsidies taken from the public budget should only apply to actions or equipment that are cost effective from the collective point of view, but which would not otherwise be undertaken or purchased by consumers. Subsidies can be defined as a fixed amount, as a percentage of the investment (with a ceiling), or as a sum proportional to the amount of energy saved. Subsidies may also be given to equipment producers to encourage the development nd marketing of energy efficient equipment, to improve the quality and the cost of production. In some case the producer approach may lead to better results.

[101] In France for instance, the tax credits are applicable to solar water heating equipment that have been awarded CSTBat or Solar Keymark certification. Similarly, in India, only solar collectors certified by the Bureau of Indian Standards are eligible for low-interest loans.

[102] For instance, in the Netherlands, the amount of the subsidy is determined by the performance of the installation.

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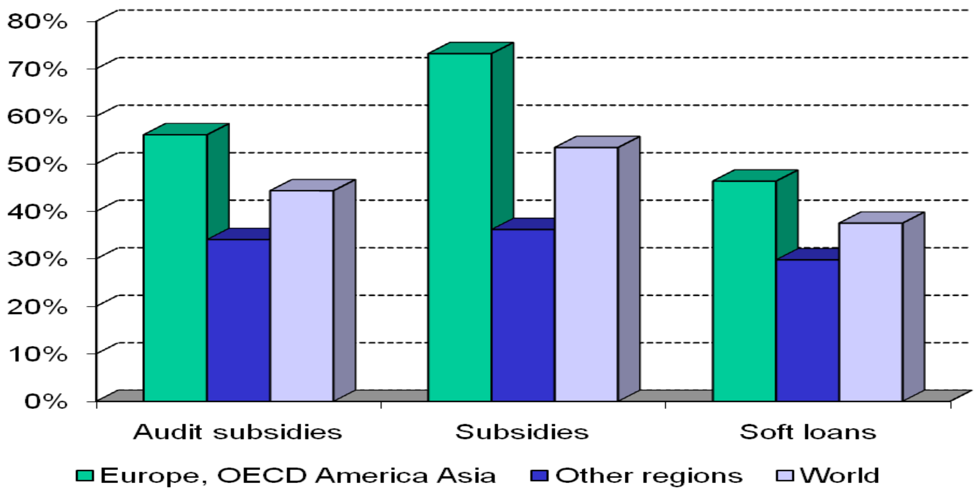
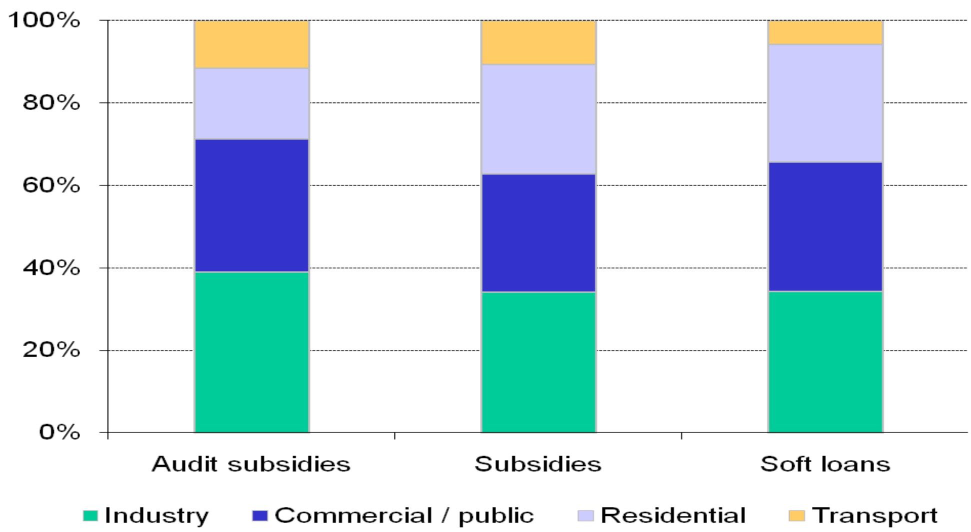
Figure 3.18: Financial incentives by type
Incitations financières par type



Source: WEC/ADEME Survey

Figure 3.19: Financial incentives by sector
Incitations financières par secteur



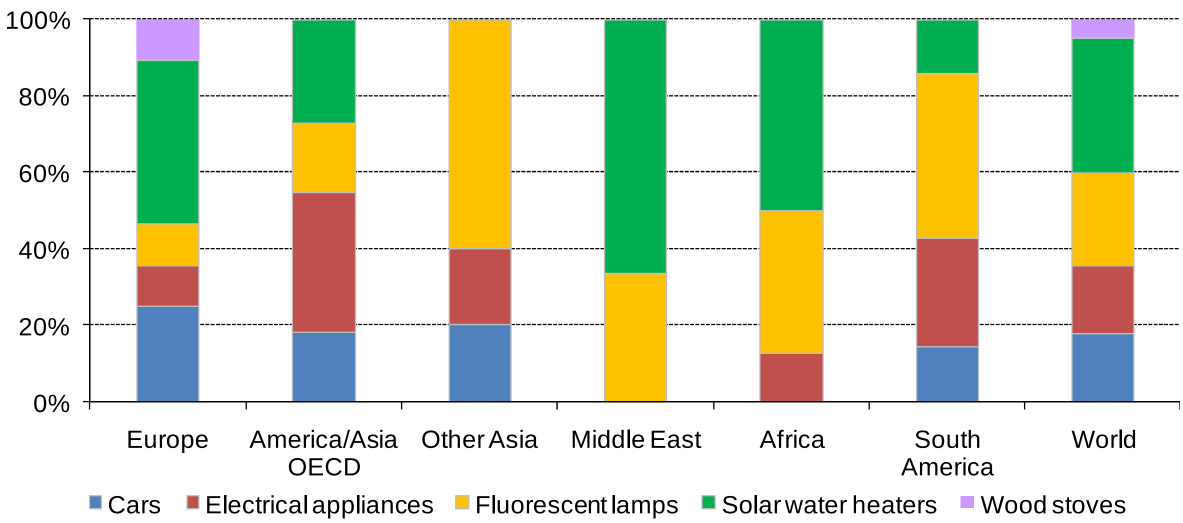
Source: WEC/ADEME Survey

This measure is especially popular in OECD countries where more than 70% of the surveyed countries have subsidy schemes, against 35% for the other regions (**Figure 3.18**).

According to the survey, about 2/3 of financial incentives are given in industry and services, of which almost 40% in industry. Audit subsidies are more frequently distributed in industry (1/3) and public/commercial buildings(1/3) than in residential buildings (20%)(**Figure 3.19**).

Investment subsidies are directed almost equally in industry (1/3), in public/commercial buildings (30%), and residential buildings (slightly less than 30%), with the balance (about 10%) going to transport. Soft loans are distributed almost evenly between industry, residential buildings and commercial/public buildings.

Figure 3.20: Subsidies by type of equipment
Subventions par type d'équipement



Source: WEC/ADEME Survey

At world level, around one third of the subsidies on energy efficient equipment are dedicated to solar water heaters and 25% to CFL. In OECD countries and Asia, more than 20% of the subsidies concern also investments in a new clean and efficient car (**Figure 3.20**).In the Middle East and Africa all countries that have subsidy schemes have focused their subsidies on CFL and solar water heaters.

Subsidies are not without a certain number of drawbacks, the main one being the cost for the public budget if the financial incentives concern a large volume of equipment or investments over a long period of time. For this reason, economic incentives are increasingly linked to energy or environment funds with financing mechanisms that tend to diversify the sources rather than coming from the public budget alone: funding from international financing institutions, from dedicated taxes or from the banking system.

Ex-post evaluation of grant schemes showed several drawbacks:

- Subsidies schemes often attracted consumers who would have carried out the investments even without the incentive, the so-called "free riders" (e.g. high income households or energy intensive industries).

- Consumers who could use the subsidies and were targets of the scheme (small to medium industries, and low income households) did not take advantage of them because they were unaware of its existence. This demonstrates the challenges of informing a multitude of consumers adequately about the existence of the incentives.

- Procedures for grants applications were often found to be too bureaucratic (complex forms to be completed and long delays in obtaining the agreement) and costly (high transaction costs), especially in comparison to fiscal incentives (staff necessary to process the forms).

- Finally, subsidy schemes may have a negative impact on the market by leading to an increase in the cost of equipment, if manufacturers or contractors raise their prices in anticipation of the rebates that purchasers will be granted, and to the diffusion of equipment with a poor quality, unless subsidies are linked to quality standards[103].

These drawbacks do not prevent the use of subsidies, but lead to a more careful utilisation, taking into account their real effectiveness. Grants are now better targeted to limit the number of beneficiaries (e.g. low income households[104], tenants). They are also restricted to certain types of investments (from a selected list of equipment), with a long payback time but high efficiency gains (e.g. renewables, co-generation), or to innovative technologies (demonstrative or exemplary investments)[105]. Subsidies are increasingly viewed as a temporary measure to mobilise consumers, to prepare for new regulations, or to promote energy efficient technologies by creating a larger market than would otherwise exist, with the objective of a cost reduction for the subsidised energy efficient technologies.

The experience of several countries (e.g. Tunisia and Taiwan) with subsidies for solar heaters shows that if subsidies are discontinued prematurely it is quite possible for sales to plummet in a market that is not sufficiently mature. However, once the critical mass has been reached economic incentives can be reduced and even stopped without slowing down the diffusion dynamics (e.g. Greece)[106].

To limit these drawbacks, it is first of all necessary to avoid changing too often and in an inconsistent way the subsidy schemes. Subsidies could also be reduced progressively as the market develops so as actors can anticipate their phase out.

Audit subsidies

Subsidies for audits aim at making them more attractive and requested by consumers, when they are not mandatory. The subsidy is either a fixed amount or a percentage of the audit cost (e.g. 30%). About 40% of the surveyed countries subsidise audit (55% in Europe/OECD America-

103 Subsidies are also used to promote quality if they are granted on condition that the equipment or the contractors comply with certain quality criteria.

104 UK has had for several years a very strong programme targeted towards low-income households (see & 3.8 below).

105 The approach used in Thailand is innovative, as the selection is not based on a list of equipment but on a criterion of cost-effectiveness (grants apply to investments that have an internal rate of return above 9%).

106 Greece, Israel, Japan and China have succeeded in making solar water heating a technology that now competes with conventional water heating systems without incentives.

Asia). Almost 40% of the subsidies for audits are given to industry, 30% to commercial and public buildings 20% in residential buildings (**Figure 3.19**).

Soft loans

Easy access to credit with appropriate conditions for financing the initial investment is a fundamental measure to overcome the initial cost barrier. The most common measure is to offer soft loans, i.e. loans at subsidised interest rates (i.e. lower than the market rate) to consumers who invest in energy efficient technologies and equipment[107]. Soft loans have the advantage of being easily implemented by banking institutions.

In the case of developing countries, there are additional barriers for households to access of credit: the low banking rates of households, which is likely to exclude a large proportion of households obtaining a bank loan to finance energy efficiency investments; the high cost of credit distribution because of the diffuse nature of demand and low amount of loans, discouraging banks to target this market; the high interest rates often as a result of the high transaction costs.

Various measures are often used to overcome these constraints, such as the establishment of specific credit lines with the help of donors, and the establishment of credit guarantee scheme by the State to encourage banks to be more active in financing such operations by taking more risk.

Soft loans are less popular than subsidies as shown by the survey (**Figure 3.18**)[108]. Slightly less than 40% of all surveyed countries had such schemes (about 50% of them are European countries and OECD countries). Soft loans are almost equally used in industry, services and for households.Another way to address the initial cost barrier is to develop third-party financing where the party paying for the equipment, usually an ESCO (energy services company), is reimbursed from the savings made.

Fiscal incentives

Fiscal incentives include first of all measures to reduce the annual income tax paid by consumers who invest in energy efficiency: they comprise accelerated depreciation (industry, commercial sector), tax credits and tax deductions (households)[109]. Another form of fiscal incentive is to reduce the tax to be paid when purchasing energy efficient equipment (VAT, import duties or purchase for cars) or when investing to improve energy efficiency in buildings (reduction in VAT rate on labour cost). They also include tax reduction for the use of efficient cars (annual registration tax)[110]. Tax credits and accelerated depreciation are considered better than subsidies, as they are less costly for the state budget. They can work well if the tax collection rate is sufficiently high. They

[107] In Spain and Tunisia, the possibility of obtaining low interest loans has greatly facilitated implementation of legislation on solar installations. In France exist under special conditions zero interest loans.

[108] This is especially true in OECD countries where market rates are very low.

[109]With tax credit households can deduct part of the purchase cost of equipment from their income tax.

[110] Road charges are also considered as a fiscal measure with effect on energy use although their primary goal is to reduce congestion and pollution. Several cities have implemented such schemes: Singapore, the pioneer since 1975, several. Norwegian cities (e.g. Oslo, Trondheim and Bergen), London in 2003 and Stockholm in 2006.

usually have a poor performance in an economy in recession or in transition. They are more adapted to well developed countries. However, unlike subsidies, tax credits do not lower the barrier of the initial upfront payment, and therefore do not help low-income households[111].

Tax credits exist only in ¼ of OECD countries: they apply either to selected equipment[112] or to building retrofitting.

Accelerate depreciation is used mainly in industry and concerns less than 10% of countries.

Tax reduction for energy efficient investment/equipments exist in around 2/3 of OECD countries (**Figure 3.21**): they apply either to selected equipment[113] or to building retrofitting.

Reduction on VAT and on import tax on energy efficient equipment (e.g. CFL, efficient motors) is mostly used in emerging and developing countries in Asia, Africa & Middle East[114]. The compact fluorescent lamp is the most common equipment to which this measure applies outside the OECD followed by solar water heaters (e.g. Tunisia, Jordan, Syria, Columbia).

Reduction on the purchase tax and/or annual registration tax have been introduced in several European for efficient cars (usually linked to the CO2 emission of cars and therefore indirectly to their energy efficiency): the objective is to give incentives to the consumers to buy more efficient cars[115]. In France, there is combined system of tax for inefficient cars with high CO2 emissions and subsidies for the efficient/low emission ones[116]. When energy efficiency/ CO2 considerations are taken into account for the annual registration tax, consumers will take into account such a tax when buying a new or a used car[117].

VAT concessions on labour costs to reduce the investment cost in building renovation exist in several European countries.

Tax concessions for companies that make concrete commitments to energy efficiency gains/ CO_2 reduction and meet their target are also another innovative way to promote investment in energy efficiency and CO_2 reduction (e.g. Denmark or UK).

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[111] As such they are sometimes considered as being not socially equitable.

[112] Many countries have implement tax credit schemes for solar water heaters. Double glazing although not the most cost effective action is often selected by consumers because of its multiple benefits (heating comfort, noise).

[113] Many countries have implement tax credit schemes for solar waters.

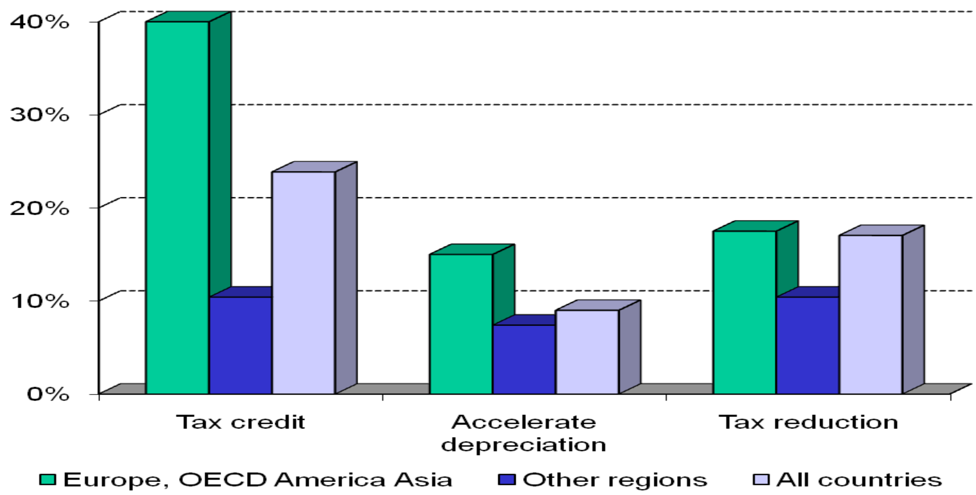
[114] Several European countries have lowered their VAT rates on solar equipment (e.g. Spain and Austria where solar are fully exempt from VAT).

[115] Austria (since 1992), Denmark (since 2000), Norway (since 1996), the UK for company cars (since 2002), France for "powerful" cars (since 2006) and the Netherlands (since 2006).

[116] Scheme called "bonus malus" with the income from the tax used for the subsidies.

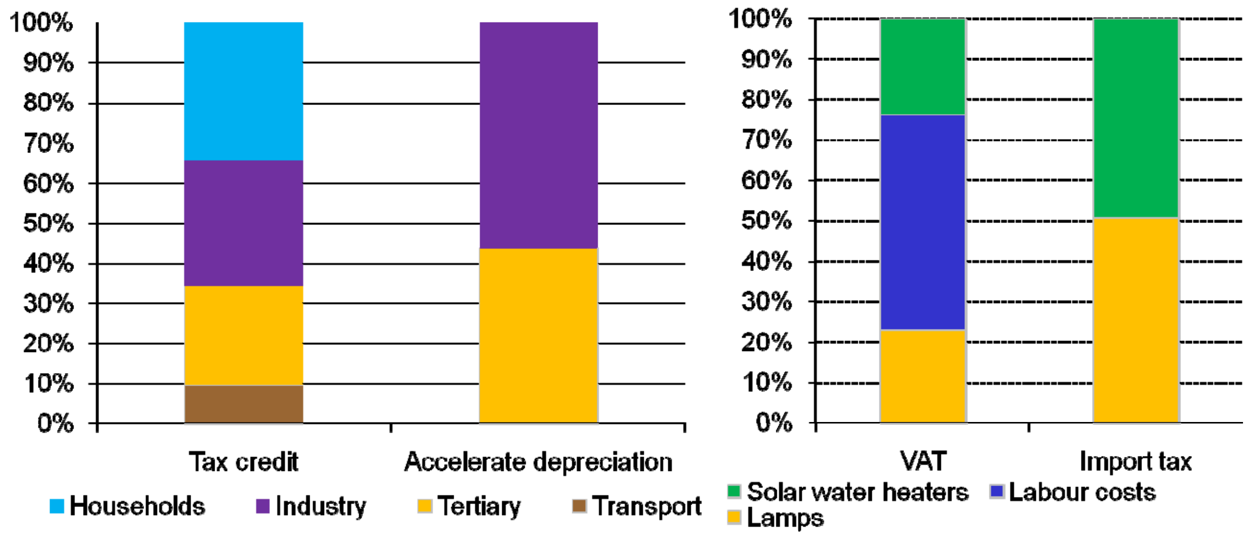
[117] This is the case for instance in Denmark since 1999, Germany since 1997, the UK since 2001, France since 2006 (for company cars), and Sweden. Before the tax was usually based on the power of the car.

Figure 3.21: Countries with fiscal incentives
Pays avec incitations fiscales



Source: WEC Survey

Figure 3.22: Tax credits by sector and type of equipment



Source: WEC Survey

Energy Savings Obligations[118]

Energy savings obligations is a recent and innovative measure in which energy companies (supplier/retailer or distributor) have a legal obligation to promote and stimulate investment, which will save energy in their customers' premises or households. When this obligation can be met involving buying or selling of the energy saving credits towards the obligation, this is usually called White Certificates.

Energy savings obligations are similar in some aspects to the older Demand side management (DSM) activities in that there is an obligation on energy companies to undertake energy efficiency activities with their customers. However compared to many of the 1990s DSM programmes, the obligations approach focuses on outcomes (i.e. energy saving targets) rather than money spent and has developed much cheaper monitoring and verification systems.

Existing Energy Savings Obligations in Europe and South America

Six countries have currently got active and significant energy savings obligations on energy companies in Europe: Belgium (Flanders Region), France, Italy, UK, Denmark and Brazil. Energy Savings Obligations will be placed on energy suppliers in Poland in 2010[119] and similar activities are under consideration in the Netherlands.

The approach to energy savings obligations on energy companies has developed very differently with different obliged parts of the energy industry and a wide variation in the end use sectors to which the obligations are applied (**Table 3.2**). Nevertheless such obligations have been shown to be extremely flexible and have proved capable to work either with a traditional monopoly energy utility or in a fully liberalised market.

Table 3.3 provides some details of the nature of the targets, their size and other key parameters of the energy savings obligations in the four countries. This review of energy savings obligations in Europe will concentrate on the four major experiences which have been underway for some time and which are of a significant scale: Belgium, France, Italy and UK.

There is an alternative approach which simply uses the energy companies as a way of raising funds for Government. Such an approach has been adopted in both Spain and Portugal. In Spain, a levy equivalent to 1.5% of fuel bills is raised on electricity and gas distribution companies to provide a “pot of money” to which are added funds from the central Government and European regional development funds. In Uruguay, the Government has also adapted a similar scheme with annual energy savings targets and the creation of an organization, FUDAEE, to manage the Energy Efficiency Certificate mechanism. A key source of funding for FUDAEE will come from a 0.13% levy of total energy sales from energy providers .

[118] This section is based on a report prepared for the project by Eoin Lees. The report is available on the WEC web site: “European and South American Experience of White Certificates “, ADEME, 2010. The study includes 4 country case studies (Brazil, France, Italy and UK).

[119] In Poland, the White Certificates are also including the supply side. However it is proposed that 70% of the savings should come from the end use sector with the remaining fractions split equally between generation and transmission and distribution.

Table 3.2: Countries with significant energy savings obligations
Pays avec des obligations d'économies d'énergie

Country	Obligated Company	Eligible Customers	Target set by	Administrator
Belgium- Flanders	Electricity distributors	Residential and non energy intensive industry and service	Flemish Government	Flemish Government
Brazil	Electricity suppliers/ distributors	All except transport	Government	Regulator (ANEEL)
Denmark[120]	Heat, electricity, gas & oil distributors[121]	All except transport	Government	Danish Energy Authority
France	All suppliers of energy	All including transport except EU ETS	Government	Government
Italy	Electricity & gas distributors	All including transport	Government	Regulator (AEEG)
UK	Electricity & gas suppliers	Residential only	Government	Regulator (Ofgem)

Table 3.3: Detailsountries with significant energy savings obligations
Pays avec des obligations d'économies d'énergie

Country	Nature of saving target	Current size of target	Discount rate	Cost estimate (€M/yr)	Penalty if missed target	Trading
Belgium-Flanders	Annual final energy	0.58 TWh annual	no	25.8	10€/MWh + fine	No
Brazil	Annual money expenditure	0.5% of electricity revenue	no	120		No
Denmark	Annual final energy	0.82 TWh annual	no	25		Between distributors
France	Lifetime final energy	54 TWh over 3 yrs	4%	180		Yes
Italy	Cumulative primary energy	24.7Wh/ year in 2009	no	196	Related to non-compliance	Yes
UK	Lifetime final energy		no	900	Related to size of miss	Between suppliers

[120]Denmark is embarked upon an expanding programme which in 2010 will expand by 83% from the current size of the obligation and is expected to produce annual energy savings equivalent to 1.2% of present Danish consumption. There are many more obliged players (over 200) than in UK, Italy and France (~2,500 obliged companies but around 80% of the obligation falls on EDF and GDF-Suez.)

[121] The legal obligation is only for heat distributors; for electricity, gas and oil distributors, it is a voluntary agreement with the sector as a whole.

3.7 Experience from the Five EU Countries and Brazil

Although there are many differences between the way the targets are set, the size of the targets, the obligated parties and the energy using sectors covered, there are in fact many similarities. The common experience to date in the four European countries is analysed below in a common format . However the programmes do vary considerably in their nature, in the length of time that they have been running and the extent to which they have had independent evaluation, which is publicly available. Consequently it is not possible to cover all aspects to the same extent.

The size of the target, the end using sectors to which it applies, etc vary from country to country. However, the key principles are that an obligation is placed on an energy company by Government (or a Regulator) and that a formal monitoring and verification process is enacted to ensure the targets are met by eligible energy saving measures.

Most countries have penalties for those energy companies which do not fulfil their energy savings obligation. In practice, no penalties have been issued as virtually all the obligated energy companies have met their targe ts.

- **Target Sector & Size**

Usually the size of the target and the sectors to be covered are decided by government rather than the regulator for that energy industry although often the Regulator is the appointed body to oversee and verify the energy savings obligation process. Having national governments decide on the size of the obligation seems appropriate as energy savings obligations are linked to environmental concerns and have an important social dimension. It is not easy for an unelected regulator to make judgements which are not solely based on economic grounds and which can have a significant impact on energy bills in the short term. The targets are set in relation to the volume of electricity or gas supplied or distributed. In the residential sector, the simple proxy of customer numbers is often used rather than volumes of electricity.

Table 3.4: Breakdown of Energy Savings by end use sector in energy savings obligations (2008)
Répartition des économies d’énergie par secteur dans les obligations d’économies

	Residential	Commercial	Industry	Transport	Other
Belgium (Flanders) 2008	58%	42%	n/a	n/a	
Brazil 1998-03	22%	9%	14%	0	55% (public lighting;
Denmark 2008	42%	50% trade and industry		n/a	8% public sector
Italy 2005-08	83%	0%		10%	6% public lighting; 3% CHP
France 2006-09	86.7%	4.3 %	7.4 %	0.4 %	1.3% (district heating)
UK 2005-08	100%	n/a	n/a	n/a	n/a

There is considerable variation in the end use sectors which are covered by White Certificates. In practice, as shown in Table 3.4, most of the activities have been focussed on the residential sector. In Brazil, the focus on public lighting was for a variety of commercial reasons but since 2005 the electricity companies have been required to spend at least 50% of their funds on low income households and so Brazil now conforms to this pattern.

For those countries where there is freedom to choose between the end use sectors to achieve their targets, only Denmark has a significant activity outside the residential sector (42%).

Energy savings obligations are probably best suited to those end use sectors for whom the options of emissions trading are unlikely in the foreseeable future, i.e. end uses involving residential and small business customers.

The cost or implied cost varies considerably but even in the UK it is currently less than 4% of household fuel bills[122] (**Table 3.5**).

Most of the energy savings obligations allow "banking", e.g. the carrying forward of excess savings from one target period to the next. This has important benefits, not just for the obligated energy company but also for the energy efficiency industries[123].

In Flanders and the UK, the obliged energy companies are required to ensure that there are savings in low income households[124]. This is achieved by ring fencing a fraction of the energy saving target that has to be met by savings in such households.

[122] For DSM activities in the USA, there is a similar range of costs, e.g. the range extends up to the Vermont level of 5% of end use bills being used to support the delivery of energy efficiency.

[123] In the UK in 2000, when there was a transition and before the carrying forward of savings was permitted, the energy suppliers met their targets early and the insulation industry suffered nearly a 25% drop in activity until the new obligation started.

[124] A similar measure is being introduced in France.

- **Interaction with Other Policy Mechanisms**

Inevitably national governments have a variety of policies designed to improve energy efficiency in all end use sectors. There can be complications from interactions between such policies, which are either required by legislation or are subsidised by central Government and the obligations on the energy companies.

In other words, is there either genuine additionality (in the case of existing legislation requiring Minimum Energy Performance Standards) or double subsidies of the measure by Government and the energy company?

A pragmatic approach has been taken to dealing with these issues in all countries. For example, in the UK only energy efficiency measures, which produce a performance better than that required by legislation (e.g. in new build or major refurbishment or EU Minimum Performance Standards for appliances) are accredited as eligible energy savings and only for that part which is in excess of the regulatory requirement. Several countries have gone further in the appliance field by only allowing an energy saving for an energy efficient appliance or heating boiler, which is well above the market average of such products (e.g. in the EU several countries now only accredit energy savings from the installation of refrigerators or freezers with an energy label A+ or A++).

In a similar vein, countries disallow that fraction of the savings which are supported by any other central government funding. However, in Italy and France, certain energy efficiency measures can be offset against income tax and still be eligible for support from energy subsidies via White Certificates. Similarly, in Brazil prior to 2005, one of the reasons why the public lighting programme proved so popular with distribution companies was that there was an activity by Procel and Eletrobras to fund 75% of the investment of new public lighting systems at very low interest rates. The remaining 25% could be funded through the distribution obligation but the whole cost of the investment could be counted towards the fulfilment of the 1% wire charge obligation.

- **Nature of Target**

There is widespread variation in the nature of the target set. There are of course local reasons for why this might be the case but it is perhaps worth running through some of the key considerations here.

In the EU, the energy saving credits are based on final energy savings. For countries concerned about reducing their energy imports, then the use of primary energy (which is usually taken to be 2.5 times final energy for electricity with the other fossil fuels being taken as equivalent to their delivered energy) is common. For countries which are concerned about reducing carbon dioxide, then as in the UK, the energy savings were weighted by the carbon content of the saved fuel and since 2008, the target is explicitly CO2 savings. In Brazil the target is annual expenditure and each distribution company submits proposals to ANEEL with estimates of the expected energy savings.

In terms of for how long the energy savings should be accredited, the two extremes are simply to accredit annual energy saving and the other is to accredit the lifetime energy savings[125].

The other issue for debate is whether the energy savings should be discounted over time to reflect the time preference of money as is common in normal financial appraisals. The discount rates have varied between 8% and (currently) 3.5- 4% where used. The key question is perhaps whether this is being done for economic or environmental reasons. If for economic reasons, then the use of discount rates merely conforms with standard energy appraisal options. However, if being done for climate change reasons, then it is perhaps not so clear that it is appropriate to discount the energy and consequently carbon dioxide savings, certainly with a high discount rate[126].

- **Definition of Eligible Measures**

Again the eligible measures are usually defined in advance by the monitoring and verifying authority. This means that it is only measures which have been independently proven to save energy that are utilised. In one sense this is clearly a good safeguard for consumers but it has been said that it can mitigate against bringing in innovative technology. To counteract that, Italy, France and the UK have the option of allowing energy suppliers to put in innovative technology and to monitor the resulting energy savings which can then subsequently be claimed. This option has been rarely used outside the industrial sector and consequently the UK introduced a specific innovation aimed at encouraging new technology[127].

[125] In Italy, energy savings are counted for the period of the obligation, i.e. for five years, except for building fabric measures where the savings are counted for eight years. This is to address the criticism that by only counting annual energy saving, longer life measures are discriminated. For example, for two measures with the same cost and the same annual energy saving, lasting respectively 5 and 20 years, there would be no difference with an annual saving target, although the savings for the longer life measure would be 4 times as great.

[126] Climate change is driven by the concentration of CO_2 in the upper atmosphere. Thus it is the total amount of carbon saved rather than the annual carbon savings which are more important

[127] The energy company can undertake a demonstration action which is reasonably expected to achieve a reduction in CO_2 emissions but is currently unproven; the total costs of the demonstration are then translated into a CO_2 saving based on the Government's best estimate of saving a ton of CO_2 and this saving is accredited to the energy company irrespective of the outcome of the demonstration project. If the demonstration is successful, then the values monitored in the demonstration will be used as the basis for any subsequent replication of the energy saving measures by the energy company.

Table 3.5: Measures employed to save energy in the residential sector

Measure		Brazil	Flanders	Denmark	France	Italy	UK
Appliances:	Cold	OO		OO		OO	OO
	Set top boxes						O
	Standby savers			OO			OO
	Wet					O	OO
Cogeneration						OO	O
CFLs		OO	OO	OO	O	OO	OO
Condensing Boilers			OO	OO	O	O	OO [1]
Fuel switching				O		OO	OO
Glazing			OO	O	OO	O	O
Heating controls			OO	OO	O	O	OO
Heat pumps			O	O	OO	O	O
Insulation:	Roof		OO	O	OO		OO
	Draught proofing			O			O
	Hot water tank			O			O
	Wall				O		OO
Low flow showerheads			OO			OO	
Low flow faucets (taps)						OO	
Smart meters				O			O [1]
PV panels						O	O
Solar water heating		O	OO	O	O	OO	O

OO widely used ; O used

To date, most of the obligations have focussed on energy saving measures and less on renewables or cogeneration, as usually different policy mechanisms exist to support the development of renewable generation technologies. CFLs have clearly been the mainstay of all programmes though not in France where the normal retail routes are not eligible for White Certificates.

While heating measures feature strongly in all EU countries, there are marked differences in the appliance and insulation areas. Some of this can be explained by local conditions, e.g. the UK has low standards of insulation in its existing stock.

At present there are few, if any, energy saving credits for "behavioural" change measures, such as smart meters with consumption feedback to households, energy efficiency advice, etc. However, this reflects more the difficulty in establishing firm energy saving values and the appropriate life time for such measures rather than any fundamental barriers. Indeed, provisional values are being used in the UK and further monitoring is underway to finalise accredited energy savings for the future.

- **Monitoring and Verifying of Energy Savings Attained**

The great majority of projects have been carried out by utilities utilising the deemed[128] or ex-ante energy savings, or in the case of industrial and commercial measures, by scaling engineering estimates of proven energy savings. This approach greatly simplifies the monitoring and verification process which in effect becomes the equivalent of counting the number of energy efficiency measures implemented and can be verified using the standard "dip check" or random sampling procedure of audits. In the UK system, energy suppliers submit in advance of carrying out the project an outline of what they intend to do and the energy savings they are likely to claim. This has benefits both for the Regulator and the energy company in minimising later disputes in terms of energy savings achieved. The final accredited energy savings are of course related to the actual outcome rather than the outline plan. In the fully traded White Certificate schemes, such as in Italy, the energy company can provide either the accredited savings from its own projects or purchase the appropriate number of White Certificates to meet their targets[129]. In Brazil, each distribution company submits proposals to ANEEL for approval with estimates of the expected energy savings: to date, the ex post evaluation has tended to focus mainly on expenditure verification rather than energy savings.

Obviously, to make the deemed energy savings or engineering estimate approach work successfully, there needs to be transparent and clear information from the body responsible for accrediting energy companies with their energy saving values or White Certificates, published well in advance of the commencement of the obligation[130].

- **Supplier or Distribution Obligation. Which is Optimum?**

There are pros and cons of both approaches. Suppliers have strong links to their customers and, in a liberalised market, increasing marketing skills. Perhaps the biggest obstacle for using energy suppliers is that the customers perceive it as "unnatural" for an energy supplier to wish to sell less of its product and consequently can be suspicious of the energy saving offer.

[128] Deemed savings refer to predetermined and validated estimates of energy savings based on the type of energy saving action implemented.

[129] None of the existing White Certificates schemes trade certificates outside of the specific energy efficiency obligation although there is an expectation that in the future trading may take place in wider carbon markets

[130] In France, standardized technical file have been prepared to specify the amount of savings linked to all eligible energy savings actions or equipment. They are available on the Ministry web site (in French) (http://www.industrie.gouv.fr/energie/sommaire.htm).

Distribution companies are more stable organisations, being regional monopolies, and are already regulated bodies. The main disadvantages are that they have fewer contacts with customers, and usually only when there is a failure in the wires or pipes business. However, in Italy this has been turned to an advantage by allowing non obligated parties (such as energy efficiency installers of equipment) to directly enter the White Certificate market and has eventually led to greater transparency on the real costs to the energy companies. Denmark has also said that they intend from 2011 to have more involvement from external parties with the distributors playing more of contract issuing role.

If the supply and distribution functions have been separated into different companies, there is a greater financial disincentive for energy distributors, compared to energy suppliers, to reduce the amount of energy distributed to their customers depending on the regulatory system. In the USA and Italy this problem has been overcome via the distribution regulatory price control. For example, the regulator ensures that there are no incentives for the distributor to financially benefit (or financially be penalised) if the energy transmitted through the distribution network increases (decreases), i.e. the volume driver in the distribution price control is removed[131].

- **Meeting the Target: Energy and CO_2 savings**

The experience to date in all the European Countries has been that the obligated companies have easily met their targets. In the UK, on average the energy suppliers have met their targets with an expenditure of 20% less than the Government expected and since 2002 have carried forward energy savings from one phase of the obligation to the next. In Flanders, the energy distributors met their targets at 24% less cost than budgeted in 2005. In France the first phase target of 54 TWh cumac[132] to be achieved by July 2009 was exceeded by 20%. In Denmark for the period 2006-8, all obligated fuel sources exceeded their target (on average by 11%) but some of the individual heat distribution companies did not; for 2008 the electricity distribution companies exceeded their target by 25%.

- **Trading**

To date, the experience of trading of White Certificates has been somewhat limited. This is perhaps because only in the more recent energy savings obligations, in Italy and France, are there opportunities for market players other than the energy companies to trade White Certificates. Thus the market is in its early stages and will undoubtedly grow in time.

In the UK, trading is only permitted between energy suppliers and has rarely been used. Trading has

[131] An alternative approach in the USA is similar to the Spanish and Portuguese methods, whereby a levy is placed on the distribution company to raise funds but the responsibility for delivering the energy efficiency activities is an independent third party. For example, Vermont has contracted the delivery of the energy efficiency obligations to an independent entity with no commercial interests in either energy supply or as an installer of energy efficiency measures.

[132] Cumac: cumulated and discounted

been used by some suppliers to fulfil target requirements but in absolute terms it has always been very small (<1% of the total target).

In Italy, initially only 20% of White Certificates were traded on the market and most White Certificates were done as bilateral or subcontract arrangements with the energy distributors. There was also considerable deviation from the cost recovery figure of €100/certificate and the market price of the certificates. By 2007 White Certificate prices averaged around €40 for electricity, €77 for gas and €22 for other fuels.

Following the reforms by the energy regulator at the end of 2007, the market for White Certificates has operated more actively. From mid-2008 both quantities and prices of bilateral deals (i.e. of over the counter trades) have to be registered[133]. Between June 2007 and May 2008 Italy has seen buoyant trading (mostly bilateral, but an increasing share of spot market trades). Indeed in 2007, the total amount of certificates traded amounted to 136% of the target: the spot market trades represented 48% of the saving target whereas bilateral trades represented 88% of this target. More than 80% of the certificates were issued for energy efficiency projects implemented by non obligated parties.

[133] The obligation to register bilateral prices has been introduced by AEEG in order to increase the transparency of trading, to the advantage both of market operators and of the Regulator. Market signals, if not distorted, monitor the costs incurred by the system to meet its energy efficiency goals, and they are one of the possible reference parameters for updating the tariff contribution and defining the penalty for non- compliant parties.

Although, trading of energy savings is not widely permitted in the Flemish and UK energy savings obligations, certain facets are similar. For example, energy companies may carry forward excess energy savings from one phase to the next.

- **Energy and CO2 Savings**

In the UK, the energy savings in the 3 year period (2005-8) have been evaluated to achieve discounted lifetime savings of some 46 TWh of electricity and 146 TWh of fossil fuel for fossil fuels. In terms of annual energy saving, these would be around 3.9 TWh/year for electricity and around 6.3 TWh/year for fossil fuels. The carbon savings from EEC2 (excluding deadweight) are estimated at 59 Mt CO2 lifetime or 2.1 Mt CO2 per year in the middle of the Kyoto period 2010 (1.4% of household emissions).

In Italy the cumulative energy saving targets for 2008 were equivalent to >8 TWh electricity saving and >18 TWh gas savings (both figures in delivered units). The Italian regulator has reported that the combined target was easily exceeded but the contribution from electricity savings was much greater than expected. The 2008 annual savings target (2.2 Mtoe/year) corresponds to 1.8% and 1

arget (2.2 Mtoe/year) corresponds to 1.8% and 1.4% of Italian electricity and gas consumption respectively. The 2008 target implied CO2 savings over 4 Mt CO2/year[134].

[134] This is higher than the 3.9 MtCO2/year expectation of the original target due to the higher contribution from electricity savings than originally expected (electricity CO2 content/kWh in Italy is more than a factor of 2 higher than the equivalent figure for natural gas).

In France, the actual energy savings achieved in the period 2006-2009 were estimated by ADEME to be equivalent of 0.6% of energy consumption in French buildings or the equivalent of 0.3% of national consumption[135].

- **Financial Costs and Benefits Arising from Energy Savings Obligations**

Data are available for Italy and the UK. The costs and benefits are viewed from an energy company's perspective and from a national perspective. The former only considers expenditure by the energy supplier; the latter includes the costs to all participants, i.e. energy companies, customers, third parties (e.g. local authorities, landlords, manufacturers, charities etc.)

- **The energy company perspective**

Irrespective of the details of the energy efficiency obligations, the obliged energy companies try to meet their targets in the most cost effective manner possible within the "rules of the game". This does not necessarily correspond to the optimum when viewed from a national perspective. Using published data, broad estimates for cost effectiveness from an energy company perspective have been derived as shown in **Table 3.6**.

Comparison is complicated by the difference between the targets (annual or lifetime), the use of a discount rate (3.5%) for lifetime savings and the different measure mix and hence average lives. The estimate for Italy is derived using a market price for White Certificates for electricity of €89/toe primary energy saving. For the UK, the cost in c€/kWh for all parties was adjusted to include only energy supplier contributions to the cost of delivering the measures. The reason for the much lower cost effectiveness figure for France is linked to the significant tax breaks available for households (e.g. for boilers, heat pumps, insulation etc.) which the energy suppliers tended to market and hence resulted in lower direct subsidies from the energy suppliers. In other words the subsidy to the consumer was provided by the taxpayer and the energy suppliers

Table 3.6 : Comparisons of cost effectiveness from an energy company's perspective for electricity savings.

Country	**Cost to save electricity (c€/kWh)**
Italy (2008)	1.9
France 2006-9	0.33
UK (2005-8)	1.6

- **The national perspective**

[135] However, these figures would be considerably lower if boiler saving estimates were awarded relative to the energy performance of the market average as in Italy and UK instead of the building stock average; in the UK a minimum of 86% boiler efficiency has even been in place since 2005.

The only readily available data are from the UK and the results from the evaluation of the energy savings obligations are used here[136].

The net resource benefit for saving each ton of carbon dioxide is around £53 (60€), i.e. the net present value of the ongoing energy savings set against the costs of all the parties involved is such that the UK benefits by £53 (60€) for every ton of carbon dioxide saved.

The net present value of the measures necessary to meet the 2008 target after including all party costs and benefits (including comfort but excluding deadweight) was £3.1 bn (€3.5bn) over the life time of the measures discounted at 3.5%. This NPV figure includes a total cost to all players of £1.3 bn (€2.5bn).

An alternative way of looking at this in more familiar units is to look at the cost to the nation of saving a delivered energy of electricity or gas. This was 2.2 c€/kWh for electricity and 0.8 c€/kWh for natural gas; both figures are considerably less than the average consumer prices during that period of 11 c€/kWh and 2.9 c€/kWh respectively.

Conclusions

- **Lessons learnt**

From the preceding discussion and case studies, it is clear that although energy savings obligations are increasingly used in Europe and South America, there are considerable variations in the way that they are applied and on whom the obligations are placed. Equally clear is that the obligations have been a success and are expanding in those countries which have implemented them. From these experiences, the key lessons for successful obligations are the following.

Energy savings obligations have been shown to work in both monopoly and fully liberalised situations and both on the supply and/or the distribution elements of the energy chain; these energy savings would not have been achieved without recourse to energy regulation.

There needs to be a clearly defined part of the energy supply and/or distribution chain upon whom the obligation to save energy in their customers' premises is placed.

The obligations to date have been delivered mainly in the residential sector due to the use of the deemed savings approach and the large number of potential recipients who can benefit from such energy efficiency measures; by extrapolation such obligations are best suited to those sectors with low individual energy demand and for which trading arrangements cannot be envisaged in the near future.

There are considerable differences in the values and the way that the deemed energy saving values are determined (e.g. the allowance for "snap back" or increased amenity effects, the heat replacement effect for appliances and lighting etc., whether replacement boiler savings are measured against

[136] The evaluation covers the period 2005-2008. Insufficient data have been published for Flanders to make any estimate possible; likewise for Italy.

the historic stock average or the current market place average efficiency). Some of this is inevitable due to climate differences and the different stage of the energy efficiency markets in different countries but a more consistent monitoring and verification protocol would permit easier identification and transference of best practices. Until such a consistency is attained, these problems are likely to hinder the development of a European wide White Certificate mechanism.

By using deemed or ex ante savings, the administration, monitoring and verification costs can be kept low, typically <1% of total energy company expenditure; any criticisms of the lack of accuracy are more than compensated by the benefits of allowing such projects with individually small energy savings to proceed. However, it is important to get these savings value accurate as the energy company will naturally focus on the most cost effective measures viewed from their perspective and mistakes can lead to priorities for the companies which are not correct from a socio-economic perspective.

To date, the Energy savings obligations have largely operated without significant trading of their energy savings (White Certificates); while it does add cost and complexity, the additional costs are not a major factor when compared to the potential benefits of competition and increased transparency. Many countries remain convinced that this is the way forward.

There has been a growth in energy efficiency activity and the obligations have stimulated new approaches and routes to market; however, outside of lighting, there has been little technological innovation with the focus being on expanding the number of well proven energy efficiency measures in use; as a policy to deliver energy savings rather than innovation, this is to be expected.

Behavioural measures have not yet played a major part in the energy savings counted towards meeting the energy companies' targets; in part, this is due to the difficulty of establishing reliable deemed savings but given the long term importance of changing behaviour in tackling climate change, this is an area that warrants further effort.

The concept of additionality or free riders (those that would have invested in the energy efficiency measures even without the energy company involvement) has to be addressed; at low levels of activity it can be dealt with and minimised on a project by project basis but as the supplier activity grows, it is probably most sensibly dealt with by incorporating the deadweight into the energy company's target.

The “rules of the game” need to be clear and transparent to all and should not be changed except in exceptional circumstances to ensure regulatory certainty for the energy companies.

Energy savings obligations are attractive for Governments as the cost of the obligations is not met by the Government; the costs to date are typically around the 1-4% of energy bills and considerably less than the financial benefits of the energy saved.

All consumers pay (explicitly or implicitly) through their energy bills to the cost of the obligations, yet the financial benefits flow to those consumers who have energy efficiency installations. This can be partly addressed by ring fencing some of the activity for low income households and by using low cost measures such as CFLs which spread the benefits widely; however the environmental and energy security benefits are shared by all.

- **Relevance of Energy Savings Obligations to Developing Countries**

Translating these experiences to Developing Countries, the most relevant relate to the electricity industry. Developing Countries have a priority to increase the access of their citizens to the benefits of electricity and there can be competition between capital expenditure on increasing the electricity supply and on reducing the energy demand through energy efficiency. In principle, these objectives are not in conflict but in practice with constrained cash flows, they inevitably are. Energy savings obligations offer a way for Governments to tackle energy efficiency at a fairly modest increase (1-2%) on electricity customers' bills. Furthermore, as energy efficiency is so cost effective, then this 1-2% modest investment will pay for itself fairly rapidly over a few years.

Energy savings obligation are more relevant than the White Certificate mechanism for developing countries. The experience to date in Europe with White Certificates is limited and requires financial infrastructure and knowledgeable and skilled market players. However as the benefits from Energy savings obligations are overwhelmingly large, then countries such as Flanders, France and UK demonstrate that even without the benefit of full trading mechanisms, there still are significant financial benefits.

There does need to be a clear framework for operating Energy savings obligations and in particular, the use of deemed savings considerably reduces the "administration" expenditure, freeing up more resources for energy efficiency investment. Developing Countries will need to establish deemed savings for their own local circumstances although many electrical end uses are increasingly global, e.g. energy efficient lighting and appliances, etc. Furthermore, by tying in with the mechanisms being developed for Clean Development Mechanisms and/or voluntary carbon off-setting schemes, there could be an additional source of revenue forthcoming to further the energy saving activities.

Overall, it is judged that the barriers to establishing Energy savings obligations from perspectives of technical knowledge, administration, monitoring and verification are not insurmountable. The benefits that would flow to Developing Countries from the introduction of Energy savings obligations are identical to those that apply in the EU and South America, i.e. financial benefits to consumers in the long run, less need to import energy, and reduced impact on the environment, particularly through reduced carbon dioxide emissions from fossil fuels, though the relative importance of these will vary from developing country to country. There are likely to be job creation benefits to be included as well.

Two possible approaches for energy efficiency obligations on electricity companies spring to mind:

- saving electricity in situations where energy inefficient technology is already in use;
- encouraging energy efficiency technology in new customers benefiting from electricity for the first time.

Again, it is likely that the relevance and priority of each option would depend on local circumstances and would require cost benefit analysis in each developing country.

However, the main conclusion remains that energy savings obligations could be an important policy option for developing countries in meeting their sustainable development goals of lower long term costs of electricity services for consumers and commerce, increased energy security and improved environmental performance**.**

Role and Importance of Compliance for Regulations

Introduction

Regulations represent a powerful instrument to promote energy efficiency but their impact depends on good implementation and effective compliance. This section focuses on the importance of compliance; how it is addressed in regulatory measures that are being used to promote energy efficiency; and, what can be done to improve compliance[137]. Unfortunately compliance is frequently overlooked or under-funded. Moreover, there are few evaluations of programmes that focus on compliance.

Regulation compliance has gained attention in recent years with the growing evidence that compliance can have a major impact on the overall effectiveness of programmes. Unfortunately, there are few documented studies but anecdotal evidenced illustrates how crucial effect compliance is if the specifications of regulations and standards are to be achieved. The "average" compliance is not well assessed to this point. According to many experts, poor implementation—due in large part to non-compliance—can reduce a programme's impact by 20-50 %[138].

On the other hand, a UK consultation report on non-compliance stated that poor compliance lowered the impact by 6.2%. A study undertaken by ANEC, the European consumer voice on standardisation issues, suggests that about 15 % of energy using products on the market are non-compliant[139]. The UK government believes that the

[137] This section is based on a report prepared by Rod Janssen for ADEME, "Regulations and Standards in Energy Efficiency: The Role and Importance of Effective Compliance; it contains in Annex country case studies on Argentina, Australia, Canada, China, the European Union, Finland and the United States.

[138] As noted by the chair at a 2008 IEA workshop on compliance ("Enhancing compliance, monitoring and evaluation", indicative levels of non-compliance span approximately 25% for appliance programmes to 50% for building regulations , IEA, 28-29 February 2008.

[139] www.anec.org and Mark Ellis, Ingrid Barnsley and Shane Holt, Barriers to maximising compliance with energy efficiency policy, ECEEE summer study 2009.

estimate is conservative and that it could be as high as 25 %[140].

Compliance: What does the term really mean?

As stated by Ellis et al, compliance is not black or white "with either full compliance on the one hand, or zero compliance on the other. Rather, most programmes include multiple requirements spanning both process and performance issues, and non-compliance can occur at any of these levels." Therefore, they prefer the terms optimal and sub-optimal compliance to describe the level of compliance

Compliance is important for the overall integrity of a measure.

If compliance is poor, the public can lose confidence in the measure thus reducing its credibility and overall impact. Once trust is lost, it is hard to regain. This has occurred in several EU countries where an energy performance certificate for buildings is required before a sale is complete.

In industry, compliance problems can lead to misplaced investments – or investments that do not achieve the expected economic return.

With inadequate compliance, policy objectives are not met

In many countries, the priority for energy efficiency is already tenuous. Poor compliance can adversely affect the decision-makers and public's support for energy efficiency.

Regulatory programmes are increasingly used in energy efficiency strategies today, and as shown above, benefits that accrue from compliance can be significant. If there is leakage in the system that allows for sub-optimal energy-using products to be deployed, then the full, expected impact of the energy savings will not be achieved. This can seriously affect national, regional and global energy efficiency targets.

Establishing a compliance system can be complex and relatively expensive, discouraging many governments from developing the systems. Institutional issues can further complicate the process. In many jurisdictions, building codes are established by the national (or state/regional) government but the enforcement of the code is the responsibility of the local authority: this can lead to resource concerns because often the jurisdiction for enforcement has other priorities or budget constraints and need support from the national body.

Regardless of these barriers, all experts agree that a functioning compliance system is necessary for the overall impact and sustainability of the strategy, so the issue is not whether or not to ensure compliance but how to do it well.

Addressing compliance

There are numerous variables that can lead to sub-optimal results:

- programmes are poorly designed and implemented;
- management problems occur;

[140] DEFRA (2009).

- measures are underfunded and given low priority by governments;
- institutional issues arise from different ministries being responsible for various aspects of implementation; and
- inter-governmental institutional problems are generated, e.g. between levels of government within a country).

Successful compliance therefore requires a rigorous approach. There is a growing body of literature on this topic but unfortunately there are few evaluation programmes that give insight into how the compliance process was carried out and how issues were resolved. Thus the information that is readily available tends to be case studies that are a mixture of evaluations, studies, peer-reviewed papers and briefings.

The case studies summaries have been selected to demonstrate various aspects and challenges of compliance. The summaries outline programmes from Argentina, Australia, Canada, China, the European Union, Finland and the United States and predominately focus on appliance standards and labelling. Voluntary agreements from Finland are included, in large part to show how monitoring and compliance evolved as implementation continued. Building codes are discussed for the United States. Unfortunately there are no case studies on regulations in the transport sector.

Compliance policies

Australia, Canada, Finland and the United States have been very active in integrating compliance directly into their programmes. China is in the process of integrating compliance while the European Union leaves it to its member states. Under the EU system compliance can be difficult to "enforce" because it is so de-centralised to the member state level. This means the level of compliance can vary significantly between member states.

Having a stated policy on compliance is important because it gives attention to the issue; it explains stakeholder's obligations and makes the entire process transparent for all; and, reflects the priority that the government is giving to the issue. As an example, Canada integrated a compliance policy into its standards development right from the start and its public compliance document is readily available for all stakeholders to consult. Australia has a similar, rigorous approach. In the European Union compliance is built into the Eco-design directive[141].

Building codes are naturally enforced but initially enforcement was for other reasons, e.g. fire regulations and safety (ensuring electrical wiring installed correctly). The proposed recast of the Energy Performance in Buildings Directive in the EU has an entire article and an annex on the requirement and procedures for compliance (Box 3.1). The United Kingdom recently held a public consultation to determine the most appropriate compliance system for its appliance labelling and standards programmes.

[141] According to Article 3 of the Eco-design Directive 2005/32/EC of the European Union, Member States have to "designate the authorities responsible for market surveillance", which should "organise appropriate checks on EuP compliance, on an adequate scale, and oblige the manufacturer to recall non-compliant EuPs from the market". They should "take samples of products and subject them to compliance checks".

The Australian E_3 Committee provides a forum to exchange information on enforcement/compliance issues and community information and marketing initiatives.

Box 3.1: Example of compliance: EU Energy Performance of Buildings Directive[142]

Independent control systems for energy performance certificates and inspection reports

1. The competent authorities or bodies to whom responsibilities for implementing the independent control system have been delegated by the competent authorities shall make a random selection of at least 0.5 % of all the energy performance certificates issued annually and subject these to verification. The verification shall be carried out at one of the three alternative levels indicated below and each verification level shall be carried out at least for a statistically significant proportion of the certificates selected:

(a) validity check of input data of the building used to issue the energy performance certificate and the results stated in the certificate;

(b) check of the input data and verification of the results of the certificate, including the recommendations given;

(c) full check of input data of the building used to issue the energy performance certificate, full verification of the results stated in the certificate, including the recommendations given, and on-site visit of the building to check correspondence between specifications given in the energy performance certificate and the building certified.

2. The competent authorities or bodies to whom responsibilities for implementing the independent control system have been delegated by the competent authorities shall make a random selection of at least 0.1 % of all the inspection reports issued annually and subject these to verification. The verification shall be carried out at one of the three alternative levels indicated below and each verification level shall be carried out at least for a statistically significant proportion of the inspection reports selected:

(a) validity check of input data of the technical building system inspected used to issue the inspection report and the results stated in the inspection report;

(b) check of the input data and verification of the results of the inspection report including the recommendations given;

(c) full check of input data of the technical building system inspected used to issue the inspection report, full verification of the results stated in the inspection report including the recommendations given and an on-site visit of the building to check correspondence between specifications given in the inspection report and the technical building system inspected.

Barriers

Compliance does not receive the attention it needs and deserves. The reasons are numerous.

[142] Annex II from proposed recast of the EU Energy Performance of Buildings Directive.

- Lack of manpower to carry out building code enforcement or verification of labels and standards in general.
- Enforcement is expensive and often not given sufficient resources. This concerns both enforcement officials and field and laboratory tests.
- Insufficient time available to spend on building sites to inspect for energy code compliance.
- Energy codes are often considered a lower priority than other areas such as health and safety.
- Enforcement officers do not receive sufficient training in energy elements of building codes.
- Jurisdictional conflicts resulting in unclear allocations of responsibility.
- Lack of appropriate enforcement powers and processes.
- Lack of awareness of the importance of compliance and the effects on overall impact by poor compliance.
- No product registration and reporting requirements for MEPS (China) and for only four products for labelling.

Essentially, the barriers can be summed as a lack of priority, awareness and resources.

Impact of compliance/non-compliance

It is important to have a better appreciation of the impact of effective compliance. To date, there have been few rigorous studies on this; more is documented through anecdotal evidence than through rigorous data gathering and analysis.

There is, however, some important information available For example, in 2009, the British government produced a consultation report that provided an important quantitative assessment of the impact of one programme, linking it to the both the costs and the benefits of non-compliance. Internal projections for the total benefits—assuming full compliance—from the Eco-design and the appliance labelling directives are estimated at current day value of £11.3 billion. Factoring in the non-compliance that was used in the government's impact assessment, they estimate that the cost of non-compliance would be £700 million. The government, however, believes this is a "significant underestimation"[143].

There have been separate studies in the United Kingdom on compliance in meeting obligations under the buildings regulations. A 2004 study, undertaken by the Buildings Research Establishment (BRE), showed that up to one-third of the houses were non-compliant. Many of the Buildings Control Officers admitted that they did not take energy efficiency seriously and that they would not withhold approval just because the thermal efficiency obligations were not met.[144].

[143] Consultation on the Implementation of the Market Surveillance and Enforcement Requirements of the Eco-design of Energy Using Products and Energy Labelling Framework Directives, DEFRA, June 2009, p. 7.

[144] More information on this study and other related ones are available on the Energy Efficiency Partnership for Homes website: www.eeph.org.uk.

Cost of compliance/non-compliance

One of the major concerns of policymakers is the cost of implementing a measure. Getting an idea of how much compliance will cost is not straightforward; compliance can be quite a complicated process and one that needs careful attention. Moreover, the cost of compliance includes costs for testing laboratories, compliance/enforcement officers, data management etc. For example, the estimated enforcement costs for an appliance labelling programme in the Netherlands is to be about €400,000 per year.[145]

However not all compliance activities have to be costly; costs range with regards to the scope of the measure. In China, the total budget for product testing for household appliances, home electronics and lighting was only US$72,000. This was, however, because the sample sizes are a very small percentage of products manufactured and sold in China and that the budget for compliance activities is very small.[146]

Finland estimated that the development costs for the new monitoring system used for its new series of voluntary agreements were about €0.4 million.

In summary, there is no easy rule of thumb as to what are reasonable costs for compliance.

Capacity Building and International Co-operation

[145] Personal communication Hans-Paul Siderius, NL Agency, the Netherlands.
[146] Mark Ellis, Ingrid Barnsley and Shane Holt, Barriers (2009), p. 343.

International cooperation can help designing and implementing compliance systems

A better understanding on how to develop and implement compliance systems is needed. It is also important to increase the awareness of the need for compliance. Much of this can happen through greater international cooperation. Examples of such cooperation, especially in terms of capacity building are provided by CLASP, APEC and CECED.

CLASP, the Collaborative Labelling and Appliance Standards Programme has provided standards and labelling technical assistance with national implementation to over 50 countries. It monitors the full extent of standards and labelling globally, the results of which are available on its website[147]. CLASP has also teamed up with **ClimateWorks**, a California-based foundation, to set up a best practice network on standards and labelling in North America, China, India, Europe and Latin America.

The Energy Standards Information System of APEC[148] (Asia-Pacific Economic Cooperation) provides in particular up-to-date information and links to experts on appliance and equipment energy standards and regulations being used by APEC and other economies;

[147] http//www.clasponline.org; since 1999, CLASP has assisted with the implementation of 24 standards and/or labels. CLASP also has a guidebook on standards and labelling that is available in English, Chinese, Korean and Spanish. CLASP currently has a study underway that compares standards and labelling test procedures, efficiency metrics, thresholds, certification, accreditation and compliance procedures (to be released in 2010).
[148] http://www.apec-esis.org

In Europe, the European Committee of Domestic Appliance Manufacturers (CECED)[149] has established a new protocol, called BVP, to accelerate the correction of inaccurate declarations on energy labels. Under this process, an organisation can challenge the declaration of a given energy label[150].

Conclusions and recommendations

Conclusions

Compliance needs to be rigorously addressed. There are few such studies on compliance; this needs to be remedied in order to better understand the impact of non-compliance and on the costs and benefits of non-compliance.

There are more conference papers and presentations available. International organisations, such as the International Energy Agency (IEA), are playing a bigger role in promoting the importance of compliance. The studies they have produced in the past years support stronger compliance regimes. However, this makes rigorous qualitative analysis very difficult, if not almost impossible.

Ellis et al., state that in one study "there was insufficient centralized collection of compliance data making it impossible to quantify the extent and effects of the compliance 'problem', let alone undertake analysis that might identify repeat offenders"[151].

Poor compliance can have a long-term negative impact on energy efficiency strategies. Compliance comes at a cost but they are significantly lower than the benefits. Some countries have integrated compliance into their strategies seamlessly and have provided adequate resources to ensure it is done well. However—all too often—countries dismiss the role of compliance and worry little about the resultant impact.

More attention is being given to compliance and improvements are being seen, but, there needs to evaluate the actual compliance systems. Compliance is not black and white. Programmes cannot easily be categorised as in non-compliance and thus the idea of ranking measures as optimal or sub-optimal compliance is more appropriate.

To improve monitoring and enforcement, the following suggestions have been proposed at the IEA workshop[152]:

- A dedicated and integrated monitoring and enforcement agency with clear responsibility and adequate funding;
- A mandatory reporting and certification system for all products covered under the

[149] http//www.ceced.org

[150] The challenging organisation and the organisation that is being challenged have a two week period to share documentation and come to an agreement. If no agreement is achieved, then there is a one week period to select a certified laboratory to verify the declaration. The laboratory has four weeks to carry out the testing. Costs are borne by the loser to the challenge. The purpose of the BVP is to overcome problems with enforcement in Europe.

[151] Mark Ellis, Ingrid Barnsley and Shane Holt (2009), p. 344.

[152] Presentation by Zhou Na at workshop on Meeting Energy Efficiency Goals: Enhancing Compliance, Monitoring and Evaluation, February 28-29, 2008, www.iea.org.

mandatory standards and labelling programs;

- An expanded and transparent verification testing programme that includes all products covered under the mandatory standards and labelling programmes;
- Creating a national registry and reporting requirement for MEPS products;
- A strong network of testing laboratories accredited by the CNCA;
- Improve the consistency of test results;
- Credible penalties for non-compliance;
- A clear procedure for dispute resolution;
- Other than the top-down regulatory approach, the U.S.'s manufacturer self-regulation approach could be effective for China as well. Anonymous reporting hotline could be set up for companies to check each other.

Recommendations

As countries design and implement new programmes, it is important to integrate compliance from the beginning. This will be less expensive and more effective.

It is useful to look at the UK example of consultation and compliance. By reaching out to the full range of stakeholders, this allows for better awareness of issues and greater agreement on the way forward.

All programme evaluations should include an analysis of compliance as a factor in determining overall impact.

More analysis is needed as to why compliance is not being implemented well.

There should be a better sharing of best practice on compliance methods.

More capacity building initiatives are needed to improve the development and implementation of compliance systems.

Good practices in the public sector

Introduction

Public sector facilities and operations have significant opportunities for energy efficiency improvements. The public sector's energy demand is in most countries of significant size, and public sector actors are also major buyers of energy-using equipment such as office appliances and vehicles.

Benefits of improved energy efficiency in the public sector are many and include lower energy bills for public actors and reduced demand for investments in energy supply systems. Further benefits result from the public sector's exemplary role relative to other sectors. For example in Europe, such a leadership role for the public sector is mandated by various directives[153]. Similar role for the public

[153] Energy End-Use Efficiency and Energy Services Directive (2006/32/EC) and a recent recast of the Energy Performance in Buildings Directive (2002/91/EC).

sector has been promoted in China, where government actors should strive for resource efficiency. The public sector's purchasing power can be used to create demand for highly efficient technologies and thus create entry markets for more efficient products, which may otherwise lag behind due to insufficient and unreliable market demand.

Public sector activities and operations cover multiple end-use sectors from buildings to transport and housing, infrastructure and service provision. Such variety of activities offers multiple opportunities for energy savings. The potential for energy savings varies among different activities and in many cases estimated and realised savings can reach up to 20-30%. Available measures include both simple, low cost measures, such as lighting, and more complex and time-consuming improvements in building retrofits, and other infrastructure systems. In addition, changes in user behaviour and other demand-side management initiatives are required if the significant potential for improved energy efficiency is to be harnessed.

Public sector energy use

Although the exact scope of public sector activities varies among countries, the sector commonly includes authorities at national, regional and local levels, government agencies at different levels and various public services. The scope of public services varies depending on which services are provided by public and private actors, mainly in the areas of education, healthcare and social housing. The most comprehensive definition includes in the public sector all sectors in which public actors at different levels act as owners, operators or purchasers of facilities and services (i.e. in which public funds are used to pay for these services[154]).

A major part of public sector energy use results from energy used by public buildings (offices, healthcare and educational facilities, public housing) for lighting, heating, cooling and ventilation as well as equipment in these buildings (e.g. office equipment, white goods). Transportation related energy use combines vehicle fleets used in public services (e.g. post or waste collection) and public transportation. Additional energy use in the public sector is related to utility provision (e.g. water and wastewater treatment) and public lighting (including street lighting and traffic lights). Public authorities manage various other facilities such as museums, prisons and public parks that use energy. Finally, military installations and operations contribute to the public sector energy footprint in most countries.

Data on public sector energy use is limited in many countries. Although sectoral energy charts have been drawn up for years in many countries, the public sector is often not analysed as a separate entity. Some parts of the public sector such as public lighting, water distribution or defence may be analysed as an individual sector or alongside various industrial activities. Pure governmental operations are usually included in the service sector with other services such as banking or insurance.

[154] With a broad definition, the public sector may include public companies and public energy companies. Here however we will restrict the definition to the most common one.

Consequently, few detailed breakdowns of public sector energy use are currently available and are often not comparable due to different boundaries. The range generally considered is 1% to 5%of total final energy consumption[155] and 2-10% of the energy consumption of buildings[156] and 10-20% of the consumption of the service sector consumption.

Energy efficiency in the public sector

Potential for energy savings

The actual energy saving potential in the public sector is most often not known. The estimated and realised energy savings for individual measures are, nevertheless, often as high as 20-30%.

Public infrastructure and buildings offers the largest savings potential. The potential for energy savings in the building sector through improved building design and practices, more efficient lighting systems and electric equipment is huge, and public buildings are no different in this respect. Studies of office buildings in the EU indicate 30% savings potential in energy use.[157]

Public purchasing and public procurement is another area with a significant saving potential. Billions of dollars are used by public actors to purchase energy-using products and services every year. Including energy efficiency requirements for office equipment, lighting systems and white goods purchased through public procurement can achieve notable savings and greatly facilitate the market expansion for energy efficient appliances[158]. Introducing energy efficiency and other environmental criteria in public procurement processes can deliver quick savings, as often the money is already available in budgets, as well as longer term savings through lower life cycle costs of energy efficient equipment.

Public sector buildings provide multiple opportunities to demonstrate and disseminate information about energy efficiency measures. They are a visible aspect of the public sector's operations and activities and thus serve as flagships of public sector leadership in promoting energy efficiency. Programmes can also be used to spread information and experiences of energy efficiency to the wider society through educational elements and inclusion of public sector personnel and e.g. school students in specific programme activities and implementation.

Barriers

Despite visible benefits of energy efficiency in the public sector, large-scale programmes remain relatively few and public sector initiatives face multiple challenges in design and implementation.

[155] In Germany, local authorities (municipalities) accounts for 60% of public sector energy consumption, whereas the central ("Federal") and regional ("Lander") governments have a similar importance with 18% each (Source: Ringel, quoted in ECS, 2008).
[156] i.e. household and service sector.
[157] According to one survey, best-practice office buildings could achieve an annual energy consumption of 50-150 kWh/m2 compared to an average consumption of 400 kWh/m2 (Bertoldi and Anatasiu, 2007)

[158] For example in the US, early action by the federal government to procure only Energy Star labelled computer equipment and printers resulted in a rapid market shift to more energy efficient appliances, as manufacturers were keen to maintain their share of the $10 bn annually spent on energy-using products by the government.

In all, multiple barriers result from the nature of the public sector itself. Organisational, institutional and financial aspects specific to the public sector define how programmes and measures are designed and implemented. A recent report on public sector energy efficiency made a distinction between a lack of enabling conditions and the existence of specific barriers to energy efficiency[159]. Main challenges include:

- Lack of awareness and low priority leading to absent or insufficient policies and targets. Related challenges arise from periodic changes in leadership and competing policy priorities across various levels of government.
- Insufficient institutional capacity and expertise in design and implementation.
- Lack of available financing and budgetary autonomy.

Additional barriers include lack of life cycle costing evaluations in public purchasing processes and a consequent bias towards buying low priced products that may not rank very high on efficiency. Disincentives such as subsidised energy prices are an additional barrier in many countries, in particular in transitional and developing countries (Energy Charter Secretariat, 2008; Van Wie McGrory et al., 2006).

Financing public sector energy efficiency

Lack of available finance for energy efficiency improvements in the public sector is one of the most common and visible barriers to scaling up energy efficiency programmes in many countries. Finance is an issue at all levels from national governments to individual municipalities. There are various options that public sector actors can pursue to finance energy efficiency initiatives. Broadly, these can be divided into existing budgetary funds that can be used with energy efficiency considerations in mind (e.g. public procurement and money allotted for new construction) and additional funding which is channelled to support energy efficiency in the public sector, such as performance contracts, public-private partnerships, and other sources of funding (e.g. carbon finance or external finance from international financing institutions).

Performance contracts that include energy saving targets can be either external (agreements with external companies providing energy efficiency services or products, ESCO) or internal (Public Internal Performance Contracting, PICO). Necessary conditions for successful performance contracting include access to seed finance, economic stability and a legal framework for contract law. Experiences with ESCO financing have highlighted the importance of contractual details, which reinforces the need for technical expertise in contractual issues and a sufficient legal framework to support it. Performance contracting is becoming increasingly popular in both industrialised countries and economies in transition. This option is looked upon as one of the main ways of financing future initiatives in energy efficiency.

[159] Energy Charter Secretariat, 2008.

Public-private partnerships (PPP*)* include private sector operation of some government service, normally coupled with public oversight of the contracted entity. This way, private money is used for investments and operational budgets. The main area where PPP has been used is utilities provision where energy efficiency opportunities are often large.

Examples of public sector projects that generate carbon finance have so far been very few, generating finance from selling emission reductions offers significant potential as more experience from carbon trading accumulates. Developing countries and economies in transition can mainly benefit from external finance in the form of incentives, grants and soft loans from International Financing Institutions.

Table 3.7: Overview of measures in public sector.

Regulations	
Energy performance standards for buildings, appliance, vehicles	USA, France, Australia, Denmark, Portugal
Phase out of incandescent lamps	Uruguay
Mandatory inspections and audits	France, Denmark
Mandatory planning and reporting	Turkey, Mexico, USA
Green procurement for appliances, buildings and vehicles	USA, Denmark, EU
Voluntary agreements	
Voluntary agreements of local/regional authorities	Finland
Financing	
Special funds for municipalities	Hungary (EBRD), Thailand (ADB), Canada (Saskatchewan), USA (California)

These include finance for capacity building activities such as training for municipal energy managers and support for building and strengthening institutional structures that may pave the way for additional investments in the field of energy efficiency.

Typical policies and measures in the public sector

Governments use a variety of policy instruments to achieve policy goals. In the area of energy efficiency, applied instruments cover regulatory, economic, informative as well as cooperative measures. **Table 3.7** gives an overview of policies

and measures implemented in the public sector in selected countries based on the survey.

Public sector efforts to improve energy efficiency in its operations include cross-cutting energy efficiency programmes as well as programmes and measures that target specific issues such as buildings or procurement practices. Different mixes of the types of instruments outlined in Table 3.7 are used by governments at all levels to achieve energy efficiency improvements. The following sections provide an overview of the typical measures being implemented by the public sector, drawing on examples and experience from different countries.

Some countries have energy efficiency programmes with quantitative targets for the public sector. This is the case for instance of some EU countries (e.g. France, Slovenia) and several emerging countries (e.g. China) (Table 3.8). The EU Directive on Energy End-Use Efficiency and Energy Services Directive (2006/32/EC) has specific provisions on the public sector, to show the exemplary role of the public sector (**Box 3.2).**

Cross-cutting programs that target the public sector alone combine a variety of measures focusing on different end-use sectors. When multiple measures are grouped under one coordinated management, programmes can address barriers more effectively and pursue synergy benefits available in different areas. Examples of successful implementation of

Table 3.8 : Example of overall quantitative targets in the public sector:

Country	Programme	Target	Target value	Year
Slovenia	National Energy Efficiency Action Plan	Rate of energy savings	18 %	2016
Spain	Action Plan 2008-2012	Volume of energy savings	0.69 Mtoe	2012
Argentina	Plan Nacional PRONUREE (2007)	Rate of energy savings	10%	
Taiwan, China	Energy efficiency and conservation programme	Energy consumption reduction	7%	2015
Egypt	National Plan of Energy Efficiency	Rate of energy savings	20% (10 Mtoe)	2016
USA	Federal Leadership in Environmental, Energy, and Economic Performance (Nov 2009)	Under preparation		2020

Source: WEC ADEME survey

these programmes can be found for instance in Switzerland[160] and the United States where federal level programmes have been running for years.

More recently, such programmes have been set up in Australia (2006), Japan and a number of European countries.

Some countries have also set up regulations for improving energy efficiency in the sector, especially for public buildings (**Table 3.9**).

Public procurement

Public procurement is an area where energy savings can be achieved within existing budgetary limits, as money for purchases is normally allotted in annual budgets and additional financing is seldom required.

Table 3.9 : Example of regulations for government buildings

Country	Regulation	Objective	Year
France	Mandatory certificates for all buildings Mandatory energy/carbon balance Mandatory standards for new public buildings Thermal retrofitting of all existing buildings	 <50kWh/m2 40% savings	2008 2010 2012
Denmark	Mandatory certificates for all buildings Energy efficiency in public procurement Mandatory implementation of energy savings projects with payback < 5years Public reporting of energy use for buildings >100 MWh Extension to buildings of regional and local authorities		2009 2005 2009
Australia	Maximum specific energy consumption values : • light & power • other uses	 7,5 GJ /cap 4 GJ/m2	2011
USA	Mandatory energy consumption reporting Contracts include energy efficiency products[1] New zero energy buildings Zero energy buildings Fuel use by vehicles	95% All -30%	2010 2010 > 2020 2030 2020
Turkey	Mandatory energy consumption reporting (>10000 m2)		2008
Mexico	Mandatory energy consumption reporting and audits Maximum specific electricity consumption values	 100 kWh/m2[1]	

[160] The SwissEnergy programme comprises since 2001 a number of voluntary measures targeting almost all aspects of the public sector, making it one of the broadest cross-cutting national programmes. SwissEnergy was originally developed for federal and state (canton) levels, but has since been extended to municipalities. By early 2009, 175 cities which accounts for over 1/3 of the population had qualified for the Energy City label.

Box 3.2: Reference to the public sector in the EU Directive on Energy End-Use Efficiency and Energy Services

EU Member States shall ensure that the public sector fulfils an exemplary role in the context of this Directive, so as to communicate the exemplary role and actions of the public sector.

EU Member States shall ensure that energy efficiency improvement measures are taken by the public sector, at the national, regional and/or local level, and may consist of legislative initiatives and/or voluntary agreements.

EU Member States shall publish guidelines on energy efficiency as a possible criterion in competitive tendering for public contracts.

Member States shall facilitate and enable the exchange of best practices between public sector bodies, for example on energy efficient public procurement practices, both at the national and international level.

At least two measures shall be used from the following list set out in Annex VI:

(a) use of financial instruments for energy savings, including energy performance contracting;

(b) purchase equipment and vehicles based on lists of energy-efficient product specifications based on minimum life-cycle cost;

(c) purchase equipment that has efficient energy consumption in all modes, including in standby mode;

(d) replace or retrofit existing equipment and vehicles with the equipment listed in points (b) and (c);

(e) use energy audits and implement the resulting cost-effective recommendations;

(f) purchase or rent energy-efficient buildings, or retrofit purchased or rented buildings to make them more energy-efficient.

Green public procurement practices have been implemented in OECD countries for years. The US was one of the first countries to pursue energy-efficient purchasing initiatives at the federal level in the early 1990s and many more countries have followed since. In Europe, the foundation for green procurement legislation was laid by a communication encouraging member states to increase green procurement in 2003 and two public procurement directives in 2004. The regulatory framework was further strengthened in 2007 when the European Commission regulated that all office equipment purchases at the European level as well as by central authorities in member states must meet or exceed Energy Star labelling requirements. Furthermore, Article 5 of the Energy Services Directive (ESD) assigns an exemplary role to the public sector which includes a variety of procurement related requirements such as purchase of energy efficient equipment and vehicles, and building and renting of energy efficient buildings (**Box 3.2)**. Following such legislative developments, the EU and its member states are very active in public procurement. Examples include green procurement guidelines for public officials and technology procurement programmes which support the market development for energy efficient products through public sector demand[161].

In the US, the Federal Energy Management Programme (FEMP) includes a significant procurement component. The US experience has guided the design and introduction of government purchasing initiatives in Mexico[162] and China[163]. The Mexican and Chinese experiences indicate some key enabling conditions that are required for public procurement programmes. All programmes require mandatory energy efficiency performance standards, effective energy efficiency endorsement mechanisms such as labelling programmes, need for energy savings and identification of benefits of energy efficiency, a successful pilot phase with limited products, technical assistance, and sufficient support and training for purchasing officials. For successful top-down programmes, additional conditions include high-level political endorsement and procurement legislation. Municipally led programmes on the other hand require legislative autonomy and authority for municipalities to set their own purchasing policies, support from municipal leaders as well as from networks of local governments[164].

In addition to energy-using products which have traditionally been the main focus of public procurement programmes, more attention is beginning to be directed at services. For example in Australia, where the government leases more office space than it owns, strict standards for the energy performance of leased office buildings have been enacted[165].

Demonstration : building retrofit programmes

Government-owned buildings form a major part of public sector energy consumption. In addition to office buildings, schools, hospitals, military facilities and public housing estates are examples of the public sector's building stock. Retrofit programmes are introduced at periodic intervals to maintain and improve public buildings, which offer significant opportunities for cost savings, improved environmental performance and higher occupant satisfaction if energy efficiency considerations are integrated into retrofit plans and their implementation.

Buildings suitable for retrofit programmes are often identified and selected through audits of public buildings. Typical measures included in retrofit

[161] More information regarding public procurement in the EU is available in the Annex.

[162] The Mexican programme was initially designed in 2000 to be federally led and very ambitious, but produced few results until the programme was modified in 2004 to focus on local governments. ICLEI, Local Governments for Sustainability, and AMMAC, a Mexican association for municipalities, launched a pilot programme in eight municipalities. Limited products (office equipment and lighting) that qualified for the Mexican Sello FIDE or the US Energy Star label were selected for the pilot phase. By 2006, nearly all pilot municipalities had begun purchasing energy-efficient products according to the programme specifications.

[163] The programme focused initially on compiling comprehensive lists of labelled and domestically available energy-efficient appliances and on training purchasing officials. Introduction of a new, mandatory labelling scheme presented additional challenges to the programme's implementation, as the programme was set up based on a voluntary labelling scheme.

[164] (Van Wie McGrory et al., 2006).

[165] Leased office spaces above 2000 m2 are included in the Energy Efficiency in Government Operations (EEGO) policy, which includes provisions for minimum energy performance standards based on the Australian Green Star buildings rating system, frequent energy metering, and review of metering data.

programmes are indoor lighting replacements, insulation improvements in colder climates and air-conditioning upgrades in warmer climates, and water heater replacements. In addition to retrofit measures, audits can identify measures related to maintenance and operational management on buildings. Building retrofit programmes require accurate and comprehensive data on building energy use. Without such information, it is difficult to identify where largest savings are available and also monitor building energy performance post-retrofits. Installation of adequate metering equipment is thus often the first step of any retrofit initiative. In addition to direct savings resulting from retrofit measures, public sector retrofit programmes are frequently used to demonstrate more efficient building techniques and benefits of new equipment[166]. Experiences accumulated in such programmes can be used effectively to increase public awareness and the skills of local builders and suppliers, which can serve as a catalyst in introducing energy efficiency measures in industrial and residential building segments.

Voluntary building standards

Adoption of voluntary building standards by public actors is relatively recent. This measure can facilitate the use of environmentally sound and efficient building practices not only in its own building stock, but also in the general building stock through requirements on leased properties. Public sector demand can also be used effectively to disseminate awareness and expertise on new materials and building techniques across the building sector to overcome traditional inertia. Another important aspect of voluntary building standards is their impact on building regulations. While they use building codes as their baselines against which they set their own requirements, in the long term they also drive the development of building regulations. By adopting voluntary building standards as the required performance level of its own buildings, the public sector can prepare the market for stricter regulations. In this respect, US experience with the Leadership in Energy and Environmental Design (LEED) rating system makes for an illustrative example (**Box 3.2**).

Box 3.3: US experience with the Leadership in Energy and Environmental Design (LEED)

Public sector endorsement of the rating system at federal, state and local levels has been instrumental in disseminating information and expertise of green building practices across the country. LEED rated buildings have demonstrated 20-30% energy savings in comparison to national building stocks and building code requirements, which puts public sector actors in an advantageous position in anticipation of increasing regulatory demands on public sector energy reduction and emission reduction targets. Public sector actors in the US have been instrumental in making LEED the fastest growing voluntary building rating system in the world, both via their actions at home and abroad through demonstration of LEED in US embassies and military bases[167].

[166] Examples of such approaches include the municipal EcoEnergy network in Bulgaria and a regional school retrofit programme in Russia, where replication and dissemination of results country-wide was given high priority. More information on the Russian programme is available in the full case study.

[167] More details of the US LEED system in public sector use is available in the full case study.

Voluntary building rating systems were initially developed for new constructions, but have since been expanded to cover major retrofit operations as well in order to tap into the large efficiency potential in existing buildings.

Lighting programmes

In addition to building related lighting retrofits, efficiency gains are available in the area of public lighting including both street lighting and traffic lights. New technologies such as light-emitting diodes (LED) can deliver significant savings and have often short payback periods. Increasing the efficiency of lighting systems delivers multiple savings from lower energy use, longer product lifetimes and less frequent replacement and maintenance[168]. Lighting retrofits are easy and quick to implement and costs are reducing all the time while markets for energy efficient lighting expand and domestic suppliers become available especially in developing countries. Lighting programmes rarely require extensive technical expertise and support, which makes them an easy first step for many public actors wanting to improve the energy efficiency of public lighting services. Consequently, lighting programmes are often successful in less developed countries which might lack institutional and financial capacity to implement wider-scale programmes[169].

The gains from lighting programmes across the world have been notable and an emerging trend in the lighting area is regulations that ban the purchase and use of less efficient technologies such as incandescent light bulbs. These developments change the lighting market as a whole, but often include a leadership role for the public sector through the use of lighting in public facilities, spaces and infrastructure[170].

Learning and replication

Opportunities to harness energy efficiency potential in the public sector are available in every country. Although available technologies, legal frameworks and the level of technical expertise may vary significantly between countries, finance and capacity are available everywhere and can be further developed through existing networks between public sector actors at different levels. Depending on the economic structure of a country, climatic conditions and various other factors the exact scope for energy efficiency improvements may also vary, but as public sector activities reach across various end-use sectors there are always opportunities ranging from small-scale lighting retrofits to larger scale utility upgrades. Public money is being used to purchase products and

[168] When the city of Stockholm in Sweden shifted to LED traffic lights, their primary motivation was not the 85% energy savings delivered by the technology but the much longer lifetime which reduced the need for maintenance and thus made the technology very appealing to the public works department.

[169] One example from the city of Ekurhuleni in South Africa is provided in the Annex.

[170] For example, Uruguay banned the purchase incandescent bulbs in the public sector in 2008, from which it is expected to spread to other sectors once public leadership has established sufficient experience.

services and build facilities anyway, and by integrating efficiency considerations into procurement processes public money can be more effectively and with higher long-term returns.

There are thus few restrictions for introducing energy efficiency measures regardless of the income level of an individual country. The first enabling condition is recognition of the potential of energy efficiency measures to deliver cost savings and emission reductions and consequently sufficient priority both in terms of policy and budgetary allocations. The potential to learn from the experiences of other countries at different level of governance is enormous and existing networks for public actors can provide instrumental support in this process. In addition to horizontal learning and dissemination of experiences across national borders, learning opportunities are available also from one level of government to another. In Europe, the Energie-Cités DISPLAY campaign has successfully engaged municipalities in different EU member states to learn from each other's experiences, but involvement by regional and national government representatives has been very limited (Harris, 2005).

The global experience of for instance lighting programmes and public procurement initiatives indicates that public sector energy efficiency experiences can be disseminated successfully. Thus, it is important to recognise learning opportunities and replication potential not only across countries but also within them across different levels of governance.

Measures focused on low income households[171]

Measures focused on low income households contribute to the three aims of sustainable development: social, by ensuring an affordable access to basic energy services (e.g., heating, cooking, lighting); economic, by reducing the weight of the energy bill in their expenses; environmental, by reducing indoor air pollution related to the use of solid fuels.

Energy efficiency programmes for low income households are often (but not always) related to the objective of alleviating energy / fuel poverty. But the definition of energy or fuel poverty varies from one country to the other. The concept of energy poverty refers mainly to the issue of access to safe and clean forms of energy. So the corresponding fuel poors are mainly living in rural areas of developing countries[172].

[171]This section is adapted from the following report "Measures focused on low income households", prepared by Jean-Sébastien Broc and Bernard Bourges, Ecole des Mines de Nantes, France, with additional contributions by Santiago Garcia Herreros and Luca Lo Re. The report reviews four energy efficiency programmes for low income households: Brazilian Electricity Public Benefits Fund, ProBEC (Programme for Biomass Energy Conservation) in Southern African countries (SADC), the UK Fuel Poverty Strategy and the WAP (Weatherization Assistance Program) in the United States.
[172] This was actually the topic of a previous WEC report (WEC, FAO 1999).

summarises the definitions and statistics encountered in the case studies.

In Brazil, the issue of fuel poverty mainly concerns the fast growing populations living in urban slums. This situation is materialised by eligibility conditions for the social tariff, which is based on consumption levels, connection type and the inscription to other social benefits. In Europe, the EPEE[173] project has proposed a general definition for fuel poverty

:

"Fuel poverty as a household's difficulty, sometimes even inability, to adequately heat its dwelling at a fair, income indexed price".

In the United States, HSS (the US Department of Health and Human Services) produces regular statistics on low income households and energy, through its programme named LIHEAP[174]. It refers essentially to the income level: low income households are households with incomes below 150 % of HHS' poverty guidelines.

Table 3.10. Definitions used, context and size of the issues for the four case studies

	Definitions used
Brazil	Based on consumption levels, connection type and inscription to other social benefits.
SADC*	Energy poverty mainly related to access to clean and safe energy.
UK	Household spending more than 10% of their income on fuel to maintain heating comfort
US	Households with incomes below 150 % of HHS' poverty guidelines.
	"Size" of the issue
Brazil	Around 37% of residential consumers are qualified and benefit from the Social Tariff (i.e. around 18 M). Corresponding subsidies amount to US$650 million. Their average consumption is 780 kWh/year, of which 70% for refrigerators and 20% for lighting.
SADC	More than 80% of the population in SADC countries still rely on biomass for the bulk of their energy requirements, consuming on average 2 tons of firewood per year.
UK	4 M households in fuel poverty in the UK, whose 3.25 vulnerable households.
US	Between 23 and 34 million low income households, with energy expenditures representing 13.5% of their income.

[173] EPEE (European fuel Poverty and Energy Efficiency) estimates that between 50 and 125 million people could be considered as fuel poor (www.fuel-poverty.org).

[174] The Low Income Home Energy Assistance Program (LIHEAP) aims at assisting low income households in affording their energy bills (http://www.acf.hhs.gov/programmes/ocs/liheap/index.html).

Experience from the case studies

In most of the countries, energy efficiency programmes were not the main policy measures used to fight against fuel / energy poverty.

In the rural areas of developing countries, the priority (when dealing with energy issues) has mostly been set on increasing the share of the population having access to "modern" energy sources (i.e. mainly electricity and natural gas or LPG). Consequently most of the efforts have been focused on the development of new energy infrastructures.

However, despite ambitious political objectives, recent analyses highlighted that the means finally engaged are so far insufficient. Especially in rural areas, many inhabitants may still wait for years before seeing the situation changes. And these are most often households in situation of poverty.

The SADC case is an illustration that the promotion of simple solutions can make it possible to improve the energy efficiency for cooking with biomass. This can be done using local resources, developing small local businesses and above all without waiting for considerable funding.

In the urban slums, once electricity is available in an area, one of the major energy issues is the level of illegal connections. On the households' side, this causes unsafe connections leading to incidents from little damages to serious fires or electrocutions. On the suppliers' side, this leads to "non-technical" losses, i.e. unpaid consumption. In Brazil, this "power theft" was assessed to represent around 17% of the electricity sales for residential customers, being as much as 25% in the poorest regions.

The first measure taken by the Brazilian Government to help low income households regularize their situations was to provide them with a social tariff for electricity. In the 1990's, distinct forms of social tariffs existed, according to the different utilities. Then the Brazilian regulator, ANEEL, defined a national frame for these tariffs in 2002. This became necessary due to the liberalisation of the electricity market and the obligation set on utilities to achieve progressively a 100% electricity coverage in their service areas.

The Brazilian case shows that energy efficiency programmes are cost-effective solutions to reduce the need for energy subsidies, while improving the quality of the services delivered (safety, etc.) and the payment rates.

In OECD countries, as emphasised in the EPEE project, the three main factors whose combination leads to fuel poverty are: low household income, poor heating and insulation standards and high energy prices. As most of these countries have now liberalised their energy markets, the options to act on energy prices are rather limited. However, the regulator may ask to energy suppliers or distributors to take measures to protect the most vulnerable customers, as recently required in the update of the EU directive on electricity markets.

Consequently, the main public efforts have been dedicated to public funding for social tariffs or direct financial support to help low income households paying their energy bills[175]. The recent combination of energy prices increases together with the economic crisis has caused a dramatic growth in the number of households needing assistance[176].

In the US, energy efficiency programmes for low income households have always existed in parallel to direct financial aids. Actually the Weatherization Assistance Program (WAP) was initiated in 1976, while LIHEAP started in 1981. However, a greater priority was put on direct

[175] This is the case in UK with the Winter Fuel Payments (regular assistance) and Cold Weather Payments (emergency aid for extremely cold weeks). In the US, the LIHEAP (Low Income Home Energy Assistance Program) provides low income households with similar direct financial aids funded by the Federal State and administered by each state: Block Grants (regular assistance) and Contingency Funds (emergency situations).

[176] For example in the US, the Block Grants of LIHEAP were more than doubled to $4.5 billion in 2009

financial aid compared to improving the energy efficiency of the housing stock[177].

In the UK, even if local programmes existed in the 1990's, the energy efficiency programmes for low income households really started to become important in the early 2000's, after the definition of the UK Fuel Poverty Strategy. Like in the US, public funding for these programmes where much smaller than these for direct financial aids[178].

The Brazilian Public Benefit Funds

The Brazilian Public Benefit Funds is an obligation set on utilities to invest 0.5% of their annual revenues in energy end-use efficiency programmes, of which 50% in end-use efficiency in low-income households (since 2005). This represents a total investment of US$ 80 million/year.

Most projects aim at replacing refrigerators and/or installing CFL. Some of them work in a give-away basis. In other cases, the user is involved paying a part, or the whole of the investment. In such situations, various scenarios are present in current practice, including rebates and monthly payment integrated to the electrical bill.

ProBEC: Programme for Biomass Energy Conservation

ProBEC is a development programme initiated by the Southern African Development Community (SADC) and implemented by GTZ. The total institutional funding for 1998-2008 was around 10 million Euros. Its principles are to promote improved energy solutions (especially improved cooking stoves) through market development and policy support. First, preliminary studies are performed in each participating country in order to find the most adequate way to manufacture improved cook stoves, taking account of local habits, and especially looking for solutions that can be produced locally (to ensure that the devices will be affordable and to develop the local economy). These studies are also used to select a local or national coordinator (most often a NGO).

Then public actors, NGOs and other stakeholders (e.g. research organizations) are trained to support the private sector with training, awareness campaigns, monitoring, etc. This way, local private entrepreneurs (formal and informal sector) are trained to produce and market the chosen efficient stoves. This "training chain" makes possible the "commercial" approach which constitutes the core of ProBEC. A coordination office at the regional (i.e. SADC) level provides each participating country with technical support and policy advice.

[177] While $55 billion were spent in funding LIHEAP for the period 1981-2009, the direct public funding for WAP amounted to around $6 billion for the period 1977-2009, i.e. more than 9 times less.

[178] Over the period 2000-2008, the global public funding to alleviate fuel poverty amounted to more than £20 billion, whose around £5.6 billion for the two main energy efficiency programmes (£4 billion for the Decent Homes Standards, and £1.6 billion for the Warm Front Scheme).

The UK Fuel Poverty Strategy

The UK Fuel Poverty Strategy includes policies on the three main factors affecting fuel poverty: energy prices (market regulation), household incomes (direct financial aids) and housing energy efficiency. The energy efficiency programmes are a mixture of direct public policies and legal obligations on energy suppliers. The three major energy efficiency programmes are the Warm Front scheme, the Carbon Emission Reduction Target (CERT) and the Decent Homes Standard.

The Warm Front scheme is a English programme launched in 2000 by the Department for the Environment, Food and Rural Affairs (DEFRA)[179] which relies upon a contractor (Eaga) for its administration. Eaga manages 139 sub-contractors responsible for the installation of heating and insulation measures. The scheme provides a grant to pay the installation cost of heating and insulation measures in vulnerable private sector households. A technical survey (free energy audit) is done before implementing the actions, and then a quality inspection and "aftercare" once the works done.

The Carbon Emission Reduction Target (CERT)[180] is an obligation set on energy suppliers in Great Britain to achieve energy savings and reductions of carbon emissions in the domestic sector. 40% of the corresponding energy reduction target has to be met among a so-called "priority group" which includes low income and elderly (70 and over) households.

The Decent Homes Standard[181] is a set of requirements on minimum energy performance (among others) for social housing in England (from 2001 on). Then objectives are set in terms of percentage of the social housing stock complying with the standard by given deadlines. The corresponding public investment programmes involve the national government, the local authorities and the social housing associations.

The US Weatherization Assistance Program

The Weatherization Assistance Program (WAP) is a US federal programme started in 1976: the US Department of Energy (DoE) provides funding and technical guidance to every states, which then define their own programmes to provide low income households with weatherization services[182]. These services are managed by local agencies and include a visit by an energy auditor, then the installation of the chosen energy-saving measures and finally the verification of the works done by an inspector.

[179] Now the Department of Energy and Climate Change (DECC).

[180] See the section on energy savings obligations for more information on the CERT and its predecessor, the EEC (Energy Efficiency Commitment) which was started in 2002, and which required 50% of the savings from the priority group.

[181] As well as the Scottish Housing Quality Standard (from 2004 on) and the Welsh Housing Quality Standard (from 2002 on).

[182] The WAP is going to receive more than a 20-fold increase in funding (from $227 million in 2009 to $5 billion in 2010) due to the "economic stimulus plan" decided by Obama's administration.

These services apply for dwellings needing improvements, but not too critical. Dwellings requiring "heavy" refurbishments are not eligible for this programme.

3.8.1 Policy instruments

Diverse policy instruments can be considered for programmes targeted to low income-households. However, they always include a major funding component, either direct public funds, or through obligations set on private stakeholders. This is indeed essential as the target population has by definition low resources and cannot afford themselves the energy efficiency actions. Then the main issues are the delivery mechanisms, both for the funding and the actions.

For the funding, this is related to the definition of eligibility conditions for the households (see below). And these are often relying on other existing frames (e.g. for other social policies), in order to be consistent with these other policies, to minimise the administration costs and to use rules as fair as possible. Therefore, the possibilities of delivery mechanisms for funding depend on the types of eligibility proves that can be used. This is especially important when considering options making distinctions between the potential participants.

These differentiations are mainly made according to income levels, main energy careers (fuel oil, natural gas, electricity), and actual state of the dwelling (e.g., energy performance level). The objective of using such criteria is to target the most vulnerable households, taking account both their own resources and their current level of energy expenditures.

The main difficulty is then to find the best compromise between fairness and minimisation of administration costs. Fairness would require grants or other aids proportional to the needs or at least using several eligibility thresholds. Minimisation of administration costs would require delivery schemes as simple as possible, especially limiting the need for registration and controls.

Moreover, as large funding is necessary to reach the high number of potentially eligible households, the programmes are also design to favour leverage effects, through attracting funding from complementary sources.

For the actions, the delivery mechanisms are related to the level of involvement expected from the households. The delivery of the actions may be fully supported by the programme agents, corresponding to a case of "one-way assistance" (e.g., for certain UK projects). Or at the opposite, households may be the core of the implementation of the actions, corresponding to a case where empowerment is looked for (e.g., ProBEC).

The primary key factor in the actions delivery is the availability of a sufficiently numerous and skilled workforce. Therefore all programmes include direct (i.e. public) or indirect (i.e. private) training schemes. These trainings are also a good way to make households become local programme agents (empowerment or "commercial" approaches).

Then the installation of the actions is most often preceded by a technical survey. Likewise, the installation is usually followed by a quality inspection. The pre-studies are to propose solutions specific to the audited dwellings or intervention areas, as experience proved that this led to higher results than "standardised" actions. The post-inspections are to ensure public money has been used effectively and households have been provided with good quality services.

Eligibility conditions

Together with raising sufficient funds, the targeting of the programmes is most often the main difficulty. Indeed, the theoretical objective is to make the best use of the money spent, by reaching first the most vulnerable households. While easily said, this may be very hard in practice.

The principle is to look for the best compromise between fairness and minimisation of administration costs. That's why most often the eligibility conditions are defined according to other existing frames (e.g., other social policies), thus using already available means of registration and control.

These pre-existing criteria are mostly related to income levels, and to a lesser extent to the household composition (e.g. eldery, disabled, etc.).

In addition, more technical criteria (e.g., connection type, main energy career, energy certificate of the dwelling, energy bills) may be used to complement the social dimension by taking account of the level of energy expenditures and/or the energy performance of the dwelling.

A regular monitoring and evaluation of the programme is often needed to detect possible bias leading to "mis-targeting". Actually most of the programmes have refined their eligibility conditions over time. This may occur in both situations:

- because households which were not really vulnerable did receive a significant share of the aids;

- and/or because some of the most vulnerable households could finally not be eligible, or were not claiming for the aids they could get.

Careful attention should therefore be dedicated to eligibility and targeting issues. No perfect solution exists, and the best formula mostly depend on the national (or even local) context. A common recommendation from experience feedback is to develop local partnerships. Because local stakeholders (e.g., local authorities, NGO) have a good knowledge of their territories and may therefore advice where to focus the efforts.

Evaluation system and issues

As most of the programmes imply significant public funding, they are subject to monitoring and evaluation. Corresponding reports and studies are most often quite comprehensive about the analyses of the processes (i.e. how the programmes work, success and failure factors, etc.) and the outputs (i.e. number of participants, number of actions implemented, etc.).

However, there are fewer information on final impacts, in terms of costs and energy savings (especially ex-post data). Except for the case of WAP (United States), due to a longer experience and a more sophisticated evaluation system.

This may be explained by evaluation difficulties specific to “low income” programmes, particularly more obstacles for data collection, lack of official data, unusual conditions of energy use.

Another specificity of evaluating “low income” programmes is the bigger importance of non-energy benefits (e.g., socio-economic impacts), above all when assessing cost/benefit ratios. They most often improve significantly the cost-effectiveness of the programmes. Put in monetary terms, they can represent as large (or even higher) benefits than the direct energy savings. And this is actually expected from the programmes’ design, as their objectives are much broader than energy savings (e.g., health impacts, housing improvements, etc.).

Finally, it has to be noticed that the “low income” programmes may appear to have low cost-effectiveness on a short-term perspective (especially compared to other programmes), however they come out to be very valuable on a mid- or long-term perspective. This has to be taken into account when reviewing the decisions for their funding.

Main results

The main results of the programmes are summarised in **Table 3.11.**

Table 3.11. Main results of selected programmes for low income households

Brazil (Public Benefit Funds)	- Around US$80 million invested/year in "low income" programmes ; - 5 million CFL and 60 000 efficient refrigerators installed over 2005-2007 ; 18 000 solar water heaters installed and upgrade of existing electrical installation of 130 000 dwellings in 2005/2006 - Average unitary savings around 70% or 750 kWh/year for refrigerator replacement (high standard deviation of 390 kWh/year, i.e. +/- 50%); - Replacing incandescent bulbs by CFL led to around 23% savings and peak demand decrease by 15 to 20%
SADC/ ProBEC (Programme for Biomass Energy Conservation)	- Around 97 000 stoves produced/sold from early 2000's to May 2008, and then 120 000 stoves from June 2008 to December 2009. - Average 50% decrease in use of firewood, but with a wide dispersion (20 to 80%) due to diverse levels of awareness and practices; - Up to 30% of monthly income savings when fuel is bought and time savings between 10–20 hours/week, allowing women to engage in productive labour.
UK (Fuel Poverty Strategy)	**Warm Front Scheme** - Around 2 M households assisted over 2000-2009; - Average annual fuel bill reductions of between £360 and £400; - increased average energy performance of buildings of 60%; **EEC/CERT** - Around 6 M households have benefited from subsidised or free insulation over 2002-2009; - EEC1 (2002-2005): around 23.7 million CFLs, over 1.2 million appliances and 0.23 million cavity wall insulations; - EEC2 (2005-2008), lifetime discounted savings of around 82 TWh (85% from insulation measures), representing around 44% of the whole savings; - CERT*: 44% of the total achievements among the Priority Group (around 70% from insulation measures and 28% from lighting). **Decent Home and other Standards** - 36% reduction in the number of social sector homes failing on the thermal comfort criterion between 2001 and 2009; - Doubled glazed windows for over 1 M council houses, new central heating for over 1 M houses and improved insulation for over 820,000 houses between 2000/01 and 2007/08,. - Estimated average reduction in tenant's fuel bills of £152 a year (2008 prices) between 1996 and 2006.
US (Weatherization Assistance Program)	- More than 6 M households received weatherization services over 1976-2009; - Annual energy savings of around 3.5 Mtoe/year ($2.1 billion/year); - Average annual energy savings per household of about 30% ($300-$400).

* April 2008 – January 2010

Problems encountered and adaptations

The main recurrent problems encountered in "low income" programmes are related to two interrelated issues: targeting and funding. The underlying objectives are to ensure that the public money is used as cost-effectively as possible, while bringing improvements to the most vulnerable households.

One common question is to find the most adapted level of aid (e.g., grants), i.e. the best compromise between high enough subsidies to make actions affordable by vulnerable households, and moderate enough subsidies make possible to offer them to the highest number of households.

On the technical side, a frequently observed issue is a too narrow list of promoted/eligible actions. Indeed, efforts may be focused where solutions are well-known (e.g., cavity wall insulation in UK) or where the needs are supposed to be the most important (e.g., heating in the US). However, field feedback showed that this leads to unfair distribution of subsidies, as dwellings not corresponding to "usual" cases were found to be in fuel poverty conditions as well as or even worse than the "usual" cases.

Programmes were then adapted to cover more situations (e.g., extending the lists of eligible actions). In addition, specific approaches were encouraged instead of "standardised" ones, especially by using preliminary studies or advanced energy audits. This often comes with the development of local partnerships and area-based projects.

Possible interactions between policies with distinct objectives are another recurring problem, which can also be an opportunity. These may occur between energy efficiency policies and social or health policies, but also within energy efficiency policies between "low income" programmes and other programmes. The main issue here is often the distribution of funding among the different programmes. However, there may also be synergies, e.g., putting in common administration means, developing partnerships.

Finally, the available experience feedback also highlighted that, as usual, the devil always remains in the details, especially in the implementation details. That's why regular monitoring and evaluation are essential to adjust the programmes and favour continuous improvements.

Feedback and recommendations

The four case studies analysed provide interesting feedback that can be used to draw recommendations for future programmes:

- programmes should be organised in multilevel frameworks;
- a core public funding should be maintained together with attracting additional funding;
- low income programmes should be long lasting activities;

- local communities should be involved;
- training schemes should be included;
- tailor-made actions achieve higher savings;
- need pointing out non-energy benefits and synergies with related programmes;
- monitoring and evaluation is important.

Organisation and management of the programmes

All the programmes analysed are structured according to a multilevel framework, at least with a national and a local level. The central level is used to raise significant funding and to put in common resources and experiences (e.g., through a national technical support centre).The local level appears to be the most adapted for the implementation part, thanks to a good knowledge of the territories and communities, and to partnerships' opportunities. Coordination of both is often favoured by the development of local agencies' networks.

Funding

The alleviation of fuel poverty is above all a matter of public policies. Therefore it is essential to ensure a public core funding over time. But most of the countries are facing restrictions for public budgets. Consequently, it is important to maintain or develop leverage effects. Most of the programmes analysed managed to attract additional funding through the guarantee of quality and cost-effectiveness for their results. This is a key success factor in the long run. In parallel, regular monitoring and evaluation can be used to adjust the eligibility criteria, level of grants, etc. over time, according to experience feedback and past achievements.

Looking for lasting activities

The alleviation of fuel/energy poverty is a long run issue. Of course strong immediate efforts are welcome as the challenges to address are considerable and currently increasing. But past experiences emphasised that continuous support is needed over time, as eradication of energy poverty cannot be reached in one shot. Likewise, regular activities are often mentioned as a key factor to maintain the commitments of partners and households.

Involvement of local communities

Most successful projects have in common to succeed in involving local communities in their activities. This is one of the key messages: programmes targeted towards low income households should not be designed as "one-way" assistance. Of course providing low income households with technical support and financial aid is a prerequisite to improve their life conditions. However, they should not be considered passive recipients of these benefits. Unless, costs to reach the households would be higher, effective adoption rates of the measures would be smaller, etc. The target population can be the best ambassador for the programme in their neighbourhood. They can also form the required workforce, then creating local economical activities.

Training schemes

Training schemes are needed for two main reasons:

- on the one hand, most of the programmes analysed recently aim at large changes of scale, inducing needs in new but skilled workforce;

- on the other hand, the dissemination of energy savings measures is a vector for local economical activity and therefore creating/maintaining local jobs, provided local staff can be trained to answer the needs.

Moreover, the training schemes are also a key component to ensure a good combination of local and national levels. “Training chains” (i.e. training of future trainers) are for example a good way to create a snowball effect and increase the number of projects.

Tailor-made actions achieve higher energy savings

Experience feedback proved that specific advices leading to tailor-made actions achieve higher savings than straightforward and standardised actions. However this may raise the programme costs. Developing enhanced energy audits or good practices database can be good ways to take advantage of past experiences improving the process effectiveness, while taking account of the possible specificities of the dwellings and households.

Non energy benefits and synergies with other policies/programmes

All the programmes analysed achieved significant non energy benefits (e.g., health impacts, job creations, etc.). Programmes should be designed taking account of the whole context, especially of other policies/programmes (e.g., social or health policies) which may have related objectives and target the same populations. Means, skills, experiences, etc. can be put in common (e.g., to make contacts with the targeted households). Moreover, including the non energy benefits in the cost/benefit analysis significantly raises the added value of the programmes.

Importance of monitoring and evaluation

Experience feedback from all programmes analysed highlighted how regular monitoring and evaluation were necessary for their sustainability, especially by:

- detecting success / failure factors and supporting continuous improvements (see e.g., the regular revisions of the eligibility criteria or of the list of promoted actions);

- attesting the achievements in order first to defend public commitments (both, financial and political), and second to attract complementary funding.

Conclusions

The current context (economic crisis, energy prices increases) unfortunately strengthens the need of public policies for alleviating fuel poverty. Low income households are particularly affected by this situation. Actually, the number of energy efficiency programmes or measures targeted to low income households has been growing, even if they are difficult to list due to differences in definitions and objectives.

All the programmes analysed have aimed at reaching changes of scales in order to answer the huge challenges of eradicating fuel poverty. Some have recently received a considerable intensification in their political and financial support[183].

Feedback from related policy frameworks highlighted how complementary are measures on energy prices (e.g., social tariff, regulation), household income (e.g., social benefits, direct financial aids) and energy efficiency programmes. The two former (energy prices and household income) are used for short term curative assistance, which can reach directly all low income households. The latter is meant to solve the issue in a preventive way, but needs more time to reach the households and get the works done. Moreover, reducing expenses for curative measures (mainly social tariff and direct aids) turns out to be an effective incentive for public authorities and/or utilities to develop "low income" programmes.

The review of the four case studies highlighted two main difficulties encountered by these programmes: raising funds in a sustainable/lasting way, and reaching the most vulnerable households (targeting issues and eligibility criteria).

The policy instruments used to answer these needs are closely linked to the national or local context and to the possible means of registering participants and controlling their eligibility. The main funding source is usually the public authority in charge of the corresponding policy. But it may also be the utilities or energy suppliers through obligation schemes. Then the delivery mechanisms are designed to look for the best compromise between fairness (higher aids to more vulnerable households) and simplicity (minimising administration/transaction costs).

Looking at the organisation of the programmes, the coordination of a central (most often national) and a local level appears to be a key success factor. A national framework is essential to develop large scale activities, especially by raising significant funds. Then local management makes it possible to set up effective partnerships, mobilising all relevant actors and skills.

[183] The most striking example is the case of the US Weatherization Assistance Program) which should receive more than a 20-fold increase in funding due to the "economic stimulus plan".

The proximity in the delivery of services or actions is crucial for several reasons: to target the most vulnerable households (knowledge of the territories, contacts with the communities), to involve local communities, especially community leaders, and to ensure the appropriation of the actions by the households (for taking part in the programmes, and then for changing behaviours and habits when needed).

Moreover, in addition to the targeting and the involvement of communities, local implementation schemes create also opportunities to gather the various social policies addressing the different aspects of poverty, deprivation or health issues. Putting in common resources and experiences, grouping contacts' prospects, etc. are ways to increase the efficiency of all related activities. Moreover, this may also be a solution to compensate the decrease or insufficiency in the public services coverage in certain areas[184], by developing local contact points[185].

Another key issue for energy efficiency programmes is the quality of the services delivered and the equipments installed. These programmes need to take advantage of best available technologies as any other energy efficiency programme. Indeed, this may induce higher investments' costs, but taking account of global lifetime costs this definitively proved to be more cost-effective[186].

In parallel, there is also a need to centralise funding sources, or at least information on existing funding sources. There are as many programmes as international organisations (UNDP, World Bank, WEC, UNFCCC, etc.). Consequently it is quite complicated to have a global view of all possible partnerships. Actually it may be time and resource consuming for implementers to look for international support. One option could be to create a specific international "energy poverty alleviation" fund as discussed by Sagar (Sagar 2005). The potential of using Clean Development Mechanisms for this type of programmes has also been studied (Manning 2008). Finally, the WEC is already involved together with the WBCSD (World Business Council for Sustainable Development) and the WEF (World Economic Forum) in the Energy Poverty Action[187]. The priority of this initiative is on developing access to modern energy for poor households. It could be considered how the same frame could be used to support complementary energy efficiency programmes.

[184] Due to the combination of restrictions in public budgets, liberalisation of certain services and finally the new "performance" approaches of services, increasingly relying on web-based interfaces or overcharged hotlines.

[185] A good example of such local networks is the French PIMMS (*Point Information Médiation Multi Services*, www.pimms.org) network, initiated in 1995, which offers to households advice on administrative procedures, support for mediation with private companies (e.g., to negotiate payment schedules), etc.

[186] For example, it has been observed that the markets of some developing countries were used by manufacturers to sell off their appliances' stock that was below the minimum requirements of other countries (Carreño Hoyos 2009)

[187] See http://www.weforum.org/en/initiatives/EnergyPovertyAction/index.htm or http://www.worldenergy.org/other/startdownload.asp?DocumentID=1761

Evaluation of residential smart meter policies [188]

This section studies smart meter programmes for residential consumers and its influence on energy efficiency.

Smart meters are measuring devices which send consumption information to the utility using communication technology at pre-programmed intervals, from hourly to every 15 minutes. Such meters can also provide information to the users to better manage its consumption; as such they can contribute to improve energy efficiency. Smart meters programmes can be divided into two categories: systems efficiency programmes and feedback programmes.

Systems efficiency programmes use smart metering technology to improve the overall efficiency of the electricity system. They include demand response[189], integration of micro generation, coordination of consumption with the availability of clean energy and integration of electric vehicles. These programmes enable consumers to lower their costs and also to decrease the overall costs of electricity supply, by lowering the number of power plants needed.

The second type of smart meter programmes encourages energy efficiency (feedback programmes) by providing information to consumers, through for instance in-house displays, in order to raise their awareness, to show them the implications of their consumption habits and to help them change their behaviour and lower their consumption.

Unless smart meter regulation requires improved efficiency measures, utilities will only have weak incentives to use smart meters to help consumers lower their consumption: lower sales can be seen as lower profits. Smart meter infrastructure creates a platform on which a variety of highly effective energy efficiency programmes can be built, but they only form

[188] This section is adapted from the report "Evaluation of residential smart meter policies" prepared for ADEME and WEC by Jessica Stromback and Christophe Dromacque, VaasaETT Global Energy Think Tank. The report includes a review of the situation in five countries: USA (California), Australia (Victoria), South Korea, Brazil and Sweden. It is available on the WEC web site.

[189] Demand response is defined by FERC, the US Federal Energy Regulatory Commission as "programme established to motivate changes in electric use by end-use customers in response to changes in the price of electricity over time, or to give incentive payments designed to induce lower electricity use at times of high market prices."

Table 3.12 : Overview of selected smart meter programmes

	Sweden	Victoria (Aus)	California (USA)	South Korea	Brazil
Residential Consumption	9,000 kWh	5,700 kWh	6,150 kWh	3,822 kWh	1,780 kWh
Numb of residential customers	5.07 m	2.4 m	14.8 m	12 m	54 m
Capacity issue	No	Yes	Yes	No	Potential
Renewables (% energy mix)	1.5	2	14	0.5	5.27
Residential Competition	Yes	Yes	No	No	No
Presence of Regulated Prices	No	No	Yes	Yes	Yes
Timeline of Smart meter roll out	2009	2013?	2012	2020	2021
Status	Completed	Mandated	Mandated	In progress	Discussion
Who pays?	End-user	End-user	End-user	DNO	Discussion
Main Drivers	Improve data handling	Peak Clipping / customer feedback	Peak Clipping / overall consumption reduction	Peak clipping	Theft reduction

one part of this infrastructure, the rest is made up of regulatory structures, financial market structures, enabling communication technology, marketing and active consumer participation. The key element is always supportive policy and regulation.

Overview of selected smart meter programmes

Each of the countries reviewed represents a stage in smart meter rollout. Sweden has complete rollout, California and Victoria are in the midst and South Korea and Brazil are analysing the possibility (**Table 3.12)**.

Sweden

Swedish smart meter rollout of 5.3 million meters was completed July 1, 2009. The smart metering regulation which resulted in the meter rollout did not originate with the Energimyndigheten, the Swedish Energy Agency (the regulator), but with the Swedish Parliament.

The legislation did not specifically require meters but only monthly meter readings for all consumers, including residential consumers. The regulation was motivated by data-handling complications occurring when customer chose to switch between electricity retailers. As switching levels increased, this system became unreliable.

The accurate billing may produce increased awareness of electricity consumption and encourage increased efficiency. This has not as yet been calculated but could possibly be estimated to 3-5% of residential consumption, based on informative billing pilots in other countries.

No other demand response or feedback rollout occurred in conjunction with the smart metering rollout. Approximated 15% of the meters installed are capable of little more than the required monthly reading; therefore upgrading the system will be expensive.

Victoria (Australia)

In Victoria State, peak demand grows very rapidly, driven mainly by the increased use of air conditioning on very hot days. This has two consequences: firstly, a potential inability of the supply system to meet extremes peak demand without significant new investment in generation; secondly, there is a cost factor as supply costs escalate exponentially on days of extreme peak demand. As a result, there is well known phenomenon of cross subsidy from electricity customers who do not use air conditioning to those who do. Everyone has to pay for the capacity to supply the peaks[190].

In July 2004 the Essential Services Commission of Victoria took a decision on a mandatory rollout of interval meters for electricity customers, which referred to manually read meters. In February 2006, the Council of Australian Governments agreed to improve price signals for energy customers and investors, and committed to the progressive roll out of smart electricity meters from 2007 to allow the introduction of time of day pricing and to allow users to better manage their demand for peak power. The main goal behind this decision was to give customers tools to manage and diminish their electricity consumption. End-users are bearing the cost of the roll-out through increased distribution costs.

[190] The Victorian Essential Services Commission has estimated that the cross subsidies between those domestic customers who do not have air conditioning and those who do could be as much as AS$200 per customer per year.

The meter roll out was formally launched in April 2009. Only a few months later the project started to face serious controversy. In November 2009, an audit of the project found that installation costs had blown out[191] and criticized the technology used and the assumptions taken to justify the business case. There was also criticism of the TOU prices which were meant to cut the peaks. It had been calculated that those who did not leave their homes during the day, such as the elderly or handicapped would be disproportionately penalized by the new pricing structure. The result has been that rollout will continue but the TOU tariffs will no longer be mandatory. This means that the utilities will have to sell the benefits of the tariffs to consumers to reach their efficiency goals.

Another criticism of the system was that feedback displays were not being provided along with the meters. This is typical of other markets as well where smart metering was sold to the public as devices which would inform them and educate them about their own consumption when in actual fact they would need to buy extra feedback technology such as an in-house-display. The meters in Victoria have the capability to support in-house-displays but these displays will not be provided by the utilities, the consumers have to buy them themselves.

Australian smart meter rollout will help to lower peak and overall consumption - if the utilities succeed in convincing the public to participate. However the regulatory frameworks are in place to support these programs and encourage their success: it will be now but up to the industry and consumers to ensure the system fulfils its potential.

California (USA)

In California, smart metering is integrated into a larger package to help control consumption as a direct method of improving security of supply for the State.

The California Public Utilities Commission (CPUC) began a rulemaking in June 2002 which it concluded in November 2005 with the aim of “developing demand response as a resource to enhance electric system reliability, reduce power purchase and individual consumer costs, and protect the environment. Subsequently the CPUC and the utilities have developed an integrated package of smart metering plus demand response measures of direct load control and time differentiated pricing tariffs.

All utilities in California have now received permission to rollout smart meters as part of a larger efficiency plans: the main demand response programs in use are critical peak pricing, critical peak rebates, time of use and automated AC thermostats. Customer feedback and education will also be used but sometimes as a support to the pricing programs only.

On top of this, each utility has asked for extra funds to provide services which go beyond the minimal requirements of the smart metering

[191] From an original estimate of AS$800 million to more than AS$2 billion.

regulation. There is good evidence that private industry as well as the utilities now have a substantial financial stake in the success of these programmes creating green jobs and business opportunities.

The positive cost/benefit for the utilities is directly related to how successful they are with their demand response programs (due to the regulatory framework in place). The overall success of the meter rollout will now be dependent on the ability of the utilities and private companies involved to educate and interest consumers. Rollout is due to be completed in 2012 for most utilities and the full impact of the programs may take a couple of years after this to be fully realized.

Brazil

Distribution companies CEMIG and AMPLA are using imported smart meter technologies with the aim of pinpointing electricity theft. Indeed, one of the main motives behind the implementation of residential smart meters differs from other countries. While in some countries advanced metering is being introduced for conservation purposes, this is not the case in Brazil, which has a generation surplus. Rather the main motivation is fraud and theft of electricity, which reaches 20% and more in some utilities. In May 2010, the Brazilian Power Regulatory Agency (ANEEL) agreed to partner with the Ministry of Science and Technology to create a standard for the local manufacturing of smart meters. The regulator also announced tentative plans for a nationwide rollout of smart metering, expecting to replace about 63 million meters by 2021. The Brazilian Electronic and Electrical Association (ABINEE) is already working with the Brazilian Standards Institute to define new standards.

Concerns in the Brazilian market include the question of how well the technology will hold in the warm, moist climate and the expense of reaching the entire population, 13 million of whom will not have the money to pay for the meters.

If smart metering is eventually mandated for Brazil, it will be largely to lower theft as well as improve efficiency. Those who live on very low incomes will most likely be exempt from paying for the meters and the costs may be divided between the wealthier consumers and the utilities.

South Korea

There is currently no specific residential smart meter policy in Korea. However, the electricity network is expected to receive a massive overhaul over the next few years as one of the major components of the county's stimulus package. This includes the creation of a smart grid which, according to the Ministry of Knowledge Economy, is expected to generate a new market worth approximately US$ 54.5bn annually, create 500,000 new jobs and reduce the country's power consumption by 3% once it is completed in 2030. Other expected benefits include a reduction in carbon emissions by 41Mt p.a. and the saving of US$ 10bn a year in energy imports. The plans also call for the nationwide roll-out of smart meters, "which could by giving end-users more information regarding daily electricity-prices, allow them to cut household power bills by around 15%". The Korean government plans to have a nationwide Smart Meter network by 2020. A new Smart Grid law is expected to be proposed to the National Assembly during the later part of this year which will specify meter installation schedule and features.

Main Conclusions

As a technology, (without appropriate regulation) smart meters provide more benefits to the utilities than to the end consumers. Smart meters do not contribute to improve energy efficiency without a proper regulation.

Smart meter programmes can provide substantial, long term societal and environmental benefits if they are placed in their correct position – namely as a platform for efficiency programmes supported through appropriate regulation and market structures. There are basic conflicts of interest caused when a utility which earns off of electricity sales, is asked to lower those sales through helping consumers lower consumption. Regulation and policy can overcome this barrier if it takes it into consideration. If the correct structures are in place, and efficiency measures are rewarded, utilities and private companies tend to exceed the minimal requirements set by regulators in their drive to maximize the benefits of the new market structures. This then creates a positive cycle of business "winning" by increasing efficiency and in turn encouraging other businesses to do the same.

Smart meters and the communication technology required for energy efficiency programs are expensive – at least €200 per household. They are therefore not necessarily appropriate tools for developing nations, or those were household consumption is low. Regulators should calculate the impact of smart meter rollout, dynamic pricing structures and new tariffs on vulnerable consumers. Regulators should take into account that an increase in costs for consumers should be included only with a method for controlling those costs, through easily accessible feedback information. Accurate monthly bills have not been found satisfactory here by residential consumers or consumer interest groups.

Case Studies on Innovative Communication Campaign Packages on Energy Efficiency[192]

Public awareness and information campaigns constitute an important element to support energy efficiency and to promote energy efficiency policies and programmes. Changes in consumer behaviour can lead to significant energy savings; various studies have suggested

192 This section is adapted from a report prepared for ADEME "Innovative Communication Campaign Packages on Energy Efficiency" by Irmeli Mikkonen, Lea Gynther, Kari Hämekoski, Sirpa Mustonen & Susanna Silvonen, Motiva Services Oy, 2010.

savings potentials even as high as up to approximately 20%[193].

Improvement of energy efficiency and related market transformation require informed consumers and awareness among all segments of society as well as tailored information, education and training for selected stakeholders[194]. Communication Campaign Packages on Energy Efficiency include different tools and activities, such as awareness campaigns, education and training programs, label schemes, smart metering, information on 'best' products, information centres, demonstrations and governing by example[195].

Typically most public awareness and public benefit campaigns are designed and implemented by government agencies or NGOs. Energy companies are also involved in energy efficiency awareness campaigns for various reasons. In countries with capacity constraints, communication campaigns on energy efficiency can reduce the risks of power shortage (e.g. South Africa). In liberalised energy markets the provision of energy services, including energy efficiency campaigning, helps to build positive company image and to attract new customers. In some countries, the government or regulator mandates companies to be active in that field[196].

This analysis will consider the five steps of the implementation of a communication campaign:

1. Contextual analysis
2. Planning phase
3. Implementation phase
4. Monitoring
5. Evaluations

Contextual Analysis

Each national behavioural change programme is designed in a context which is affected by national circumstances as well as national and international policies. The context is a significant factor in the choice of what kind of behavioural programmes are designed and implemented in a given country. In three of the case studies, security of supply concerns were the major driving force for the campaigns. Cuba and South Africa were struggling with energy shortages while Chile was threatened by one. When possibilities to avoid supply problems which have for long time hampered daily lives emerge, they can be a strong motivator for change in energy behaviour. Some campaigns have been implemented in times when high energy prices meet economic downturn. In Cuba, residential electricity tariffs have undergone a major revision. In the US, Drive $marter Campaign took advantage of the economic downturn which occurred at the same time as gasoline prices were record high. In UK, campaign messages are closely linked with money saving benefits of energy saving.

[193] Based on a literature review of 37 articles and books (Dahlbom Bo, Greer Heather, Egmond Cees and Jonkers Ruud, 2009). The savings stem from changes in energy conservation, lifestyle, awareness, low-cost actions, and small investments.

[194] For example, EU's Action Plan for Energy Efficiency states that "increased awareness and behavioural change are called for from the outset" (Commission of the European Communities, 2006).

[195] Sometimes also energy audit schemes are considered as an information instrument; here they have been dealt with separately.

[196] In the European Union, the Energy Services Directive mandates energy companies to provide energy efficiency services to their clients.

Table 3.13 : Overview of case studies

Country	Campaign	Communication channels used
Cuba	Energy Revolution (La revolución energética)	School campaigns, energy festivals, billboards, paper and electronic mass media, home and company visits by "social" workers
Chile	Good Energy Initiatives (Iniciativas con Buena Energia)	Education campaigns, guidebook for companies, eco-driving for truck drivers, mass media campaigns, movie bus, information dissemination by energy distributors, energy efficiency week
China	20 ways to 20%	Training, contests, websites, social media, leaflets, books, volunteer work, TV, radio, newspapers, magazines and websites print ads, light boxes at bus stops and subway stations, postcards
Finland	Compressed Air Efficiently (PATE)	Audit tool, training events, brochures, media campaigns, Energy Efficiency Week
France	Rallying forces to combat climate changes	TV, radio, internet, helpline, email, events, competitions, magazines, newspapers, energy saving club
Lebanon	Lebanon	TV (7 channels), radio (14 stations), newspapers, magazines, Internet, booklets brochures, cinema, bus wraps, billboards, posters, flyers, distribution of goods (notepads, calendars)
Russia	Russia: Save Energy Campaign	TV, newspapers, magazines, billboards and subway posters
South Africa	Multiple campaigns Power Alert, Energy Smart, Power Play, Pedal Power, Shower Sense, Save it)	Colour-coded information on load situation in TV, TV spots, TV reality series, media campaigns, fun interactive tools, demonstration of efficient shower heads on beaches, energy efficiency ambassadors road show with super hero characters
United Kingdom	Energy Saving Trust Consumer Campaign (Dave)	TV (starring a sympathetic character Dave and his energy saving house where appliances talk), with radio advertising and PR
United States	Drive $marter Challenge Campaign	1st phase: tip cards, media interviews, radio, billboard, mobile marketing, interactive website etc. 2nd phase: national video contest, traditional and digital media (Facebook, Twitter and YouTube)

Planning Phase

Effective campaigns typically operate following a strategic plan[197]. Planning should involve the following steps:

- setting the programme goals in line with policy goals
- analysing the determinants of desired behavioural change,
- market segmentation and choice of target groups,
- choice of instruments,
- planning the organisation and management,
- risk analysis and back-up plan,
- programme testing and pilot campaigning,
- planning the resources, and
- planning the monitoring and evaluation.

Campaign goals

Campaign goals should be established in line with policy goals. There are two principal ways how the policy goals are transposed into campaign goals. The initiative can come either from the government, which has defined the role of behavioural change in reaching its goals and established priorities, or from national energy agencies or other stakeholders who propose programmes.

Frequently, it is advised to aim campaigns to energy behaviour which has the greatest impact and is most easy to change. Changeability is a topic which can be addressed in consumer segmentation.

The campaign goals were usually clearly defined, though mainly in a qualitative rather than quantitative way. However, the clarity of objectives does not suffice. They should also be challenging, achievable, targeted and measurable. In quite many cases, the goals were not fully targeted. Instead, some campaigns tried to offer “everything to everybody”. In general, it is not unusual that communication programmes included almost all possible target groups and covered almost all possible topics[198].

Analysing the determinants of desired change

Energy efficiency campaigns aim at changing habitual energy use or investment behaviour of individuals or organisations. For individuals the determinants of desired behavioural change are

[197] It is not always clear how campaign planning was approached in most of the cases, although it is the most important phase in information campaigns in Cuba, a formalised communications strategy is mentioned and in the US, consumer market results were used to choose communication strategies.

[198] Potential problems arising from the need to address multiple target groups and technical systems can be avoided by dividing larger campaigns into sub-campaigns, such as in South Africa.

the results of various motivational, enabling or reinforcing factors.

Examples of motivational factors are awareness, knowledge, social norm, attitude, self-efficacy and intention , as well as income. The Cuban campaign clearly addresses the general lack of knowledge on energy efficiency.

The enabling factors are external to the individual such as financial, technical or organizational resources or new skills which need to be provided. The Cuban campaign also addressed enabling factors when, for example, efficient compact fluorescents were provided free of charge.

The reinforcing factors include feedback and support such as advice. In the Chilean campaign feedback was used in a very innovative way. When people reacted positively to very urgent energy saving messages, another wave of the campaign had a lighter tone and the people were thanked for their action.

These determinants need to be recognised, analysed and integrated into the campaign plan in such a way that they induce the desired behavioural change. Assessing the determinants is closely related to market segmentation because the three factors need to be related to certain behaviour of certain target groups.

The involvement of behavioural specialists, in addition to the typically involved technical and communication specialists, would help in exploiting the benefits of applying behavioural theory in campaign design. However, it is not typically the case as demonstrated, for example, by the BEHAVE Project in Europe[199].

Market segmentation and choice of target groups

Market segmentation forms an important basis for the success of a campaign, since finding homogenous subsets helps to formulate and implement programme goals and to reach the desired target groups. In market segmentation, consumers are split into sub-segments that differ from each other in respect to their attitudes, values and socio-demographic features (class, income, age, education, etc)[200].

A target group is the primary group of people that the energy efficiency campaign, is aimed at. A target audience can be people of a certain demographic variables such as age group, gender and race, or psychographic variables, such as lifestyle features, attitudes and worldviews. Without knowing the target audience social advertising and the selling of a particular value and information can become difficult and waste of resources and funding. The choice of target groups should be based on market segmentation.

199 http://www.energy-behave.net/home.html
200 In market segmentation it should be kept in mind that people act as consumers and citizens: as consumers, they look for direct fulfilment of needs without considering sustainability, whereas as citizens they may take environmental matters into consideration. In addition, they have different roles in their daily life in work, at home, and in social circles and leisure time activities.

The case examples include both cases where the whole population was addressed as well as more targeted campaigns. However, even in cases addressing the whole population, some segments such as school children were singled out as a target group of its own[201]. Some campaigns, such as in Cuba also target institutions and communities and in South Africa industry and the commercial sector.

Choice of instruments and communication channels

The selection of the detailed communication channels must start with a clear vision of the target audience. This will affect the communicator's decision on what to say, how to say it, when to say it, and to whom to say it.

Individual attitudes, values and actions also influence in the degree and the extent to which a message penetrates consumer's awareness. Therefore, communication should be developed so that it 'cuts a dash'. In other words, campaigners might want to put something into people's mind, change an attitude, or get them to act. In order to induce behavioural response, the communication channels need to be matched with the determinants of behaviour. Practical tools are use of focus groups or surveys with questionnaires which can help to identify the most important influential factors.

Only after the background research is done, the best channels to reach the target groups can be identified. Thereafter, the material should be tailored. The messages should seek a cognitive, affective or behavioural response. In practice, few messages take the consumer all the way from awareness to action. At least the following should be taken into account in choice of the media channels: cost-efficiency (budget in relation to the size and number of target groups), media brands, media coverage and media access, cultural factors, long-term view and repetition.

The size of the communications budget is a significant practical factor which has an impact also on the choice of target groups. If the target groups are small and the objective is to reach many of them, sizeable budgets are necessary. This may lead to tradeoffs between the level of tailoring the campaign and budgetary concerns. Therefore, cost-effectiveness is usually a real concern. It can be enhanced by good analysis of the changeability of behaviour and, for example, by preferring target groups whose behaviour is the easiest to change. Target groups can also be grouped at different levels and the campaign can start with key groups thereafter expanding to others.

[201] Based on consumer market research, in the USA the target group of the Drive $marter Campaign was chosen as the lower, lower-middle income drivers who were most hurt by high gasoline prices. The segmentation was taken further so that the Hispanic population was specially targeted. In the UK, the Energy Saving Trust (EST) - a public body carrying out energy efficiency campaigns among the general population - carried out a segmentation of the population in 2005. The population was divided into ten groups. For the case study campaign DAVE, EST chose four key groups who were more environmentally concerned and had the potential to make large carbon savings and the money to do this.

The countries in the case studies vary from highly "digitalised" countries with already significant energy efficiency achievements to countries where not everyone has access to electricity or TV (**Table 3.13**). Therefore, adapted strategies in choosing communication channels are needed[202]. The message should be adapted to local culture[203]. All campaigns reviewed are integrated communication campaigns using multiple instruments addressing the same target groups: none of the campaigns uses just one instrument. Traditional mass media is still used to some extent in almost all campaigns. The most frequently used channel is TV, also in the less developed countries; in more developed countries also internet is a major communication channel[204].

Organisation and management

It is quite typical that energy efficiency campaigns are implemented jointly by several different institutions and actors. For example, energy agencies may co-operate with various associations, NGOs and industry. Wide co-operation has its pros and cons, on the one hand, action can be divided between many parties and information can be disseminated widely but on the other hand, someone has to be responsible for the whole organisation and management of the program, which can be complex and time consuming[205].

Risk analysis and back-up plan

Risk analysis covers the risks related to the campaign's overall effectiveness (success of communication, attitude and behaviour change, co-operation etc.), funding, exogenous factors and the consumers' perceptions of the risks from their perspective. The risks that energy campaigns contain are mainly related to the campaign's overall effectiveness (success of communication, attitude and behaviour change, co-operation etc.) and funding. Back-up planning means preparing a contingency plan to deal promptly with the situation if risks materialize into problems. Back-up is an important factor for the success of the campaign. If problems occur there should be a contingency plan to handle the problem without interrupting the undertakings (timetables, goals) of the programme. In the

[202] In South Africa, research was carried out about the most effective television channels and programmes to communicate practical energy efficiency tips to the target groups, one for the residential audience and another one for the commercial and industrial sectors.

[203] In the UK TV-campaign DAVE, it was decided to talk about 'not wasting energy' instead of 'energy saving'. In Lebanon, the topic was tackled with humour in TV spots, which made the Lebanese react positively to the campaigns and talk about them.

[204] Innovative approaches included the use of new social media such as Facebook, Twitter and YouTube (US), roadshows to supplement TV when not everyone has access to it (South Africa), showerhead demonstration on beaches (South Africa), video contest (US), use of political meetings (Cuba), use of "social" workers (Cuba), thanking people for having made and effort (Chile).

[205] In the Drive $marter campaign the US Alliance to Save Energy partnered with 19 organisations which promoted the campaign and video contest through their websites, banners, electronic newsletters, news releases, flyers and other tactics supported by an Alliance toolkit. In Chile, energy distributors printed energy efficiency advice and campaign slogans on their bills. In China, WWF set up an NGO consortium including more than 50 influential NGOs in China. In the coming years, this consortium will carry out a series of national public awareness and engagement programs.

case examples, no references to risk analysis or back-up planning were made.

Testing and pilot campaigning

Programme testing means testing two or more concepts in a small sample of the target group before choosing the final concept. Pilot campaigning concerns implementing the programme in a smaller scale before full scale (e.g., national) implementation[206].

Resource planning

Resource planning involves planning the financial and human resources needed to plan, implement, monitor and evaluate the programme. Time, budget and personnel resources should be balanced with programme goals and existing budgetary resources. Lebanon managed to keep a low public cost due to a large-scale voluntary (free of charge) media participation.

The two phases of the US Drive $marter campaign show a successful case of rebalancing resources and objectives by innovative choice of communication instruments[207].

Planning the monitoring and evaluation

Monitoring provides first of all information on the success of the campaign to allow correct and prompt action if necessary to ensure that programme goals are achieved. Also the needs of the target group, i.e., the consumers or other end-users can be monitored by asking them questions about how they perceive a campaign. This is typically done by conducting a feedback survey where campaign-related questions are posed. The surveys are based on telephone calls, postal questionnaires or web-based elements. An effective tool in helping to reach the programme goals is to establish performance indicators which can be monitored during programme implementation.

Monitoring also provides performance data for the ex-post evaluation of the campaigns. Any comparative study is impossible to realize if there is no data available of the situation in the beginning of the campaign. Thus, it becomes impossible to find out the direction of the change at a later stage. In many cases it may be impossible to collect the data needed for evaluation after the campaign but it might have been possible or even simple if it had been planned from the outset.

Two types of evaluation and evaluation objectives can be identified. Process evaluation is a systematic assessment of the campaign for

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[206] In Russia, the energy efficient lighting campaign was first implemented in Moscow and later expanded to 15 other regions. In South Africa, the Power Alert campaign was first introduced in Cape Town and later extended to other regions. In Finland, the audit tool was first tested in pilot cases and only thereafter marketed to the whole industry.

[207] The first phase operated with a much wider array of instruments but at the beginning of the second phase, the campaign had to start with a much lower budget. At this stage the solution was to create an exciting new social media element - a nationwide video contest. The approach proved successful as the contest built substantial buzz, web traffic, media coverage and partner support.

the purpose of improving its design, its delivery, and the usefulness of the quality of services delivered to the consumer. Impact evaluation examines the effect/outcome (changes of behaviour, energy savings and CO_2 emission reduction).

Implementation Phase

The launch of a new campaign is a critical phase where effective monitoring and, if necessary, prompt reaction may be needed. Effective implementation requires two types of skills, implementation and diagnostic skills. Implementation skills mean essentially normal project management skills. Diagnostic skills are needed to recognise whether the campaign fulfils expectations or not. Collection of monitoring data is important for empowering the diagnostic process with possibilities to react to problems in a timely and correct manner. Should problems emerge, back-up plan can prove useful. Co-operation with and motivation of partners and other stakeholders is of utmost importance in the implementation phase. Just putting together a potent project group does not suffice but its functionality needs to be ensured and enhanced.

Monitoring

Monitoring the ongoing actions is needed in order to secure the achievement of the goals. If any problems or conflicts occur, corrective actions need to take place but also positive development should be recognised[208]. In continuous or long-term campaigns they need to be taken immediately when problems are detected. In annually repeated campaigns, which only lasted for a short time each year (such as energy efficiency weeks), corrective action shall be taken in the replication of the campaign.

Performance indicators with target levels can be established to help in monitoring. The term ‘performance indicator’ was not explicitly mentioned in any of the case studies but it was clear from the programme descriptions that they had been used. Typical performance indicators measure the number of materials distributed, web-site visitors, event participants, TV campaign viewers, numbers of installation etc. Others may relate to user opinions and satisfaction. It was very common in the case examples to follow indicators related to participation or media impact. Other types of performance indicators could be identified as well[209].

While not one of the case examples, further quite interesting, functional performance

[208] In Chile the campaign tone was moved from urgency to gratitude towards positive action taken by the people. In Cuba case, the communication actions are put on hold as often as once in three-month intervals to adjust the activities as necessary.

[209] For example, in the Finnish compressed-air audit campaign, quantifiable targets were set for the number of analyses to be carried out, energy savings and number of training occasions. In the UK DAVE campaign, the targets were set for numbers of website-visitors and saving action taken by them, callers to the advice centres and awareness of information available from the Energy Saving Trust.

indicators were used in Spain in an integrated package of the energy label along with subsidies for energy efficient appliances (Madrid area). Indicators monitored were:

- correct application of discounts by the retail establishments
- customers must know why the discount is given (because the appliance is efficient)
- customers must be provided with proper information and must receive informative brochures
- salesmen must have had the required training
- there has to be actual increase in the proportion of class A domestic appliances

A practical example of conscientious monitoring can be found from the UK case study. Monitoring was conducted to measure:

- exposure to the advertising and campaign awareness and reaching the target audience
- unaided and aided advertising awareness and advertising message recall. e.g. raising recognition of the Energy Saving Trust, increasing awareness of what they can do, or where to go for advice
- motivation and likelihood to change behaviour/take specific actions/contact the Energy Saving Trust
- reinforcement of current behaviours, adding to their current behaviour repertoire
- the comparative impact of each advertising channel
- the response to the advertising executions

The research methodology was to use tracking research after each burst of advertising, interviewing a large sample of 1 250 adults aged 25 plus. The large sample allowed sensitive measurement of change. An on-line research panel was used, to allow all the different adverts to be shown and played, in rotation, to large numbers, and for a long interview length, equivalent to 20 minutes. Although on-line research tends to have slightly 'greener' respondents, the Trust takes this into account by using this methodology consistently to ensure comparability of measurement across different campaigns and tests key brand awareness using a separate survey for benchmarking. The survey took into account not only response to the advertising but also comparative response to the wider advertising context of environmental messaging taking place around it.

Evaluation

The ex-post evaluation process implies five main steps: deciding the evaluation objectives, choosing the evaluation method, collecting the data, conducting the evaluation and reporting the results, and finally disseminating the results and utilising them in future programme design. With respect to data collection, this means establishing which data needs to be collected during programme implementation and evaluation.

Different types of evaluation can take place. Impact evaluation looks at the effect (change of behaviour) and outcome (e.g., energy saved) of the programmes. Process evaluation explores why savings were achieved. It may include examination of the adequacy of the data needed for subsequent impact evaluations. Consumer surveys can simultaneously collect input on programme performance including satisfaction and potential free ridership. Integrating data collection efforts may result in more cost-effective evaluation.

Independent programme evaluations typically contain both process and outcome evaluation. The main benefit of independent evaluation is an unbiased view. The downside of an independent evaluation is, naturally, its higher cost. It appears, that self-evaluation has been the dominant evaluation form, which is quite typical for communication campaigns.

The approaches available for process evaluation are questionnaires and interviews among the stakeholders (financer, executing agencies and target groups), site visits, review of programme reports and other deliverables, review of the monitoring results and assessment of the impact evaluation results. These are rather qualitative approaches but more technical process evaluations can be conducted. Technical process evaluations use site visits and surveys to assess the technical aspects of programmes including procedures for selecting programme measures, assessing measure installations, and determining market baselines.

Impact evaluation methods include evaluations based on market information and on consumer-specific information. Market evaluations can be further categorised into those using national policy models and those using market data[210]. Consumer-specific information includes billing data, end-use metered data, site data, survey data and programme tracking data.

Most of the cases applied evaluations with consumer-specific information. However, examples of evaluations using market information (market-tracking) could be found. Typical examples of the latter were programmes aiming at training salesmen or promoting certain technologies.

Programmes promoting energy efficiency and renewables have most typically been evaluated using the following methods:

- direct measurement (end-use load data)
- billing analysis (energy bills or energy sales data)
- simple engineering estimate (without on-field inspection)
- enhanced engineering estimates (with on-field inspection)

[210] Market-tracking evaluations involve more focused studies of individual markets. Such analyses examine changes in manufacturer, distributor, retailer, and contractor/installer behaviour that could lead to increased adoption of energy efficient measures.

Various techniques can be applied to conduct the impact evaluation:

- analysis of survey results acquired by mail questionnaires, internet questionnaires, telephone interviews, personal interviews, opinion polls, consumer panels, testing of pupils, testing of course participants, feedback from course participants
- comparison of “before the programme” and “after the programme” survey results acquired by the above channels
- ex-post survey comparing the target group and non-participant control group
- analysis of survey results with attribution of results to various programmes
- engineering approach combining quantitative monitoring results and default values for savings
- market surveys

No example of evaluation of the cost-effectiveness of the programmes was presented. This is somewhat surprising given the importance of cost-effectiveness in justifying financing decisions. However, actual impacts or cost-benefit ratios are very difficult to assess in campaigns aiming to change energy behaviour.

One of the findings is the limited availability of impact evaluation data. This finding is also supported by other recent publications[211]. In some cases, even if the data is available, it may be difficult to separate impacts from other factors on estimated savings[212].

In none of the cases any effort was put on analyzing the free-riders or spill over effect and very little on the multiplier effect. Also analysis of non-response, i.e., reasons why certain consumers in the target group participated in the programme or changed their behaviour and why others did not, was not reported. No information was given on the reliability of programme evaluation results.

Conclusions and recommendations

General

The role and potential contribution of public awareness campaigning to promote rational use of energy is widely recognized in the OECD countries. However, the full potential of communicative instruments in pursuing energy efficiency is still largely untapped particularly outside the OECD countries and including such industrialized countries as those in Eastern Europe.

The limited availability of even confidentiality of monitoring and evaluation data is one of the key finding of this study which is also supported by other recent publications. Because the availability of monitoring and evaluation data was a prerequisite for the case studies, various

[211] e.g. Kyung-Hee 2007, Niederberger 2008

[212] This is likely to be especially challenging at the times of increasing energy prices like in 2008. Nonetheless, price increases were recognised as a major motivating factor creating an opportunity to carry out energy efficiency campaigns

interesting and innovative campaigns could not be included due to the lack of such data. Therefore, the cases taken into the report are positively biased and not representative of typical information campaigns carried out today.

Campaign Planning

The planning phase is the most important one in carrying out an information campaign. The planners need to have a good understanding of the market needs, driving forces (studied by needs assessment) and the prevailing circumstances in which the campaigns are implemented (studied in contextual analysis). In this phase, attention needs to be put also on good timing of the activities and recognising possible niches.

Understanding behaviour and use of behavioural theories in campaign design can enhance their effectiveness. However, use of such resources was not evident in the case studies. Nonetheless, substantial effort had been put on campaign planning, but one should note that the case studies were biased toward ”good campaigns”.

Most case studies had been implemented in isolation instead of combining them with other policy instruments (regulatory, financial). Given the results of needs assessment and the mix of prevailing energy efficiency barriers, instruments should be packaged, e.g. by combining communicative instruments with other types of instruments. For example, if major economic barriers prevail preventing consumer action, different financial instruments may be necessary.

In real world, campaign goals need to be balanced with the resources available. Therefore, campaigns should be based on market segmentation which allows better focus, use of tailored instruments and more efficient use of resources. Too often campaigns try to offer “everything to everybody” which leads to inefficient use of resources. Campaign resources can be enhanced by cooperation with partners and other stakeholder which was done in several case studies. In addition to additional resources, this approach can enhance the effectiveness of the campaign.

In addition to resources, there are other factors to consider when choosing communicative instruments and combining them with other policy instruments. The planner needs to know the target group and its needs very well. Communication channels need to be chosen and messages tailored accordingly. Attention also needs to be paid to media coverage and media access. Lastly, short-term campaigns seldom lead to long-term results.

In case studies, multiple communication channels were used in order to reach all chosen target groups and to take into account socio-economic factors, language, access to media etc. Therefore, all cases featured communication channels working in an integrated manner.

The most frequently used instrument in the case studies was TV, also in the least developed countries. The second most common were other mass media and also internet in more developed countries. However, because the sample was relative small, no other major differences between the countries in various stages of industrialisation were visible apart from the frequency of internet use.

Many approaches taken in the case studies were very innovative. These included, among others, the use of new social media (US), road shows to supplement TV when not everyone has access to it (South Africa), showerhead demonstration on beaches (South Africa), video contest (US), use of political meetings (Cuba), use of "social" workers (Cuba) and thanking people (giving positive feedback) for having made an effort (Chile).

Energy efficiency campaigns *per se*, as well as the construction of the campaigns featuring humour and "energy efficiency ambassadors" were a novelty in some of the case study countries. This created positive reactions among the public.

Given the complexity and multitude of energy-use patterns and target groups to be addressed, it is not possible to recommend simple one-size-fits-all solutions in terms of choice of instruments. Instead, a highly focused and tailored approach is needed.

Monitoring and Evaluation

Monitoring and evaluation should be planned during the planning phase of the campaign. This means the definition of evaluation objectives, choice evaluation methods to be used and definition of data to be collected. Often, information for evaluation is relatively straightforward to collect when it is planned from the outset but is lost forever if this is not done. Monitoring also empowers effective campaign management during campaign implementation.

Good reporting and openness in the dissemination of monitoring and evaluation results enhances the learning process by portraying the strengths and weaknesses of the campaign. This helps in the development of effective campaigns in the future.

The case studies demonstrated various approaches to evaluation of communication campaigns, the impact of which is usually perceived difficult to evaluate. Approaches taken in process evaluation were surveys and interviews. Impact evaluation was carried out by, e.g., surveys regarding measures implemented, estimates based on market and sales data, engineering estimates based on pilot cases and monitoring changes in total consumption.

It is especially challenging to estimate energy savings and emission reductions attributable to the campaigns for example in cases e.g. where increased energy prices may have contributed substantially to observed savings. One of the particular challenges is setting up credible baseline for these kinds of projects.

4. Conclusions and Recommendations

Conclusions

By reviewing energy efficiency trends and policies globally, this report aims to facilitate the exchange of information and experiences on energy efficiency measures among different countries around the world. It can help government decision makers and analysts select appropriate and cost effective sets of measures for each sector, taking into account their national circumstances. Decision support tools such as energy efficiency/CO_2 indicators are useful for monitoring trends in energy use and CO_2 emissions and contribute to evaluating and understanding the impact of the measures implemented in each sector.

Energy Efficiency and CO_2 Trends[213]

> The energy consumption has been increasing much slower than the GDP since 2004

Energy consumption is growing less rapidly than the economic activity in all world regions, except the Middle East.

This decreasing trend for energy intensity (energy consumption per unit of GDP) grew faster since 2004 because of higher oil prices and the increase of policies: 1.9% p.a between 2004 and 2008 compared to 1.4% p.a. between 1990 and 2008.

In 2009, because of the recession, the progress was generally slower except for North America and OECD Pacific.

> Thirty countries in the world experienced a very rapid energy intensity reduction

More than two thirds of the countries in the world have decreased their energy intensity; half of them by more than 1% p.a.; energy productivity improved significantly, by more than 3% p.a. in 30 countries.

> Energy productivity improvements since 1990 "saved" 3.6 Gtoe and emissions of 8 Gt of CO_2 in 2008

The reduction in the energy intensity between 1990 and 2008 in most world regions resulted in large energy and CO_2 savings, estimated at 3.6 Gtoe in 2008 and 8 Gt of CO_2 emissions.

> The potential for further energy intensity reduction in many world regions is significant

[213] Indicators presented in this study are available at http://wec-indicators.enerdata.eu or on the WEC web site at http://www.worldenergy.org/work_programme/technical_programme/technical_committees/energy_efficiency_policies_and_indicators/default.asp. More detailed indicators exits for EU countries, Norway and Croatia in the ODYSSEE database (www.odyssee-indicators.org).

Large differences exist between world regions in their energy intensity levels, even after conversion of GDP to purchasing power parities: the energy intensity of the CIS is 2.7 times higher than in Europe - the region with the lowest value - and is about twice higher than in China, The Middle East and Africa. In North America, India and other Asia[214] the intensity is about 50% above the European value. This shows significant potential future reduction. OECD Asia and Pacific and Latin America however are only 10% above Europe.

Apart from Europe, energy productivity gains are larger for final consumers, by 20% at world level

Energy productivity gains are greater at the level of final consumers (industry, transport, households and services) than at the level of the total energy consumption (i.e. including the energy transformation sector) at world level and in all regions except Europe. Increasing losses in energy conversion[215] have offset about 20% of the gains achieved by final consumers.

[214] Other Asia corresponds to all non OECD countries of Asia and Pacific minus India and China.
[215] Most of them are in power generation (from thermal and nuclear production) and to a lesser extent T&D losses.

The increasing use of electricity by final consumers has resulted in greater losses in power generation, as most of the electricity is produced by thermal or nuclear power plants[216]. In Europe, there is an opposite trend: the primary energy intensity is decreasing slightly more rapidly than the final energy intensity due to the increasing share of gas combined cycles, wind and cogeneration in power production.

Energy efficiency of thermal power generation is still low in most emerging and developing countries, resulting in a significant potential of energy savings

Energy efficiency of thermal power generation only improved moderately, by 2.6% since 1990 at world level; the world average power generation efficiency is presently 35%, which is far from the EU average (40%). If all world regions had the same performance as the EU average, 450 Mtoe of fuel would have been saved in 2008, avoiding 1.3 Gt of CO_2 emissions.

A convergence of performance in industry because of the globalisation

The specific energy consumption of energy intensive industries (e.g. steel, cement, paper) is converging and decreasing rapidly in the regions with the worst performances because of the globalisation of industries.

[216] Electricity is the most intensive energy source in terms of primary energy (unless it is produced from hydro or wind).

The best practices are no longer found in the most developed countries.

New cars are becoming more efficient thanks to various policy measures

In the EU countries and Japan, the specific consumption of new cars has decreased regularly since 1995. (Agreement with car manufacturers followed more recently by mandatory labejls and a greening of taxes on vehicles for the EU and top-runner programme in Japan); the reduction has been slower in the US.

Increased appliance ownership driven by higher incomes have partially offset the effect of energy efficiency policies

The energy consumption of transport is stabilising and even decreasing in several large OECD countries

Since 2000, the energy consumption of transport has remained relatively stable, or its growth has even significantly slowed down in several European countries and Japan, because of higher prices and as a result of the implemented policies.

Increased appliance ownership driven by higher incomes has partially offset the effect of energy efficiency policies

In the residential sector, the average electricity consumption per electrified household[217] did not really slow down, despite the strong implemented policies. Growth in incomes has led to an increased ownership of large appliances (cold and washing appliances), to a rapid diffusion of new appliances (e.g. air conditioning, ICT[218]) and devices (e.g. stand- by mode for an increasing number of applications), which have offset the impact of the more efficient appliances.

The growth of this type of electricity consumption per household is much slower in Europe and North America (below 1% p.a.) than in emerging countries, because of stronger policies and saturation in appliance ownership.

[217] Excluding heating in OECD countries to have comparable consumption.
[218] ICT: Information and Communication Technologies: TV, PC's, modems, etc…

Growth in the electricity consumption services is faster than the activity.

In the service sector, the electricity consumption is growing much faster than the value added in almost all regions with the diffusion of air conditioning and office appliances; there is a slower growth in industrialised countries since 2000.

CO_2 emissions from energy use were 40% higher in 2008 than in 1990 at world level

CO_2 emissions from energy use have increased for all regions since 1990, except in the CIS and Europe: they were 40% higher in 2008 than in 1990 at world level. Growth is very rapid in non OECD Asia, in particular in China and India, and in the Middle East (emissions increased by multiplied by 2.6 from 1990). In Europe, climate change policies have helped to bring CO_2 emissions from energy use in 2008 back at their 1990 levels. Because of the growing role of emerging countries with lower levels of CO_2 emissions per capita, world CO_2 emissions per capita are only slightly increasing: they stood at 4.2 t CO2/capita in 2008 compared to 3.9 t in 1990 (+9%).

In most countries and at world level, most of the reduction in CO_2 emissions per unit of GDP was driven by energy productivity improvements (i.e. mostly energy efficiency) and not by fuel substitutions

4.1.1 Evaluation of Energy Efficiency Policies and Measures[219]

Trends in energy and CO_2 indicators are the results of various factors, amongst which are changes in energy prices and energy efficiency policy measures. The study conducted a comparison of the countries experiences in the implementation of energy efficiency policies. This evaluation helps to draw the following conclusions as to the most effective and innovative policy measures[220].

> About two thirds of the surveyed countries have a national energy efficiency agency and programmes with quantitative targets

About 60 of the surveyed countries (i.e. 60 countries) have a national energy efficiency agency. In recent years there has been growth in local and regional agencies all over the world (about 1300 local and regional agencies from the survey, of which about 900 in Europe).

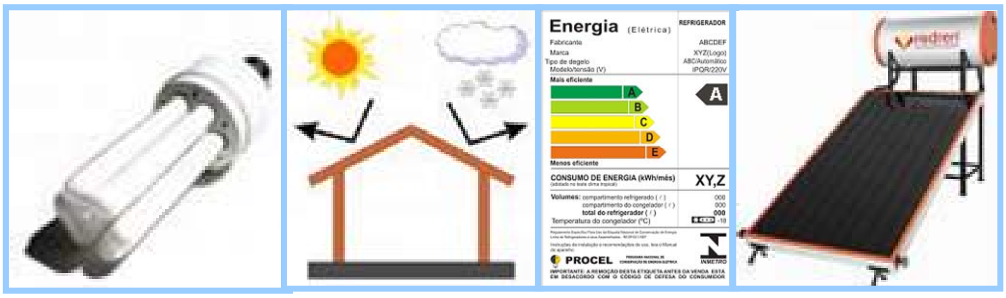
These agencies at all levels (national, regional or local) are necessary to design, coordinate, implement and evaluate programmes and measures by bringing the required technical skill. National agencies can also play a leading role in negotiating sectoral agreements with equipment producers and financial packages for energy efficiency with national banks, or international financing institutions or donors.

About two thirds of the surveyed countries have set up official overall or sectoral quantitative targets for energy efficiency improvement. This represents significant progress compared to the previous survey, especially in Europe where now around 90% of countries have a target compared to 55% in 2007. In addition, many countries have multiple targets (slightly over 1/3, of which 2/3 are in Europe). Final consumers are more often targeted in Europe than in the rest of the world, while other regions give a priority to targets on the primary energy consumption. In most regions, targets are most often expressed in terms of rate of energy efficiency improvements or energy savings. There are fewer objectives on energy intensity reduction, which used to be the dominant way for setting up energy efficiency targets. Increasingly these targets are combined with yearly monitoring requirement.

Many countries are in addition adopting energy efficiency laws. This should provide a favourable and long lasting context for energy efficiency policies and avoid the negative effect of “stop and go” actions.

[219] The results of the survey and the policy case studies can be found on the WEC web site at http://www.worldenergy.org/work_programme/technical_programme/technical_committees/energy_efficiency_policies_and_indicators/default.asp.

[220] The report also reviewed the experience with specific measures and sectors through six policy case studies: energy savings obligations; compliance for regulations; good practices in the public sector; evaluation of smart meters policies; energy efficiency measures for low income households; innovative communication/information tools and financial measures for households in emerging countries.



More countries have introduced energy efficiency label or MEPS[221]

Labelling of appliances is the main measure implemented in about 60 countries according to the survey. Usually the refrigerator is the first appliance to be labelled.

Labels and MEPS on electrical appliances and MEPS for buildings are spreading to a larger number of countries, especially in emerging countries.

Labels are increasingly used as a reference to support other measures, for instance by providing economic incentives only to specific energy efficiency labels. Thus their benefit is broader than just providing information to consumers.

The number of appliances/products with labels or MEPS is expanding

Labels and MEPS are being extended to new equipment and new areas. Five countries have more than 10 appliances with mandatory labels and 34 with more than 5 appliances. Efficiency labels have been recently introduced for cars (e.g. EU countries) and several countries have minimum fuel efficiency standards for new cars (e.g. China and EU countries). Many countries have adopted MEPS for lamps to phase out incandescent lamps. Mandatory use of solar water heaters is now implemented, e.g. in Spain.

Building regulations are increasing for new buildings and extended to existing buildings

Building regulations are extended to existing buildings to increase their potential impacts. For instance, the EU building directive imposes the production of energy efficiency certificates for existing buildings (equivalent to energy efficiency label) each time there is a change of occupant or a sale. These certificates enable the buyer to obtain information about the energy consumption of the dwelling they are going to buy or rent. In addition an update of the EU directive introduces mandatory energy standards for existing buildings undergoing renovations.

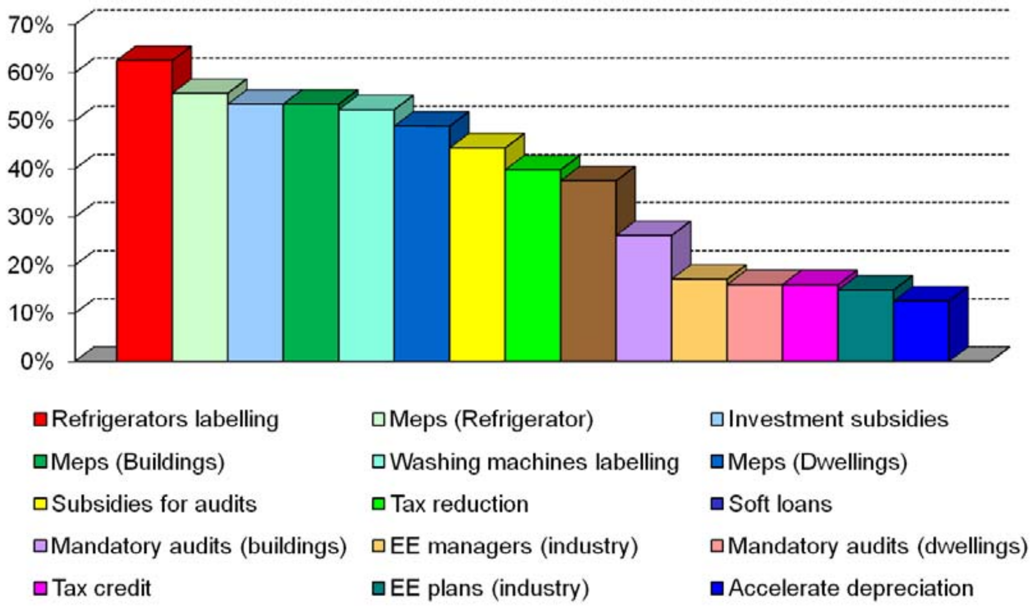
Economic incentives rely more and more on financial (e.g. subsidies) than on fiscal incentives

Two thirds of countries have subsidy schemes. Fiscal measures are mainly used in OECD countries where the tax collection system is more developed and revenues from tax higher.

Economic incentives are better targeted to the consumer population that can benefit from them (e.g. low income households, tenants). In addition, they are also restricted to certain types of investment (from a selected list of equipment), with a long payback time but high efficiency gains (e.g. renewables, co-generation) or to innovative technologies (demonstration or pilot investments). Solar water heaters and CFL are the main appliances receiving financial or fiscal incentives.

[221] Minimum Energy Performance Standards

Figure 4.1: Frequency of measures (2009)



Source: WEC/ADEME survey

Economic incentives are also used to promote the quality of energy efficiency equipment and services: in that case, the incentives only apply to products and services that have been certified or accredited by a public authority, generally the energy efficiency agency.

Tax reductions for energy efficient equipment or investments have been introduced in many countries and almost equally in all regions. They form about 30% of the surveyed countries. The compact fluorescent lamp is the most common equipment to which this measure applies outside the OECD. In some European countries, lower VAT levels are charged on labour costs to reduce the investment for buildings renovation. Another innovative way to promote investment in energy efficiency and CO_2 reduction is to offer tax concessions to companies that make concrete commitments for energy efficiency gains/CO_2 reduction, and meet their target.

Towards a greening of tax for cars

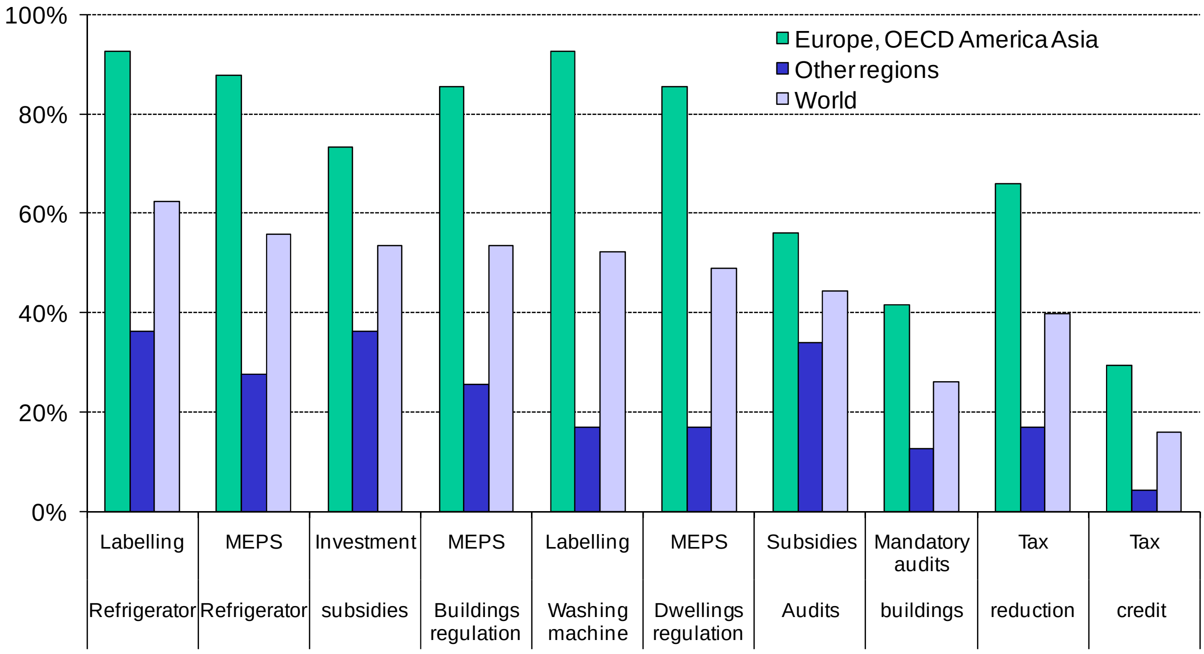
Several countries are now using an innovative approach by introducing green taxes for cars, in which the amount of the tax is function of the CO_2 emission or energy efficiency of the car[222]. This applies to purchase taxes as well as to the annual tax. Such taxes have been very effective in channelling demand towards less powerful and more efficient cars.

Labelling and MEPS of refrigerators are the most popular measures, but a variety of policy instruments can be found in the top ten

Labelling and MEPS for refrigerators are the most popular measures followed by investment subsidies and MEPS for buildings (**Figure 4.1**). Among the most frequent measures, a variety of measure types can be found (regulation on labels, regulation on MEPS, financial incentives and fiscal measures) showing that there is no preference for a specific policy instrument and

[222] France has introduced an innovative package combining a tax and subsidy scheme for new cars (known as “bonus malus”).

Figure 4.2: Most frequent measures by region (2009)



Source: WEC/ADEME survey

that a mix of different types of measures is generally preferred.

The same ranking can be observed by region. However, subsidies for audits are more frequent in non-OECD countries and MEPS for dwellings and tax reduction are more widely used in OECD countries (**Figure 4.2**).

Energy savings obligations for utilities: a promising market based instrument

Energy savings obligations are used in Europe and South America (e.g. Brazil, Uruguay). There are considerable variations in the way they are applied and on whom the obligations are placed. These obligations have been a success and are expanding in the countries which have implemented them. The obligations have been imposed mainly in the residential sector and have largely operated without significant trading of their energy savings (White Certificates)[223].

Energy savings obligations have been shown to work in both monopoly and fully liberalised markets and both the suppliers and/or distributors.

By using deemed or estimated savings, the administration, monitoring and verification costs can be kept low, typically below 1% of the total energy company expenditure.

Energy savings obligations are attractive to governments as the cost of the obligations is not met by the government.

Energy savings obligations could be an important policy option for developing countries as they offer a way for governments to tackle energy efficiency at a fairly modest increase in electricity customers' bills (1-2%). New

[223] Certificates used for the trading of energy savings are known as "White Certificates".

countries embarking on such obligations will need to establish estimated savings for their own local circumstances, although many electrical end-uses are increasingly global (e.g. energy efficient lighting and appliances). These obligations could also be tied in with the Clean Development Mechanisms (CDM) projects.

Role and importance of compliance for regulations

There is a trend to increase the number of appliances, equipment or buildings covered by efficiency standards. However, to be effective these regulations need to be properly implemented. This raises the problem of compliance. There are few studies of compliance. This needs to be improved in order to better understand the impact of non-compliance and the costs and benefits of non-compliance.

Poor compliance can have a long-term negative impact on energy efficiency strategies. Compliance comes at a cost which is significantly lower than the benefits. Some countries have integrated compliance into their strategies and have provided adequate resources to ensure it is done well. However, all too often, countries dismiss the role of compliance and worry little about the real. Compliance is not black and white. Programmes cannot easily be categorised as in non-compliant and thus ranking measures by optimal or sub-optimal compliance may be more appropriate. All programme evaluation should include an analysis of compliance as a factor in determining overall impact and more analysis is needed as to why compliance is not being followed up.

As countries design and implement new programmes, it is important to integrate the aspects of compliance from the beginning. This will be less expensive and more effective.

There should be a better sharing of best practices for compliance. More capacity building initiatives are needed to improve the development and implementation of compliance assurance systems.

Good practice in the public sector

Opportunities to harness energy efficiency potential in the public sector are available in every country. Although available technologies, legal frameworks and the level of technical expertise may vary significantly between countries, finance and capacity are available

almost everywhere and can be further developed through existing networks between public sector actors at different levels. As the public sector activities span across various end-use sectors there are always opportunities ranging from small-scale lighting retrofits to larger scale buildings upgrades.

Public money is being used to purchase products and services and build facilities: by integrating efficiency considerations into procurement processes public money can be spent more effectively and with higher long-term returns.

The potential to learn from the experiences of other countries at different levels of governance is enormous and existing networks of public actors can provide instrumental support for this process. In addition to dissemination of experiences across national borders, learning opportunities are available also at different levels of government.

Programmes for low income households

Given the current context of economic crisis and energy prices increases, the number of energy efficiency programmes or measures targeted to low income households has been growing.

Measures for low-income households concerning energy prices (e.g., social tariff, regulations), household income (e.g., social benefits, direct financial support) and energy efficiency programmes should be treated as complementary. Measures related to energy efficiency need more time to reach the households and produce results.

Two main difficulties are encountered when implementing programmes for low income households: raising funds in a sustainable/lasting way, and reaching the most vulnerable households (targeting issues and eligibility criteria).

The main funding source is usually the public authority in charge of the corresponding policy. But it may also be utilities or energy suppliers through energy savings obligation schemes. Then the delivery mechanisms are designed to look for the best compromise between fairness (higher support to more vulnerable households) and simplicity (minimising administration/transaction costs).

The coordination at national and local level appears to be a key success factor. A national framework is essential to develop large scale activities, especially by raising significant funds. Then local management makes it possible to set up effective partnerships mobilising all relevant actors and skills. The proximity in the delivery of services is crucial. Local implementation schemes also create opportunities to integrate the various social policies addressing the different aspects of poverty, deprivation or health issues. Another key issue is the quality of the equipment installed and the services delivered.

Communication campaigns: a highly focused and tailored approach is needed

Communication channels need to be chosen and messages tailored accordingly. Attention also needs to be paid to media coverage and media access. Generally, multiple communication channels are used in order to reach all chosen target groups and to take into account socio-economic factors, language, access to media etc. The most frequently used instrument is TV, followed by other mass media and also internet.

Energy efficiency campaigns, in particular those featuring humour and “energy efficiency ambassadors” create positive reactions among the public.

Given the complexity and multitude of energy-use patterns and target groups to be addressed, there is no simple one-size-fits-all solution in terms of instruments. Instead, a highly focused and tailored approach is needed. The full potential of communicative instruments in pursuing energy efficiency is still largely untapped, particularly outside the OECD countries.

The planning phase is the most important in carrying out an information campaign. The planners need to have a good understanding of the market needs, driving forces and the prevailing circumstances in which the campaigns are implemented. Understanding behaviour and use of behavioural theories in campaign design can enhance their effectiveness.

Campaign goals need to be balanced with the resources available. Therefore, campaigns should be based on market segmentation which allows better focus, use of tailored instruments and more efficient use of resources. Too often campaigns try to offer “everything to everybody” which leads to inefficient use of resources. Campaign resources can be enhanced by cooperation with partners and other stakeholders.

Smart meters: a costly but effective way to promote energy efficiency, if well regulated

Smart meters are measuring devices which send consumption information to the utility. As such, without regulatory intervention, they provide more benefits to the utilities than to the end consumers. With regulatory support, they can be used to provide immediate, easily understandable information to customers and help lower their costs and consumption. Smart meters can facilitate a change in consumer behaviour through information programmes, lowering overall consumption by approximately

Table 4.1: Selection of innovative measures

Sector	Innovative measures
Households	▪Energy efficiency certificates for buildings (existing and new) ▪Energy savings obligation (with target for low income households) ▪Phase out of incandescent lamps / MEPS for lamps ▪Mandatory installations of solar water heaters ▪Package of economic incentives and other measures
Transport	▪Taxation of cars based on energy efficiency/CO2
Industry	▪Energy savings target for consumers
Services	▪Energy savings target for public sector ▪EPC (energy performance contracting)
Cross-cutting	▪Fuel price escalators

Table 4.2 : Sectors/issues insufficiently addressed

Sector	Issues
Households	▪Behaviours ▪Existing buildings
Transport	▪Light duty vehicles ▪Public transport infrastructures (e.g. combined rail road transport)
Industry	▪SME's
Services	▪Electricity uses in services

5-10%. They can also be used to improve the efficiency of the entire electricity network through pricing programmes such as Demand Response. Demand Response programmes are estimated to cut peak consumption by approximately 15-20%.

Smart meters and the communications technology required for energy efficiency programs are expensive – at least €200 per household. They are therefore not necessarily appropriate tools for developing nations, or countries where household consumption is low.

General conclusions: innovative measures and end-uses insufficiently addressed

Table 4.1 summarises the most innovative measures implemented in various countries surveyed. The innovation is judged by the potential impact of the measures in addressing the various barriers to energy efficiency improvements and thus in tapping significant energy savings. Some sectors are still insufficiently addressed and would need more intensive policy measures to reach the existing potential (**Table 4.2**).

SME's are representing a growing share of the industrial activity but usually receive less attention from energy efficiency perspective than energy intensive branches.

Households and the service sector record lower achievements, as increased income and lifestyle changes have offset part of the technical energy efficiency gains, and new energy end-uses are expanding. In addition, in the household sector, the impact of regulation is often partly offset by more energy intensive behaviour (e.g. higher heating temperature, longer utilisation of efficient lamps)("rebound effect"). Changing behaviour is usually addressed by information and communication campaigns but additional measures are required in this area. In the transport sector, the growing consumption of light duty vehicles and the development of the infrastructure needed to shift part of the traffic from road to rail are insufficiently addressed.

Recommendations

Energy Efficiency: a winning strategy

Energy efficiency is the winning strategy to simultaneously address a variety of policy objectives, including security of supply, climate change, competitiveness, balance of trade, reduced investment need and environmental protection (local pollution, deforestation):

- By reducing the amount of energy imports it is the main strategy for improving the security of supply and reducing the demand for fossil resources, thus extending their availability.
- Energy efficiency could make up half of the reduction needed to drastically reduce greenhouse gas emissions by 2050 in scenarios with strong CO_2 constraints[224].
- Energy efficiency increases competitiveness of industries, especially for energy intensive industries, by reducing their energy costs.
- Energy efficiency limits the macro economic impacts of oil price fluctuations for oil importing countries, in terms of balance of payments, and public finances when prices are subsidised, and it can help economies prepare better for increasing cost of energy in the future.
- It reduces the huge need of investment for expanding energy infrastructure in emerging countries and frees capital for other purposes or helps avoid shortages of capital that limit economic growth; more generally, it enhances economic development by reducing energy shortages and contributes to poverty eradication.
- It contributes to the environmental protection by reducing local pollution and deforestation in particular, in Africa and South Asia where many households still do not have access to modern fuels and have to rely on fuel wood.

To be successful, energy efficiency programmes and projects need to be based on appropriate strategies. The report proposes a set of 10 main recommendations to improve the implementation and effectiveness of energy efficiency policies[225]:

1. Incentive prices are needed to make investments in energy efficiency

[224] See United Nations report (2007), IEA (2010)

[225] These recommendations rely on the discussions and conclusions of various meetings, in particular two regional seminars held by WEC and ADEME in Addis Ababa (28-29 June 2009) and in Tunis (15-16 March 2010), a national WEC seminar in Brazil (5-7 October 2009), and the final ADEME-WEC Workshop on Energy Efficiency Policies held in London (17-18 June 2010). It also relies on the discussions and conclusions of several meetings in which this project was presented, in particular an OLADE seminar on energy efficiency (Cuba, 28-29 October 2009) and an ECOWAS meeting on energy efficiency.

attractive and cost effective for the consumer.

2. Sustainable institutional support is necessary to give long term signals to market players.
3. Innovative financing schemes are needed to support consumers at a limited cost to the public budget.
4. The quality of energy efficient equipment and services should be promoted.
5. Regulations need to be regularly strengthened, enforced and expanded.
6. Measures should be combined in packages of complementary measures rather than implemented as single measures.
7. The situation in developing countries should be addressed adequately.
8. Consumer behaviour should be addressed as much as technologies.
9. The introduction and impacts of measures should be well monitored.
10. International and regional cooperation should be enhanced.

Incentive prices: a condition for successful energy efficiency policies

Low energy prices or inadequate tariffs may lead to an extended payback time for energy efficient equipment or for investments in energy efficiency and make them not cost effective at all. In addition, low energy price acts as a disincentive for a rational use of end-use equipment.

Adequate pricing is a necessary condition for promoting energy efficiency[226]. The first step of any energy efficiency policy should be to give correct price signals to consumers in order to provide them with incentives to change their behaviour or to acquire energy efficient equipment.

Prices should be adjusted to long-term marginal costs in an escalation mode (i.e. in a growing way). These adjustments should take into account the disruptive impact on low-income households and propose compensation mechanisms.

Dynamic pricing through TOU tariffs[227] and “smart meters” for large consumers can reduce the need for additional investments in peaking capacity, minimising production in low efficiency fossil fuelled power plants.

Clear price signals alone are not enough to lead to a rationalisation of energy use: policy measures are necessary to reinforce the role of energy prices by removing the usual barriers to energy efficiency and to develop and structure the market for efficient equipment and devices.

[226] Beyond energy efficiency considerations, subsidised energy prices represent a burden on the public budget of energy importing countries when domestic prices are much lower than international prices. For energy producing countries price below international prices represent a loss of revenue

[227] TOU : Time Of Use

A sustainable institutional support to give long terms signals to market actors

Energy efficiency policies and programmes should give long-term signals to market players. They should rely on a sustainable regulatory framework that can provide a long lasting context for energy efficiency policies and avoid the negative effect of stop and go actions.

Such goals can be reached by the adoption of energy efficiency laws and official quantitative targets for energy efficiency improvement by Government.

In addition, policy makers should signal in advance to both consumers and manufacturers/ constructors on future regulations so that they can adapt, especially with respect to mandatory efficiency standards

Energy efficiency policies should organise and stimulate the market of energy efficiency equipment and services by establishing energy efficiency agencies at national, regional and local levels: such agencies are necessary to design, coordinate, implement and evaluate programmes and measures. National agencies can have a leading role in developing appropriate finance mechanisms with national and international financing institutions.

The public sector, at national, regional and local levels should play a leading and exemplary role in the development of the ESCOs market as well in public procurement of energy efficient equipment.

Innovative financing to support consumers at a limited cost for the public budget

The large-scale diffusion of energy efficiency investments and equipment requires massive and sustainable funding to support customers by decreasing the payback time of these investments and by removing the barrier of initial cost.

Revolving energy efficiency funds should be set up with guarantee mechanisms to attract the participation of financing institutions. In less developed countries, projects should be grouped to be attractive for multilateral funding.

To reduce the burden on the public budget, new sources of funding should be considered, such as:

- Earmarked taxes[228].
- Public private partnership between public institutions and private investors, such as banks or private companies (ESCO's);
- Energy savings obligations for utilities, where utilities must have an active role in the promotion of energy efficiency, including provision of financial supports for consumers;
- Combined tax and subsidy schemes (e.g "bonus malus") that are neutral for the public budget[229];

[228] Earmarked taxes correspond to taxes the revenue of which has to be used for energy efficiency support.

- Use of CO_2 revenues from carbon auctions and carbon finance (CDM projects).

The financial support to consumers should be attractive, by lowering the payback time and enabling acceptable monthly loan repayments. This requires the introduction or maintenance of investment subsidies or tax credits provided the energy efficient equipment or investments have extended payback times and low interest or even zero interest loans.

Channeling of these funds to the consumers can also be improved by appropriate mechanisms, such as monthly loan repayments via energy bills[230].

A quality of energy efficient equipment and services

To inspire confidence in consumers and avoid negative feedback from low quality energy efficient equipment and services, quality labels and technical norms of equipment should be developed. This quality control of equipment should address both locally produced and imported products.

The introduction of norms and certification of equipment implies the existence of independent certification and testing facilities**.**

[229] In this scheme, the income from the tax is used to fund the subsidies.
[230] This is the case for the solar programme in Tunisia.

This may be a constraint in many developing countries (especially for small countries) and regional centres could provide a solution. The existence of a national or regional testing centre is a key element to ensure that imported products are in compliance with national standards. There is also a need for development of international recognised norms through ISO or regional bodies such as CEN and CENELEC[231] in Europe.

The performance of some efficient appliances (e.g. solar heaters) and buildings is also related to the quality of the installation or construction. In this respect, skilled installers and builders and their certification can guarantee the quality of the services offered. In the same way, audit schemes assume a certain quality of auditor as well as the staff responsible for energy management in the companies (energy managers). The certification of auditors and training of energy managers can assure this.

To ensure the success of certification schemes, independent control of the effective quality of these certifications should be implemented.

Only equipment complying with energy efficiency norms should benefit from economic support measures, such as subsidies or public purchasing.

Regulations need to be regularly strengthened, enforced and expanded

[231] CEN, European Committee for Standardization and CENELEC, European Committee for Electrotechnical Standardization.

To be effective, labelling programmes and energy performance standards must be regularly updated. Indeed, there is no incentive for manufacturers to go beyond what is required if no stricter standards have been planned for the future or when most of the models on the market are in the best efficiency classes.

It is therefore essential to review and reinforce standards at regular intervals as a way to stimulate technical progress and to ensure a steady improvement in energy efficiency. Revisions of standards for buildings and equipment should be embedded in regulations to ensure an effective strengthening of regulation over time.

Regulations on buildings or equipment are effective as long as they are really enforced. The multiplication and tightening of regulations increase the risk of non-compliance and limit their effect. This issue is often insufficiently addressed by policies, because of budget limitations. Enforcing existing regulations may be in some case as efficient as strengthening further these regulations. Compliance should be integrated in regulations and include random controls. Evaluation of the reasons for non-compliance should be studied to provide the necessary corrections to improve compliance.

More appliances and equipment need to be addressed to cover a larger part of the electricity and fuel consumption. This implies to expand regulations to a larger set of appliances (e.g. standby, ICTs) and equipment (e.g. light duty vehicles, tyres).

Measures should be combined in packages of complementary measures

Investment in energy efficiency entails a complex process due to many barriers and decision-makers. To achieve a greater impact the implementation of several complementary measures that will help address all steps towards efficient deployment. These packages of measures should combine information and communication actions, regulations, subsidies, soft loans, training and certification and should be implemented simultaneously and not one after another.

Examples of packages of measures can be information campaigns complemented with direct subsidies plus financing methods, or with economic incentives plus quality labels, or else with regulations plus subsidies or financing mechanisms and quality labels, and so on. There is no systematic miracle optimal mix: the package needs to be tuned to each target or actions according to national specifics.

The situation in developing countries should be addressed more adequately

Most measures that have been implemented in developing countries are transferred and adapted from industrialised countries. Therefore, the specific situation and needs of these countries regarding energy efficiency remain insufficiently addressed, for instance:

- Used second-hand electric appliances and cars represent the bulk of appliances/car purchase;

- Lighting is the main use of electricity in rural areas and for low urban income households;
- Cooking with biomass makes up a significant share of the household energy consumption, which is very costly if biomass is purchased or time consuming if it is collected, due to the low efficiency of traditional cooking stoves.

Therefore specific measures should be designed and implemented in developing countries, such as:

- Regulations on second-hand appliances and cars (including ban);
- Adapted incentives for efficient biomass stoves and CFL;
- R&D in improved biomass stoves and solar cookers;
- Capacity building.

Behaviour should be addressed as much as technologies

Real energy savings are always far from what is expected from technologies because of consumers' behaviour (e.g. purchase of larger efficient refrigerators, higher indoor temperature, rebound effects). It is therefore recommended to conduct more studies on the impact of behaviour and to develop and promote technologies that can limit the impact of inefficient behaviour (e.g. speed limiters, thermal regulation of room temperature, automatic switch off of lights in unoccupied rooms, light sensors, programme automatically set to saving modes for washing appliances).

It is also recommended to provide tools to the consumers to enable them to manage their energy consumption better, such as informative billing or in-house display devices. One form of informative billing is to provide comparative information that enables each consumer to understand the bill or specialised support comparing the consumption level by similar consumers (for households) or similar companies (in industry and services).

As it is difficult to reach the multitude of consumers, it is recommended to improve communication tools linked to energy efficiency campaigns.

In the transport and household sector, improving the efficiency of new equipment, vehicles and buildings is important. But it is equally important to maintain the equipment and vehicles to avoid a progressive loss of efficiency. Policy measures also need to focus on maintenance.

The impacts of measures should be monitored

Monitoring the effectiveness of the measures implemented is important to evaluate the impact on energy use, to understand how efficient and successful the measures are, to evaluate the use of public funds, to monitor targets and also to follow legal requirements in terms of reporting.

To monitor the impacts of measures it is recommended to implement the following actions:

- Develop detailed data collection system on energy uses by sub-sector or end-uses, i.e. beyond the usual energy balance data;
- Develop energy efficiency indicators to monitor progress achieved on a yearly basis[232];
- Evaluate the measures that work and do not work to better tune them;
- Evaluate the drawbacks of some measures (e.g. rebound effects[233]).

International and regional cooperation should be enhanced

International and regional cooperation is important to save time and money in the implementation of measures by benefiting from economies of scale. Firstly this can be achieved through regional testing facilities, regional certification and through exchange of experience on regulations (e.g. labels, MEPS) and other measures.

[232] In this area, norms are being developed to calculate energy savings, such as for instance in Europe at the level of CEN/ CENELEC (draft norm presently under public inquiry).

[233] The rebound effect corresponds to a change in energy using behaviour that leads to an increased level of service following the purchase of an energy efficiency equipment.

It is also important to develop harmonised regional regulations and standards to avoid distortion of competition and to create a larger market for energy efficiency products.

International and regional cooperation enables a broader dissemination of information on best practices through regional benchmarking and common and harmonised data collection at regional levels.

Regional cooperation can help to speed up energy efficiency improvements through the introduction of common measures and policies in all countries within the same economic region. (e.g. EU), ensuring that all countries move at the same pace.[234]. Therefore, it also contributes to political integration.

To be effective, cooperation and twinning programmes should accompany international cooperation between energy efficiency agencies, including technical assistance, transfer of experience and know-how.

The World Energy Council provides a unique opportunity for effective international cooperation between the energy decision-makers and energy consumers.

[234] e.g. EU with mandatory targets of energy savings, mandatory regulation for member countries.

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