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CONSEIL MONDIAL DE L'ÉNERGIE
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World Energy Perspective

Energy efficiency policies: what works and what does not

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World Energy Perspective
Energy Efficiency Policies – What works and what does not

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Published 2013 by:
World Energy Council
Regency House
1–4 Warwick Street
London W1B 5LT
United Kingdom

Registered in England and Wales

No. 4184478
VAT Reg. No. GB 123 3802 48
Registered Office
Regency House
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London W1B 5LT

ISBN: 978 0 946121 27 4

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Acknowledgements

This report has been produced under the guidance of the World Energy Council's Studies Committee. More than 60 World Energy Council (WEC) member committees and other contributors have enthusiastically participated in the collaborative process of this study, particularly by providing information for a questionnaire on energy-efficiency policies and measures. We would like to express our thanks to all the experts without whom the work would not have been accomplished. The study has also benefited from the contribution of more than 200 experts during several regional workshops organised in Romania, Mexico, France and Ethiopia by the national WEC committees. The report also benefited from inputs from other regional meetings dedicated to energy-efficiency policies, such as the various meetings of the ODYSSEE MURE project in the EU, the energy policy dialogues organised by ECLAC in Latin America, and the Southern and Eastern Mediterranean (SEMED)/Arab Region Roundtable on Energy Efficiency Policy Recommendations. The expert inputs have added much value to the report by providing a broader dimension and regional focus for the evaluation of energy-efficiency policies.

We greatly appreciate contributions from Enerdata experts for the technical coordination; particularly that of Bruno Lapillonne, the director of this study, Carine Sebi and Karine Pollier, for their assistance in the production of the report and the policy survey, Nathalie Desbrosses responsible for developing the energy-efficiency indicators, and Guillaume Routin, who developed the two interactive databases on indicators and policies. We would also like to thank the authors of the four case studies: Riccardo Enei, Giovanna Giuffrè and Andrea Ricci from ISIS, Italy (trucks and freight transport), Prof. Luiz A Horta Nogueira
from Centro de Excelência em Eficiência Energética (EXCEN)/Universidade Federal de Itajubá (UNIFEI), Brazil (air conditioning), Christophe Dromacque and Jessica Stromback from Vaasa ETT (smart billing) and Pedro Guertler, Association for the Conservation of Energy (ACE) (financing).

Finally, we extend our thanks to Elena Nekhaev of WEC London, for her encouragement and advice throughout this work.

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Remerciements

Ce rapport a été effectué sous le patronage du Comité des Programmes du Conseil Mondial de l'Energie. Plus de 60 comités nationaux et équipes nationales ont participé activement au bon déroulement de cette étude, particulièrement en répondant au questionnaire sur les politiques et mesures nationales d'efficacité énergétique. Nous voudrions adresser nos remerciements à tous les experts sans qui ce travail n'aurait pu être accompli. Cette étude a également bénéficié de la contribution de plus de 200 experts lors de plusieurs séminaires régionaux organisés en Roumanie, au Mexique, en France et en Ethiopie. Cette étude a également tiré bénéfices des présentations et idées proposées lors de séminaires régionaux sur les politiques d'efficacité énergétique, tels que les nombreuses réunions du projet ODYSSEE MURE dans l'Union Européenne, les dialogues sur les politiques énergétiques du CEPAL en Amérique Latine, ou encore au cours de la Table Ronde du SEMED/ Région Arabe sur les recommandations des politiques d'efficacité énergétique. Ces participations ont contribué à davantage refléter les spécificités régionales dans la mise en œuvre des politiques d'efficacité énergétique.

Nous tenons à remercier l'équipe de coordination technique d'ENERDATA qui nous a aidé à élaborer des indicateurs homogènes pour le rapport et à synthétiser l'enquête, et plus particulièrement B. Lapillonne qui a dirigé cette étude, Carine Sebi et Karine Pollier pour leur assistance dans la rédaction du rapport, Nathalie Desbrosses, pour les indicateurs et Guillaume Routin pour le développement des deux bases de données interactives sur les indicateurs et sur les politiques. Nous voudrions également remercier les auteurs des études de cas: Riccardo Enei, Giovanna Giuffrè et Andrea Ricci d'ISIS, Italie (étude de cas sur les camions et transport de marchandises), Prof. Luiz A Horta Nogueira d'EXCEN /UNIFEI, Brésil (étude de cas sur les climatiseurs), Christophe Dromacque et Jessica Stromback de VaasaETT (étude de cas sur les factures intelligentes) et Pedro Guertler, ACE, Association for the Conservation of Energy (étude de cas sur les financements).

Nos remerciements vont également à Elena Nekhaev du Secrétariat de la WEC qui nous a beaucoup encouragés et conseillés dans notre travail.

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Summary

This study is aiming to describe and evaluate energy-efficiency trends and policies at global level. While the French Agency for Environment and Energy Management)the Agency for Environment and Energy Efficiency, France (ADEME) coordinated the project, the study was carried out over two years with the technical assistance of Enerdata.

The first objective of the study is to identify recent trends in energy-efficiency performance for WEC member countries. A selection of indicators has been produced for that purpose: they are available on the WEC website.[1] This report looks at these indicators and analyses them by main world region.

The second objective is to describe and evaluate energy-efficiency policies carried out in a large sample of countries throughout the world. All information related to energy-efficiency policy implementation has been integrated on the WEC website.[2] 85 countries are covered, either through a survey that was carried out in 50 countries or through a literature review for the remaining countries. This survey was completed by selected experts, with detailed case studies focused on four policy measures:

- Innovative financing schemes in buildings
- Measures to accelerate the penetration of efficient air conditioners and their efficient use
- Smart billing
- Measures to improve the efficiency of road transport of freight.

Beyond a review of existing energy-efficiency measures, this evaluation aims to pinpoint the most interesting experiencescase studies and draw some conclusions on the 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 advanced countries.

Despite the still important role of market instruments (voluntary agreements, information, dissemination) and economic incentives, regulations are increasingly used, in particular in sectors in which the market fails to give appropriate signals (e.g. buildings, appliances,and so on). Because of limited public budget, there is increasing involvement of the private sector in supporting investments in energy efficiency, through energy service companies (ESCOs) and energy utilities. The study highlights a number of innovative measures, such as smart billing, energy-savings targets by sector, mandatory installation of efficient equipment, and obligatory energy savings for energy companies.

The study concludes with eight main recommendations:

1 www.wec-indicators.enerdata.eu/

2 www.wec-policies.enerdata.eu/

1. Energy prices should reflect real costs and give more incentives to consumers.
2. Consumers should be better informed.
3. Innovative financing tools should be implemented to support consumers' investments.
4. The quality of energy-efficient equipment and services should be controlled.
5. Regulations should be enforced and regularly strengthened.
6. Behaviour should be addressed as much as technologies, relying on information and communications technologies (ICTs).
7. Monitoring achievements is necessary to evaluate the real impact of energy-efficiency policies.
8. International and regional cooperation should be enhanced.

Given its 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 au travers de multiples indicateurs et d'évaluer les politiques d'efficacité énergétique mises en œuvre. Cette étude a été coordonnée par l'ADEME et a été menée durant les deux 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 les pays membres du CME. Une sélection d'indicateurs a été produite ; ces indicateurs sont consultables sur le site web du CME.[3] Ils ont été analysés et comparés dans ce rapport, par grande région du monde, mais aussi par pays sous forme de carte.

Le second objectif est de décrire et évaluer les politiques d'efficacité énergétique mises en œuvre dans un large échantillon de pays, représentatifs de toutes les régions du monde. L'ensemble des informations relatives aux politiques d'efficacité énergétique sont disponibles sur le site web du CME.[4] L'information relative à 85 pays a été collectée par une enquête auprès d'une soixantaine de pays et une revue de la littérature. Cette enquête a été complétée par 4 études de cas préparées par des experts sur les systèmes de financements innovants dans le secteur du bâtiment, les mesures mises en œuvre pour accélérer la pénétration des climatiseurs efficaces, les factures d'électricité intelligentes, et les mesures pour améliorer l'efficacité des transports routiers de marchandise. 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 qui s'engagent dans les politiques de maîtrise de leur consommation de profiter de l'expérience des pays les plus avancés.

Malgré un rôle toujours important d'instruments de marché (accords volontaires, information, dissémination) et d'incitations économiques, 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). De plus, comme les budgets publics sont de plus en plus restreints, surtout en période de crise, le secteur privé joue un rôle croissant dans le soutien aux investissements d'efficacité énergétique, comme par exemple les sociétés de services énergétiques et les fournisseurs d'énergie. L'étude fait ressortir un certain nombre de mesures innovantes, comme les factures intelligences, les objectifs d'économies d'énergie par secteur, les obligations d'installation d'équipements efficaces et les obligations d'économies d'énergie pour les compagnies énergétiques.

L'étude se conclut par 8 recommandations : les prix de l'énergie doivent refléter les coûts réels et donner des signaux plus incitatifs aux consommateurs; les consommateurs devraient être mieux informés ; des outils de financement innovants devraient être mis en œuvre pour soutenir les investissements des consommateurs; la qualité des équipements et des services d'efficacité énergétique doit être mieux contrôlée ; les règlementations doivent être effectivement appliquées et régulièrement renforcées ; les comportements doivent être mieux ciblés, à l'aide notamment des TIC; l'évaluation des résultats est nécessaire pour

3 www.wec-indicators.enerdata.eu/

4 www.wec-policies.enerdata.eu/

vérifier l'impact réel des politiques d'efficacité énergétique ; enfin, la coopération régionale et internationale devrait être renforcée. Ce rapport, grâce à une large couverture de pays et grâce à l'association des indicateurs aux politiques, fournit une source d'information exhaustive et originale d'évaluation de l'efficacité énergétique.

1

Introduction

Importance of energy efficiency in addressing multiple political goals

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, these policies are adapted to suit national circumstances and address multiple political goals.

To address the risks of climate change, an increasing number of countries, mainly from the OECD, have embarked on ambitious programmes, with energy efficiency often as the main pillar. Energy efficiency enables countries to alleviate the financial burden of oil imports on their balance of trade and also improves energy supply security. As many countries are faced with low economic growth and high unemployment, energy efficiency is seen as the best strategy to improve the competitiveness of industry, by reducing energy cost and stimulating economic growth and job creation through the investments generated. Many countries where heating is an important component of consumers' energy bills, energy efficiency can help to reduce costs for low-income consumers and can contribute to alleviating poverty.

In developing and emerging economies, energy efficiency also enables a reduction in energy investment, and helps to make the best use of existing assetsies to improve energy access. Improving efficiency in use of electricity has two benefits:

- Supplying more customers with the same Using the same electricity production capacity, thus providing electricity access for more people to s, which is often the main objectivechallenge in many countries of Africa and Asia.

- Slowing down electricity demand growth, and so reducing the investment needed for expansion of the electricity sector. This is especially important in countries with high growth in electricity demand, such as China and many Southeast Asian countries.

In these countries, energy efficiency also has many other benefits, such as reducing the impact of oil volatility on the balance of trade and on subsidies, when prices are subsidised, which is often the case.[5]

Energy-producing countries are also become concerned by energy-efficiency as they realise they are wasting valuable resources by not using them efficiently.

Limit to market forces in improving energy efficiency

Price signals alone are not enough to achieve a rationalisation of energy use. Policy measures are necessary in market economies to reinforce the role of energy prices, first to create the appropriate market conditions for energy-efficient equipment and services, second to drive consumer choice towards the most cost-effective solutions.

The following market failures are often used to justify the implementation of policy measures:

- The information is either missing or incomplete.

5 In Tunisia, evaluation of programmes have shown that for $1 spent in supporting energy-efficiency investment though the national energy efficiency fund (FNME) $4.5 are saved in subsidies.

- The availability of efficient appliances and production devices in the domestic market is limited.
- There is a lack of technical, commercial and financial services.
- Decision makers for energy-efficiency investments are not always the final users who have to pay the heating or cooling bills.
- Consumers' financial constraints 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 means they do not select the most efficient equipment or devices. Implicit discount rates in the industry are over 20% compared to less than 10% for public discount rates, and 4–6% for long-term interest rates.

Energy-efficiency policies are therefore necessary to address these multiple barriers.

The role of public intervention and complementary role of the private sector

The main objective of applying policy measures forto energy efficiency is to create the necessary conditions to speed up the development and the deployment of efficient equipment and services, through:

- information and communication, well channelled to final consumers to increase their awareness and show them the range of possible options for technical decisions
- Seupport for the purchase of energy-efficient equipment and devices through financial incentives (e.g. subsidies, – subsidised loans) with subsidised interest ratesor fiscal measures (tax credit, tax reduction, taxation of inefficient equipment)
- deployment of specific financing mechanisms to enable consumers to invest in cost-effective solutions with high investment
- regulation on appliances, equipment and buildings to mandate the display of their energy-efficiency performance through efficiency labels and to impose minimum efficiency standards to remove the least efficient from the market
- regulation imposing obligations on consumers (e.g. audits, reporting, plans, energy savings)
- research and development (R&D) and demonstration programmes for energy-efficient technologies to speed up their penetration in the market.

In a context of budget constraints and to reach multiple consumers more directly, public policies rely more and more on the private sector: energy utilities, and the energy services companies (ESCOs). The involvement of utilities can be through negotiated or voluntary agreement or through regulations that mandate these utilities to make energy savings with their customers – energy savings obligations. The involvement of ESCOs helps to introduce sthe inclusion of technical and financial solutions that can help consumers invest in energy efficiency.

Presentation of the report

Evaluation of energy-efficiency trends

The evaluation of energy-efficiency trends by world region in this report is based on a set of uniform energy-efficiency indicators covering the period 1990–2011, with a greater focus on the most recent decade (2000–2011). As the year 2009 was marked by a deep global recession, with specific trends, some comments have been added to discuss the recession's impact on energy-efficiency trends.

The data used for the calculation of the energy-efficiency indicators comes from was Enerdata world energy database.[6] This database relies on harmonised data from international organisations – International Energy Agency (IEA), Eurostat, World Bank, Asian Development Bank, International Monetary Fund (IMF) – from industry associations – Cedigaz for gas, World Steel Association for steel, Cement Sustainability Initiative (CSI) for cement, International Road Federation for transport, for instance) – as well as from national energy ministries and utilities. Thise analysis provides a consistent coverage of the world energy consumption, split by main regions, taking into account the most recent trends. Some more detailed indicators were taken for European Union (EU) countries from the ODYSSEE MURE database.[7]

The indicator trends are shown globally and for10 main world regions or countries: Europe,[8] Community of Independent States (CIS),[9] North America (US, Canada), Latin America (including Mexico), China, India, OECD Asia,[10] Other Asia, Africa and the Middle East.

Overall energy-efficiency trends through macro indicators are reviewed in Chapter 2. The indicators by end-use sector (industry, transport and buildings) are analysed in the sectoral chapters (Chapters 5 to 7). Carbon dioxide ($CO_{2)}$ emissions from energy use are considered in Chapter 8.

The policy evaluation

The evaluation of energy-efficiency policies in this report covers the diffusion of selected energy-efficiency policy measures around the world. It aims to answer the following questions:

- How important are energy-efficiency measures?
- What are the priorities?
- What are the trends in policy implementation?

6 The indicators are presented in a database developed by Enerdata: http://wec-indicators.enerdata.eu

7 The ODYSSEE MURE database is developed at EU level within a project sponsored by the Intelligent Energy Europe programme of the European Commission gathering ADEME, EU energy-efficiency agencies and EnR, the European Energy Network. www.odyssee-indicators.org.

8 EU, Albania, Bosnia, Croatia, Iceland, Macedonia, Norway, Serbia, Switzerland, and Turkey

9 CIS: Azerbaijan, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan and Ukraine.

10 Japan, Korea, Australia, New Zealand.

- What measures are being favoured by policymakers?
- What are the most innovative measures?
- What are the results of the policies?
- Which measures are cost effective?

This evaluation relies mainly on a comprehensive global survey. It also draws on four in-depth case studies on policy measures prepared by different experts. The following measures were selected as they correspond to new concerns or areas of actions that complement measures already evaluated:

- Innovative soft loan financing schemes in building.[11]
- Measures to accelerate the penetration of efficient air conditioners and their use.[12]
- Smart billing.[13]
- Measures to improve the efficiency of road transport of freight.[14]

For each of these case studies, a core report provides a comprehensive evaluation and is completed with 'country case studies'.[15] The main findings of these case studies have been included in the corresponding chapters of this report. The country case studies are available on the WEC ADEME policy database.[16]

The survey[17] of energy-efficiency policy measures covers a total of 85 countries and economies, representative of all world regions (see Figure 1):

- 34 from Europe: 27 countries from the EU, Albania, Croatia, Iceland, Norway, Serbia, Switzerland and Turkey
- Two from CIS: Russia and Ukraine
- Two from North America: Canada and United States
- 10 from Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, Paraguay, Peru, Uruguay
- Four Asian and Pacific OECD countries (Asia OECD): Australia, Japan, New Zealand, Republic of Korea

11 Pedro Guertler and Sarah Royston of the Association for the Conservation of Energy, and Dr Joanne Wade.

12 Prof. Luiz A Horta Nogueira from EXCEN/UNIFEI, Brazil.

13 Christophe Dromacque and Jessica Stromback from VaasaETT.

14 Riccardo Enei, Giovanna Giuffrè and Andrea Ricci from ISIS.

15 Generally eight countries, half of which are OECD and the other half in non-OECD were covered.

16 www.wec-policies.enerdata.eu/case-studies.php; other case studies evaluated in the 2010 report are also included: good practice in the public sector; financial tools for households; measures for low-income households; obligation of energy savings for energy utilities; regulation and compliance; and, smart meters.

17 The survey is based on a questionnaire designed by ADEME and Enerdata and sent to all WEC national committees and contacts from ADEME's network of energy-efficiency agencies. Half of the countries covered answered directly; the other half were completed by Enerdata from the 2009 survey and literature research.

- 12 emerging countries or economies from Asia and the Pacific: China, Hong Kong, India, Indonesia, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Vietnam;
- 13 from Africa: Algeria, Botswana, Chad, Egypt, Ethiopia, Ghana, Mali, Morocco, Nigeria, Senegal, South Africa, Tunisia, Zimbabwe
- Eight from the Middle East: Iran, Israel, Saudi Arabia, Jordan, Lebanon, Syria, Yemen, United Arab Emirates.

Altogether, the surveyed countries represent 91% of world energy consumption (100% for North America and Western Europe, 98% for Asia and Pacific, around 90% for Latin America and the Middle East and around 80% for Africa). As almost two-thirds of countries do not belong to the OECD, this sample gives a good representation of non-OECD countries, especially in Latin America and Asia.

Figure 1
Countries covered by the WEC survey on energy-efficiency policies
Pays couverts par l'enquête CME sur les politiques d'efficacité énergétique
Source: WEC ADEME survey 2012–2013

The survey covers institutional aspects, as well as existing regulations and financial measures. The measures considered in the survey are organised as follows:[18]

- **Institutions and programmes**
  - Institutions: agencies (national, regional and local), ministry department for energy efficiency
  - National programmes of energy efficiency with quantitative targets
  - Energy-efficiency laws.

18 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.

- **Regulations**
  - Labels for five domestic appliances (refrigerators, washing machines, air conditioners, lamps, water heaters), cars, existing and new building (both in residential and public/commercial sector) and electric motors
  - Minimum efficiency standards for electrical appliances (refrigerators, washing machines, air conditioners, lamps, water heaters, electric motors), cars and buildings (new and existing in residential or public/commercial sectors)
  - Other regulations for designated consumers: mandatory energy audits, energy managers, energy-consumption reporting, and energy-saving plans; energy saving quotas;
  - Mandatory requirement for son enenergy companies tofor promoteing energy savings for with their customers.

- **Financial and fiscal measures**
  - Energy-efficiency funds.
  - Economic incentives: subsidies for energy audits by sector (industry, commercial, public or residential buildings, transport companies); subsidies or soft loans for energy-efficiency investment and equipment by sector.
  - Fiscal measures:
    - tax credit or deduction on cars, appliances and buildings
    - accelerated depreciation for industry, tertiary or transport sectors
    - tax reduction by type of equipment (appliances, cars, lamps, and so on).

- **Cross-cutting measures**
  - ESCOs
  - Voluntary agreements
  - Mandatory training professionals.

The results of the survey are summarised in this report using different graphs showing the degree of implementation of the measures in eight world regions: Europe, CIS, North America, OECD Asia & Pacific, Latin America, non-OECD Asia, Africa, and Middle East. The results of the survey can be searcheden by type of measure, by target (i.e. sector, type of appliance) and by country using the interactive database.[19]

Although energy pricing is an important component of energy-efficiency policies, this issue was not included in the survey, as other international databases have this information to

19 www.wec-policies.enerdata.eu

already existmonitoring price level and trends.[20] For the same reason, measures related to information campaigns, training or communication were not included to avoid overloading the survey, as they exist elsewhere, and often rely on regional/local initiatives which make them difficult to track in an exhaustive way.[21] However, measures relating to pricing and information and communication will be discussed later in the report.

20 IEA provide energy prices for OECD countries; Enerdata covers a selection of non-OECD countries.

21 Only mandatory label schemes and mandatory training have been included under regulation. In the 2010 report, a specific study has been carried out on innovative information campaigns (www.wec-policies.enerdata.eu).

2

Overall energy efficiency trends

Three types of energy-efficiency indicators are considered here to monitor changes in energy efficiency and to compare energy efficiency in the various countries and regions: economic ratios, techno-economic ratios and diffusion indicators.

1. Economic ratios, referred to as energy intensities in this report, 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 (GDP), value added, and so on. 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 (PPPs) at 2005 prices and parities (see Box 1).

2. Techno-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 (such as tonnes of steel, number of passenger-kilometres) or to a consumption unit (e.g. per vehicle, dwelling, and so on). These techno-economic ratios are called unit or specific energy consumption.

3. The diffusion indicators aim to monitor the market penetration of energy-efficient technologies (e.g. share of cogeneration in industry and in total power generation, share of electric steel, per capita installed area of solar water heaters)[22] and practices (e.g. per capita mobility by rail transport).

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.[23] All indicators include biomass, as many OECD countries are now promoting the use of biomass to reduce greenhouse gases (GHG) emissions and as it is still a dominant source of energy in many developing countries.

Primary energy intensity trends

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.[24]

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 a number of factors:

22 Solar water heaters are usually considered as energy saving device as they save energy in consumer premises.

23 Electricity is converted to tonnes of oil equivalent (toe) according to International Energy Agency (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. Final energy consumption excludes non-energy uses. CO_2 emissions are calculated by Enerdata based on United Nations Framework Convention on Climate Change (UNFCCC) definitions.

24 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.

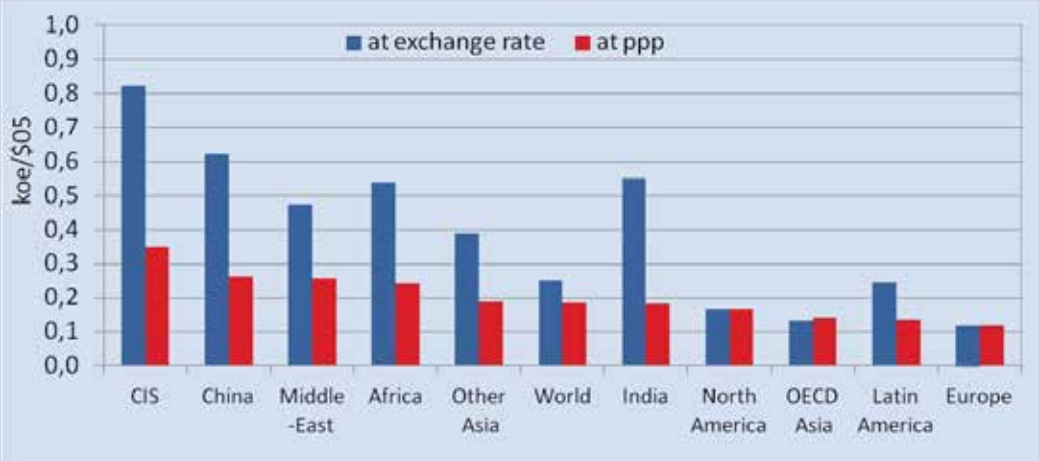
- The nature of economic and industrial activities ('economic structure', or the contribution of various sectors in the GDP)
- The primary energy mix (i.e. the share between coal, oil, gas, biomass, other renewables and nuclear).
- Climate.
- Level of development and lifestyles
- organisation of the transport sector (in particular the importance of public transport).
- The diffusion of household equipment lifestyles and end-use level (equipment and buildings) in the energy sector, power generation, other energy production or transmission activities.

Trends in energy intensities are therefore influenced by changes in all these factors. Energy efficiency, while just one of many drivers, is generally the major driver of energy-intensity trends.

Box 1: Energy intensities at purchasing power parities

GDP and value-added data for all countries and regions are converted at purchasing power parities (PPP) to reflect differences in general price levels.[1] Using PPP rates instead of exchange rates increases the value of GDP in regions with a low cost of living (i.e. most emerging countries), and therefore decreases their energy intensities[2] (Figure 2).

Figure 2
Primary energy intensity: purchasing power parities vs. exchange rates (2011)
Intensité énergétique primaire: parités de pouvoir d'achat vs taux de change (2011)
Source: Enerdata



25 National GDP at PPP come from the World Bank.

26 On average, for non-OECD countries, the GDP at 2005 PPP is 2.3 times higher than if it is expressed at 2005 exchange rates (factor 3 for India and 2.4 for China).

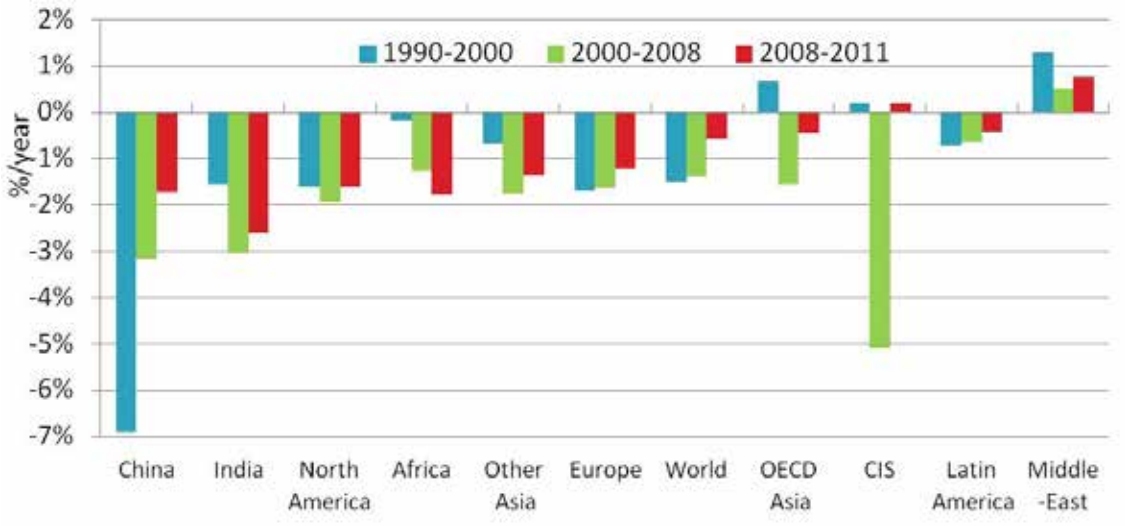
Energy intensities at PPP are more relevant for comparisons as they relate the energy consumption to the real level of economic activity and lifestyles. The use of PPP narrows the gap of energy intensity between countries and regions with different levels of economic development, compared to what would be shown with exchange rates. As the intensities are measured at constant prices and parities, the use of PPP changes the intensity level but does not affect their trends at country level.[27]

Slower decrease of the primary energy intensity since 2008 due to the economic crisis

The primary energy intensity has been decreasing worldwide and in all regions, except the Middle East. At global level, the reduction has been 1.3% per year on average since 1990 (Figure 3. In the Middle East, energy consumption has been increasing faster than GDP, mainly because of a rapid development of energy-intensive industries and air conditioning.[28]

The world economic crisis has had a strong impact on the overall energy-efficiency improvement since 2008 in most regions, except Africa and North America: worldwide, energy intensity has decreased at half the rate since 2008 (0.6% per year versus 1.4% per year between 2000 and 2008). This is due to the fact that part of energy consumption is not linked to the level of economic activity.

Figure 3
Variation of primary energy intensity by world region
Variation de l'intensité énergétique primaire par région du monde
Source: Enerdata



The fact that economic growth was most rapid in countries or regions with the highest energy intensity (e.g. China, India or the Middle East) contributed to decreasing the rate of progress worldwide.: This structural change in the world GDP offset part of the reduction observed at

27 The trend at regional level or at global level may be affected by differences in the GDP growth of countries with different intensities.

28 The rapid growth of air conditioning is driving electricity demand, produced with losses in thermal power plants.

country and regional level. If we correct the global energy-intensity trend for this structural change, the energy-intensity reduction comes close to 2% per year on average since 2000. Whatever the period, this structural change contributed to increasing world energy intensity by 0.8% per year since 2000.

China experienced the strongest improvement in energy productivity – around 5% per year on average since 1990 (and even 7% per year between 1990 and 2000). This great improvement is the result of various factors: more efficient use of coal; switch from coal to oil; industry restructuring (rapid growth of equipment manufacturing industries); closure of old facilities; and higher energy prices. The reduction of the primary intensity was about 2.3% per year in India and around 1.8% per year in the CIS.

Almost 80% of the countries in the world[29] have increased their energy productivity (i.e. decreased their energy intensity, as seen in Figure 4). Since 2000 this primary energy intensity decreased by more than 3% per year in 16 countries (e.g. 18% of countries).

Energy-intensity trends over a given period can be influenced by climatic differences between the first and last year of the period in countries where space heating or cooling in homes and buildings presents a significant share of the total consumption (e.g. Europe, North America, CIS). For that reason, it is preferable to work with intensities at normal climate, as explained in Box 2. As data on degree days was not available for all countries for the full period, it was not possible to show the impact of climate variations before 2005.

Figure 4
Trends in primary energy intensity to GDP (1990–2011) (%/year)
Tendances d'intensité énergétique primaire (1990–2011)
Source: Enerdata

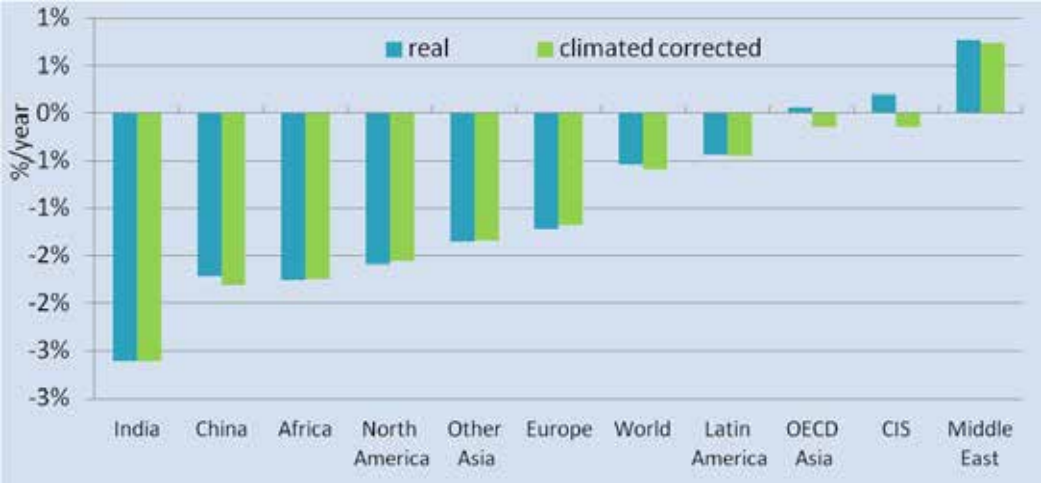
29 Based on a sample of 90 countries.

Box 2: Influence of climatic corrections

Years with cold winters will have a higher consumption than years with mild winters, all things being equal; this is the same for years with warm summers. In order to correct energy-consumption trends for the fluctuations due to climate, climatic corrections provide a measurement of consumption for a normal year. Climatic corrections are done on the part of consumption used for room heating and air conditioning. They are based on the concept of degree days which measure the difference between the outdoor temperature and a reference room temperature for each day of the heating or cooling period.[30]

At world level, the primary energy intensity decreased by around 0.5% per year over the period 2008–2011 and by 0.6% per year at normal climate (see Figure 5). In North America and Europe, the decrease was slower at normal climate, meaning that the 2011 winter was colder than the 2008 winter.

Figure 5
Influence of climatic corrections on the primary energy intensity (2008–2011)
Influence des corrections climatiques sur l'intensité énergétique primaire
Source: Enerdata

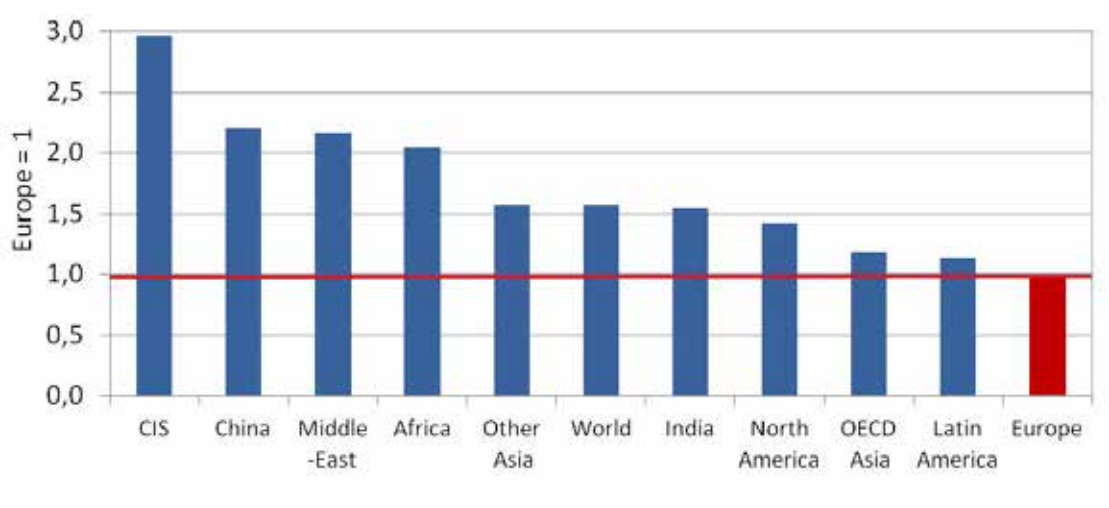


Large disparities in the amount of energy used per unit of GDP among regions

The CIS use almost three times more energy per unit of GDP than Europe, the region with the lowest energy intensity. In China, Africa and the Middle East, the energy intensity is twice the average of Europe. Highest energy intensities can be attributed to various factors, including the dominant role of energy-intensive industries (China and the Middle East) and low energy prices. Latin America and OECD Asia and Pacific are about 15% above the European level (respectively 14% and 18%). Finally India and Other Asia stand at the same level as the world average with energy intensity 50% higher than Europe and slightly below North America (see Figure 6).

30 For heating, the usual reference temperature is 18 °C and the number of heating degree days is defined as the sum for each heating day of the difference 18 – T, with T the average temperature of the day.

Figure 6
Primary energy intensity levels by world region (2011)
Intensité énergétique primaire par région du monde
Source: Enerdata



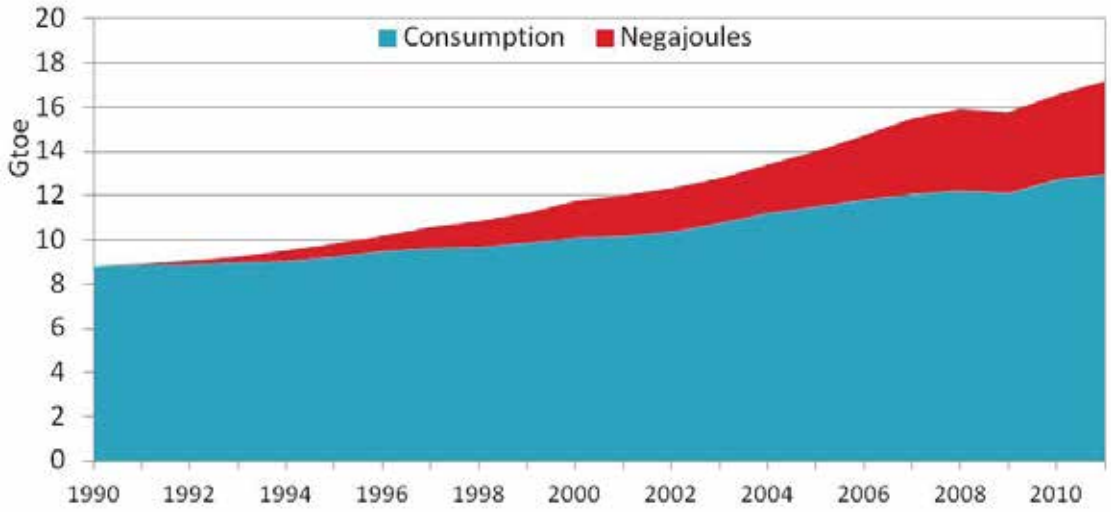
Around one-third of countries have low energy intensity in the range of the European average, including all the large countries (such as Germany, Italy, Spain, UK), five African countries (including Morocco, Tunisia), three Latin American countries (including Columbia and Uruguay). Twenty countries have very high energy intensity, more than twice the European average, including China and many oil-producing countries in the Middle East (e.g. Iran, Saudi Arabia, Kuwait), in the CIS (e.g. Russia, Ukraine and Kazakhstan) and in Africa (Nigeria) (see Figure 7). These oil-producing countries generally have low energy prices which attract energy-intensive industries and favour the diffusion of inefficient equipment and practice.

Figure 7
Primary energy intensity levels by country (2011)
Intensité énergétique primaire par pays
Source: Enerdata

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 CO_2 savings. At 1990 energy intensity by main region (i.e. at constant technologies and economic structure of 1990), world energy consumption would have been 4.2 Gtoe higher in 2011. In other words, energy savings from energy productivity improvements (negajoules) reached 4.2 Gtoe in 2011 globally, or around 32% of the primary energy consumption (Figure 8). These energy productivity improvements avoided 9.6 Gt CO_2 at world level.

Figure 8
Energy savings from energy intensity decrease at world level
Economies d'énergie au niveau mondial
Source: Enerdata



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

The final energy intensity corresponds to the energy consumed per unit of GDP by final consumers for energy uses, excluding consumption and losses in energy conversion, mainly in power generation, and non-energy uses.

The final energy intensity at world level decreased more rapidly than the primary energy intensity (1.6% per year against 1.3% per year between 1990 and 2011. See Figure 9). So, energy productivity improved 20% more rapidly at the level of final consumers than at the overall level. Thus, at the world level, 20% of energy productivity gains at the final consumer level were offset by increasing losses in energy conversion and power generation (66% in OECD Asia, 33% in CIS, 36% in India).

These growing losses in power generation are not due to the fact that power generation is less efficient (see section below) but rather to the rapid growth of electricity demand at end-use level, as electricity is predominantly produced from thermal power plants, with 60–70% of losses. The share of electricity in final energy consumption rose from 13% in 1990 to 18% in 2011 at world level; in China and other Asia, the electricity penetration was particularly rapid (from 5–20% in China or 8%–15% in Other Asia).

In Europe and North America, the primary and final intensities decreased at the same level due to the fact that energy conversion losses were stabilised by the increasing share of renewable (mainly wind and solar), gas combined-cycle plants and cogeneration in power production.

Figure 9
Variation of primary and final energy intensity[31] (1990–2011)
Variation de l'intensité primaire et finale (1990–2011)
Source: Enerdata

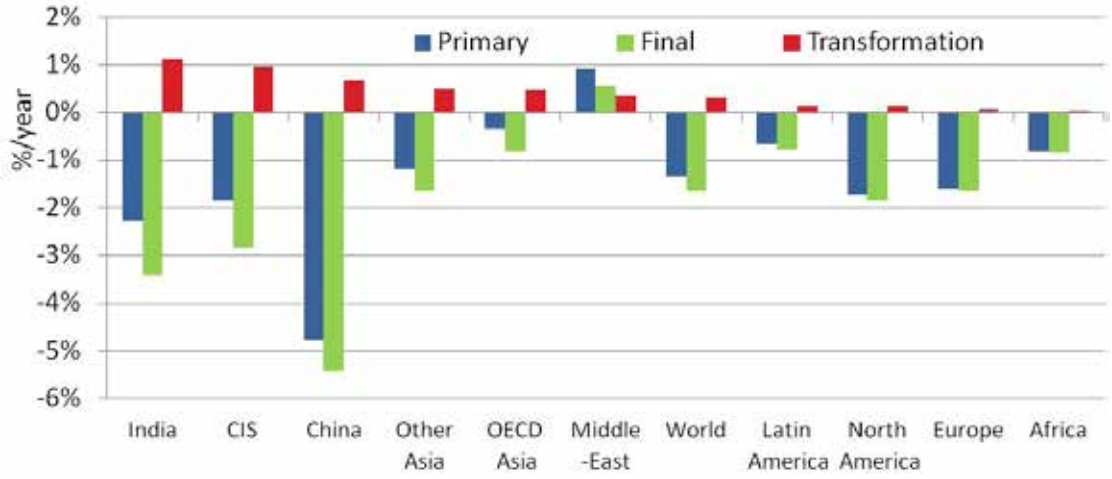
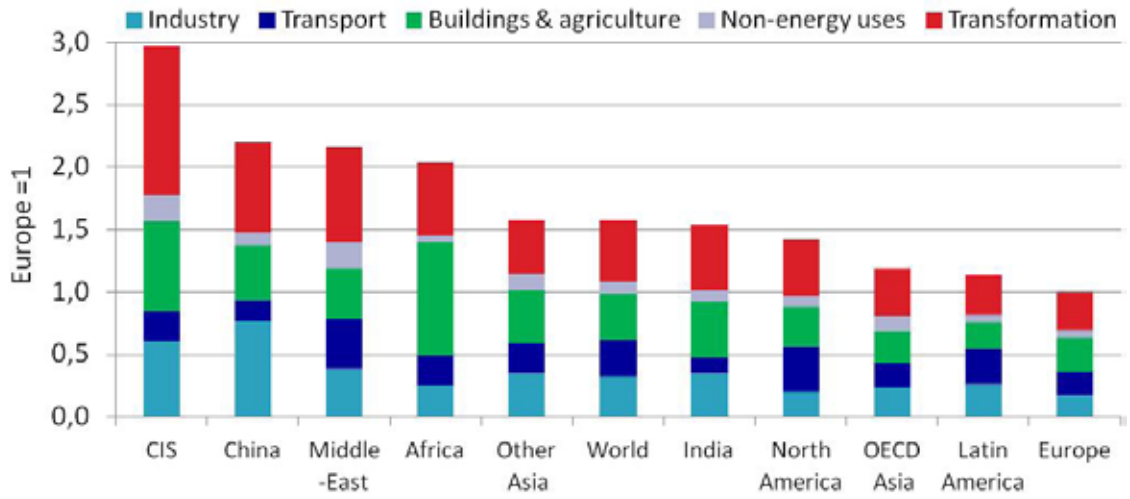


Figure 9 shows how each sector contributes to the primary energy intensity. Industry is important in China and Russia. The high contribution of energy conversion and industry explains part of the higher energy intensity of CIS, China and the Middle East (conversion: 40% in CIS, 35% in the Middle East; industry ~ 35% in China). In Africa, the dominant use of low-efficiency biomass in the residential sector explains its high energy intensity.

Surprisingly, transport has had a lower influence on energy-intensity trends, except in the Middle East and North America, probably because of the large increase in the price of motor fuels in recent years that have slowed down consumption growth and brought it in line with GDP growth.

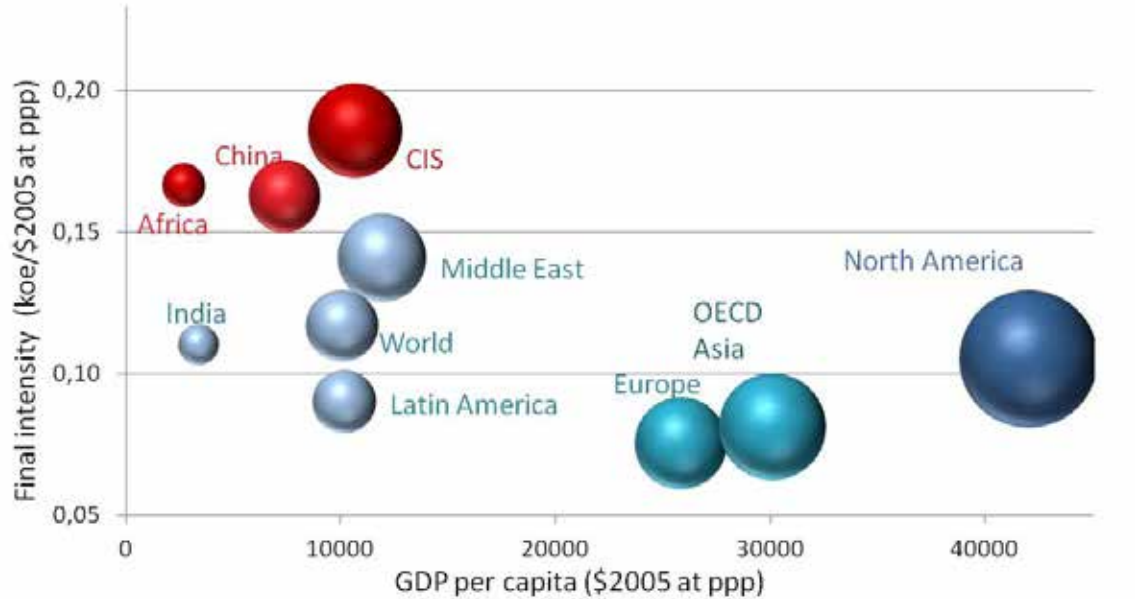
31 Non-energy uses are excluded from the final energy intensity.

Figure 10
Contribution of sectors to primary energy intensity (2011)
Contribution des secteurs à l'intensité énergétique primaire
Source: Enerdata



With the exception of North America, the higher the GDP, the lower the final energy intensity (Figure 11). There is not, however, any correlation between GDP per capita and energy consumption per capita (the size of the bubble in Figure 11).

Figure 11
Final energy intensity, GDP/capita and energy consumption/capita (2011)
Intensité énergétique finale, PIB/ habitant et consommation finale par habitant
Source: Enerdata



Changes in economic structure also influence final energy intensities

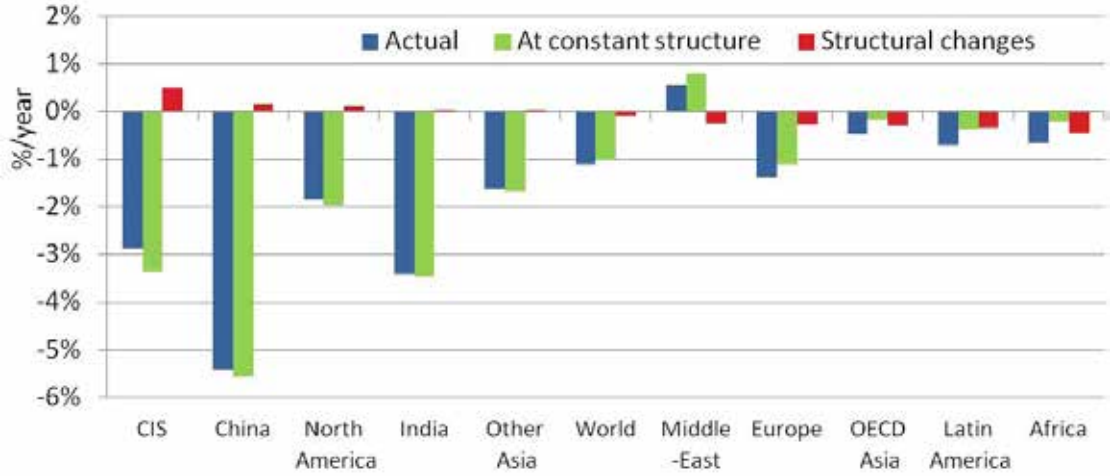
Changes in economic structure contribute to variations in final energy intensities. For example, all things being equal, the tertiarisation of the economy will decrease final energy intensities, as the energy intensity of industry is six times higher than that of the service sector at world level. In 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 country or 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.

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, as they are generally not the result of energy-efficiency policies. This is achieved by calculating energy intensity at constant GDP structure.[32] The difference in variations of the final energy intensity and of the intensity at constant GDP structure shows the influence of structural changes in the economy (see Figure 12).

In half of the regions worldwide, the final intensity decreased faster than the intensity at constant structure. This means that part of the energy productivity improvement was due to an increasing share of services in the GDP and thus to a move to a less energy-intensive economic structure.

Changes in the GDP structure explain around 8% of the final energy intensity decrease at world level, 19% for Europe, 64% for OECD Asia and 68% for Africa. In China, India, CIS and North America, there was an opposite trend linked to industrialisation: as a result, structural changes tend to increase the final energy intensities.

Figure 12
Role of structural changes in the GDP (1990–s2011)
Rôle des changements structurels dans le PIB
Source: Enerdata



32 The energy intensity at constant GDP structure is calculated by assuming a constant share of agriculture, industry and services in the GDP as well as of the private consumption for households in the GDP.

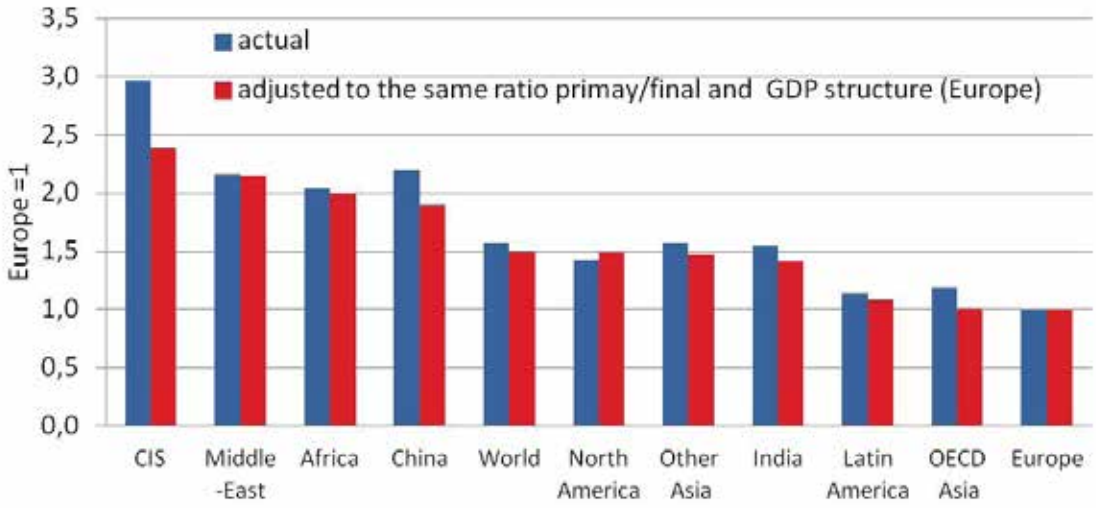
Adjustments on GDP structure and primary energy mix narrow differences in primary intensity among regions

Differences in GDP structure and in the quantity of energy lost in the transformation process (reflected by the ratio primary/final intensity) among countries and regions will affect their relative energy-intensity levels.

The share of industry in the GDP varies from 16% in North America to around 25% in Europe, India and world average, and 44% in China (2011). The share of services varies from 37% in China, around 45% in CIS, India and Africa and about 65% in Europe (60% at world level) to 71% in North America.

After adjustment to the same GDP structure and the same ratio of primary to final intensity, the difference in intensities with Europe disappears, becoming narrower for most other regions, except for North America and the Middle East.[33] The remaining gaps are due to differences in industry structure, lifestyles and, above all, energy efficiency (Figure 13).

Figure 13
Adjusted primary energy intensity (2011)
Intensité primaire ajustée
Source: Enerdata



Energy-efficiency achievements in the power sector

Slower improvement of the average efficiency of thermal power generation since 2000

Energy efficiency of thermal power generation improved by 3.5 points since 1990 at world level, from 32% in 1990 to 35.5% in 2011: this is far from the OECD Asia average (40%) or world best practice (Spain with 46% due to a high penetration of combined cycle gas turbines (CCGTs) (Figure 14). However, this improvement was slower since 2000 (only 1.5 points since 2000 compared to 2.5 points from 1990 to 2000). The largest improvements can be seen

33 The EU has been taken as a reference; the ranking would not be affected by the choice of another region.

in China with the commissioning of new efficient coal plants, as well as in Europe and Latin America with the spread of CCGTs. At world level, CCGTs represent 18% of the installed thermal capacity, a rise of 10 points since 2000 (33% for Europe and 35% for Latin America).

Figure 14
Trends in the average efficiency of thermal power generation
Variation du rendement moyen des centrales thermiques
Source: Enerdata

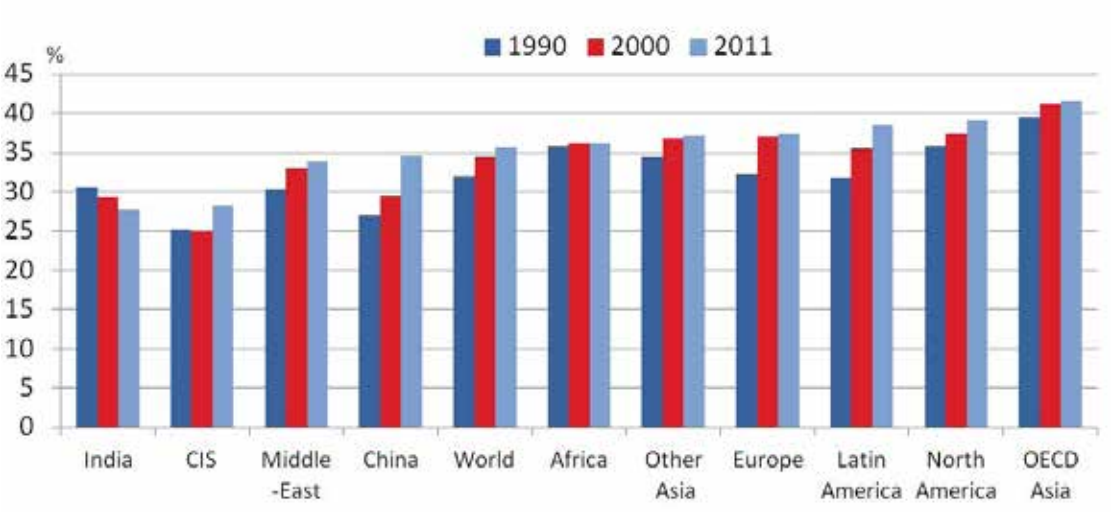
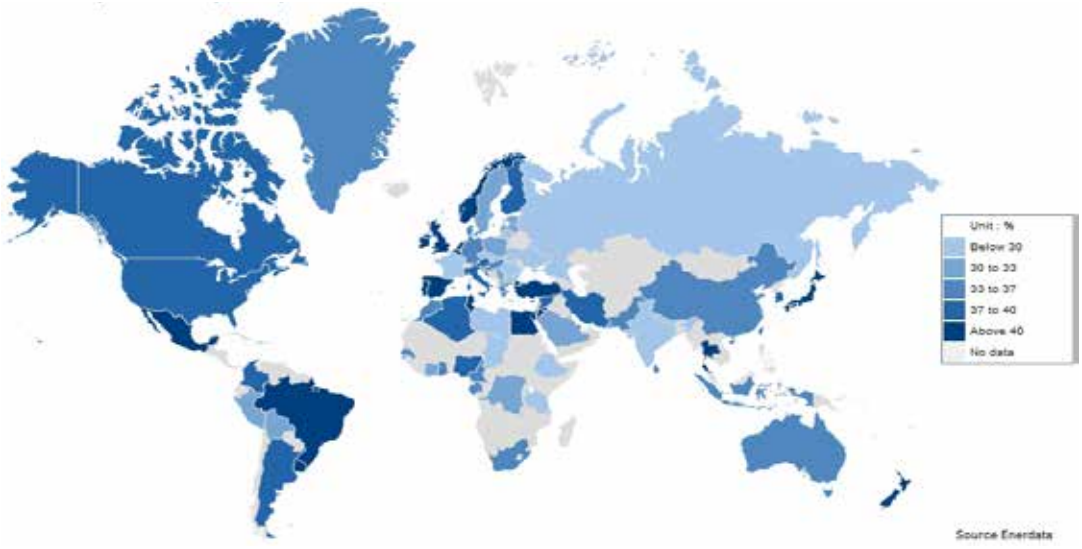


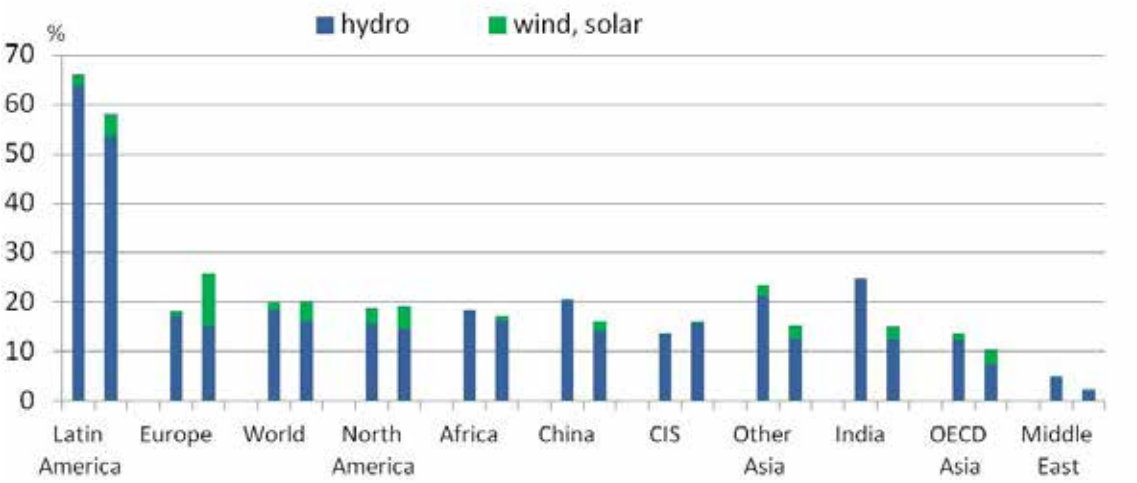
Figure 15
Average efficiency of thermal power production by country (%) (2011)
Rendement moyen des centrales thermiques par pays
Source: WEC ADEME survey 2012–2013



As hydro, wind and solar power generation are accounted for in energy statistics with an efficiency of 100%, the penetration of renewables in electricity production is improving the average efficiency of power generation. The share of renewables in electricity production remained quite stable at world level, with two divergent trends (see Figure 16). It has increased in Europe, and to a lesser extent in the CIS; it remained stable in North America

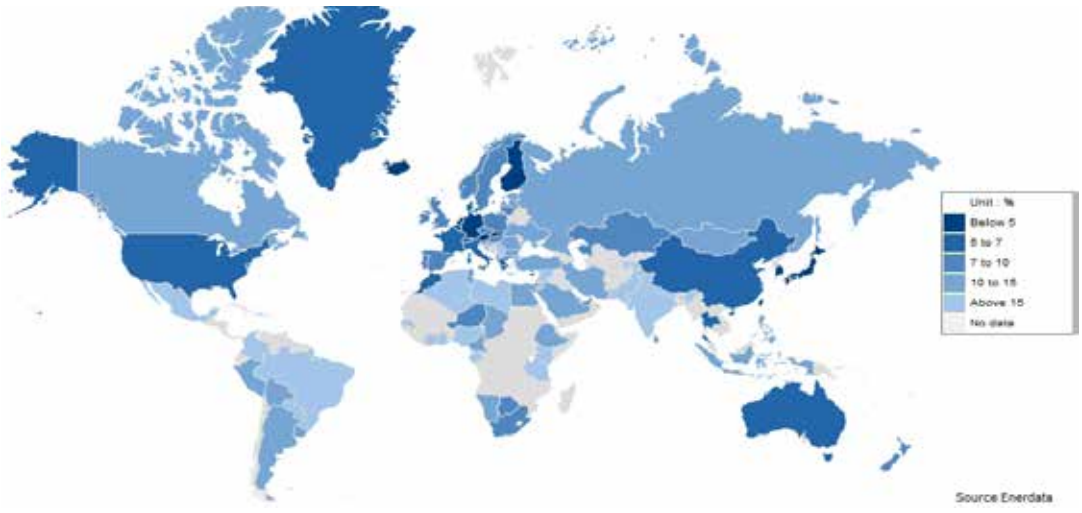
and decreased in all other regions. In Europe, the higher penetration of renewables was driven by wind and solar, which reached 10% of power generation in 2011 (4% at world level).

Figure 16
Share of renewables in electricity production (1990, 2011)
Part des renouvelables dans la production d'électricité (1990, 2011)
Source: Enerdata



At world level, the rate of power transmission and distribution losses remained quite stable over the period (9% in 2011), with large discrepancies among regions. Latin America, CIS and Africa suffered from important and increasing losses (over 15%) due to poor infrastructure reliability and irregular power supplies or unpaid bills in some countries (see Figure 17).

Figure 17
Rate of electricity transport and distribution losses
Taux de pertes de transport et distribution de l'électricité
Source: WEC ADEME survey 2012–2013



3

Institutions based on the provision of incentives

There are two main questions related to the institutional setting of energy-efficiency policies and their implementation.

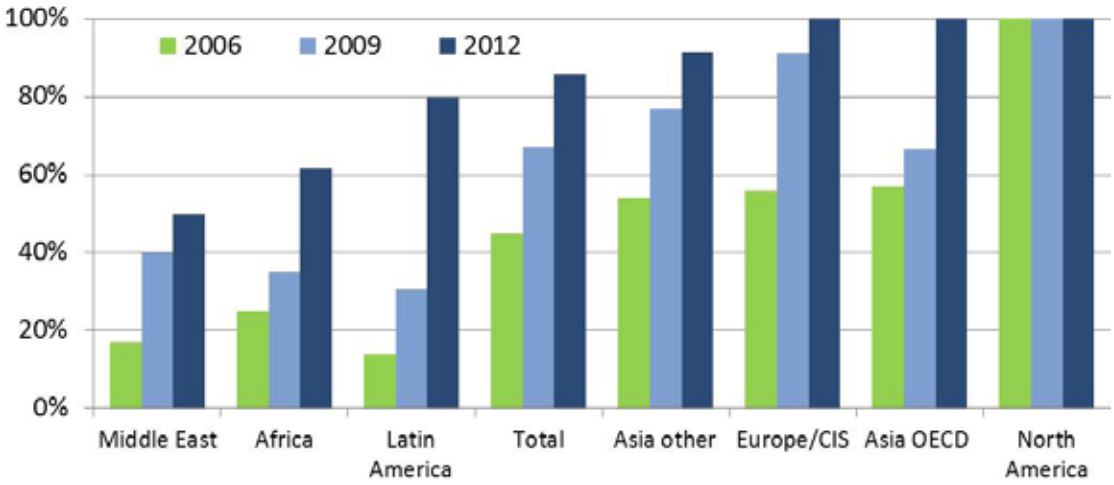
- First, what is the degree of commitment to energy efficiency? This can be monitored through the existence of quantitative targets to be achieved in the framework of an energy-efficiency programme, as well as through the existence of energy-efficiency laws.
- Second, are there institutions supporting the implementation of programmes in the different countries? This can be assessed through the existence of national and regional energy-efficiency agencies.

Quantified targets on energy efficiency

Most countries have quantitative energy-efficiency targets

Increasingly, countries are adopting national energy-efficiency programmes with quantitative targets: this is now the case with 86% of the countries surveyed in 2012 (72 countries), with most countries doubling their figures when compared to 2006 (Figure 18).The progression can be observed in all regions and reflects more ambitious policies.

Figure 18
Surveyed countries with quantitative target[34]
Pays avec des objectifs quantifiés
Source: WEC ADEME survey 2012–2013



The targets are expressed in very different ways: first of all they may refer to a rate of energy savings or efficiency improvement, which is the most common target used in 62 countries in 2012 (compared to 30 in 2006) (Figure 19). This is the case for all EU countries complying with the Energy Services Directive (ESD),[35] plus New Zealand, Japan, and Vietnam. The

34 Quantitative targets in their national energy-efficiency programmes.

35 The EU Directive on End-use Efficiency and Energy Services imposes on all member countries a rate of energy savings of 9% in 2016 of reference consumption (five years' average final consumption, usually 2001–2005).

second type of target is the phase-out of incandescent light bulbs, first launched in 2005 by Brazil and Venezuela; it is now implemented in 59 of the countries surveyed. Targets on energy-intensity reduction, which used to be the main mode of expression of policy target, are no longer popular: now, only 21 countries have targets on energy intensity reduction. The objective of reducing energy consumption compared to a reference historical year is a new and much more constraining target presently considered in six European countries. More than 40 countries have adopted three or more different targets and five countries have more than 10 targets (see Figure 20).

Figure 19
Main quantitative targets of energy-efficiency programmes
Principaux objectifs des programmes d'efficacité énergétique
Source: WEC ADEME survey 2012–2013

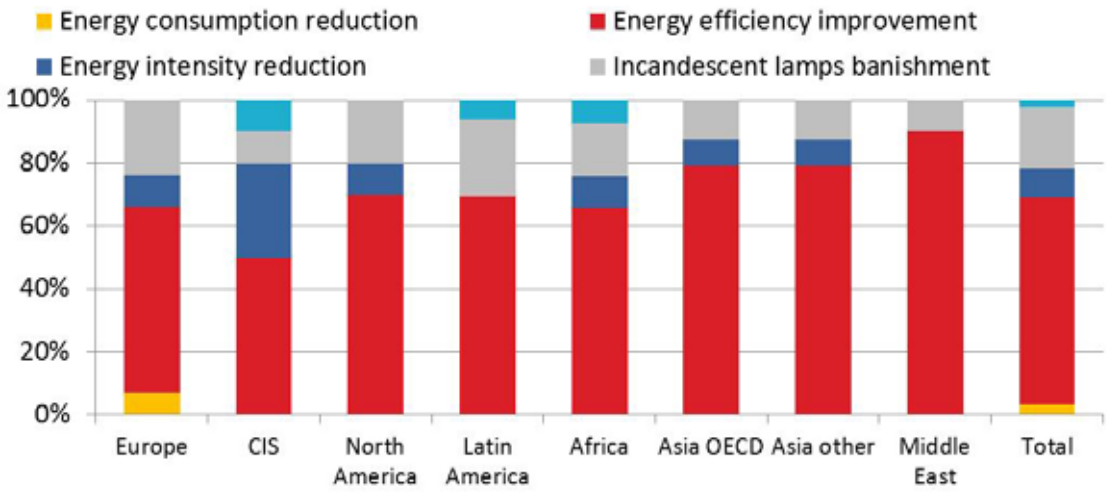
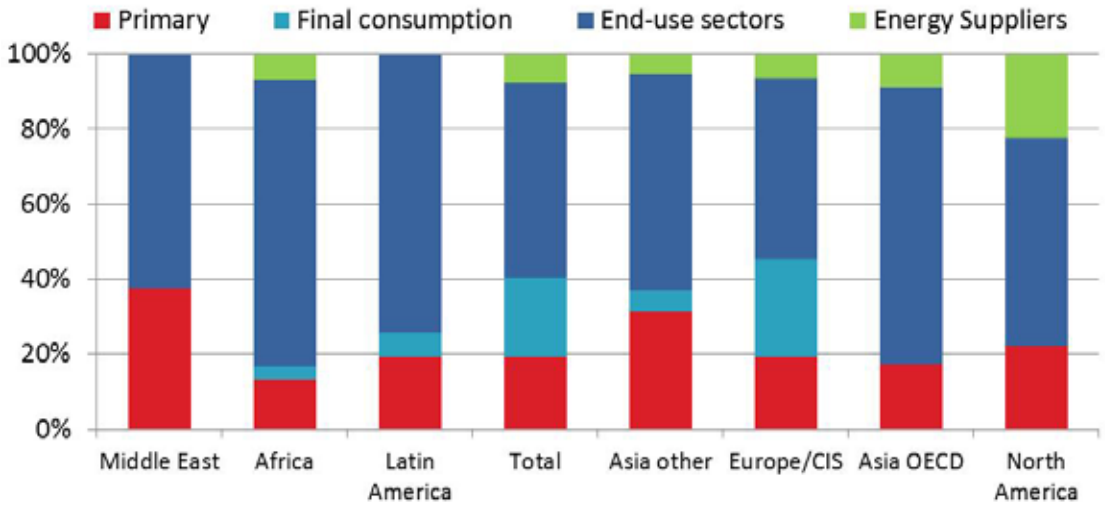


Figure 20
Energy efficiency quantitative targets
Objectifs quantifiés d'efficacité énergétique
Source: WEC ADEME survey 2012–2013

About 60% of sectoral targets and 35% on total consumption

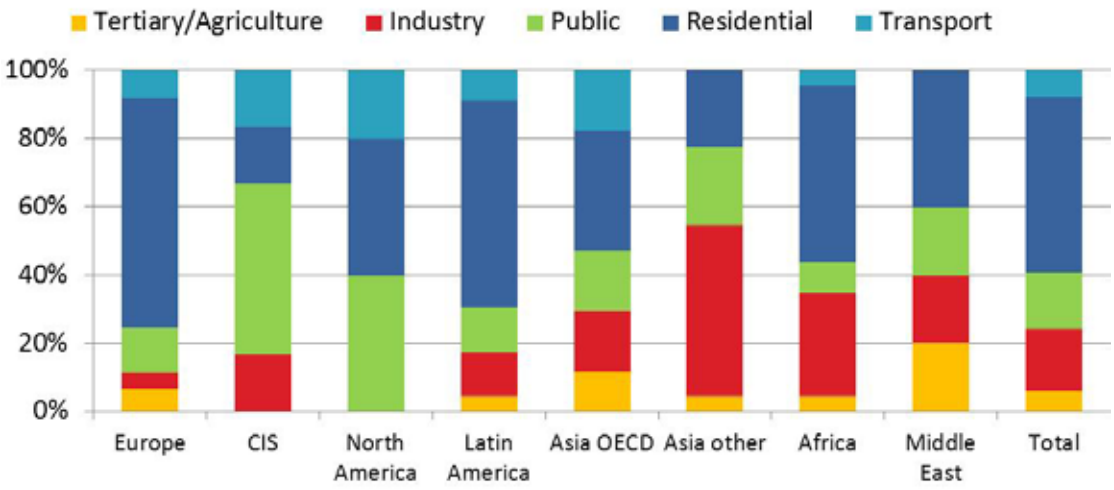
At world level, 60% of programmes have end-use sector targets (i.e. targeting sectors such as residential, industry or transport), and around 35% have targets on the total energy consumption, either the primary energy consumption (20%) or the final energy consumption (15%), the remaining 5% concerns targets for energy suppliers (Figure 21). There are different focuses according to world regions: in Europe, targets on the total final consumption are more important because of the ESD.

Figure 21
Mode of expression of policy targets by region
Mode d'expression des objectifs politiques
Source: WEC ADEME survey 2012–2013



Half of the sectoral targets concern the residential sector, and around 18% the public or transport sectors. Targets in industry are only important in non-OECD Asia, while targets on residential sector are dominant in Europe, Latin America and Africa (Figure 22).

Figure 22
Targets of energy-efficiency programmes by end-use sector
Répartition des objectifs d'efficacité énergétique par secteur
Source: WEC ADEME survey 2012–2013



National energy-efficiency laws

Half of countries have an energy-efficiency law

The adoption of energy-efficiency laws or energy laws with a strong component related to energy efficiency is a new approach to reinforce the institutional setting for energy efficiency: most of the laws have been implemented over the last 10 years. A law gives a more durable status to energy-efficiency policies as changing an existing law can often be a complex process. Energy-efficiency laws may avoid the inconsistency of energy efficiency policies linked to political changes. Often these laws provide a legal framework for the adoption of other regulations, such as labelling, minimum efficiency nergy performance standards (MEPS), obligations for large consumers (e.g. Turkey or India) or even energy-savings obligation for utilities (e.g. France). Energy-efficiency law may also provide a legal framework for setting up an energy-efficiency fund (e.g. Thailand, Uruguay). Among the surveyed countries, 43 countries have implemented energy-efficiency laws (Figure 23).

Figure 23
Countries implementing energy-efficiency law
Pays ayant une loi sur l'efficacité énergétique
Source: WEC ADEME survey 2012–2013

Energy-efficiency agencies

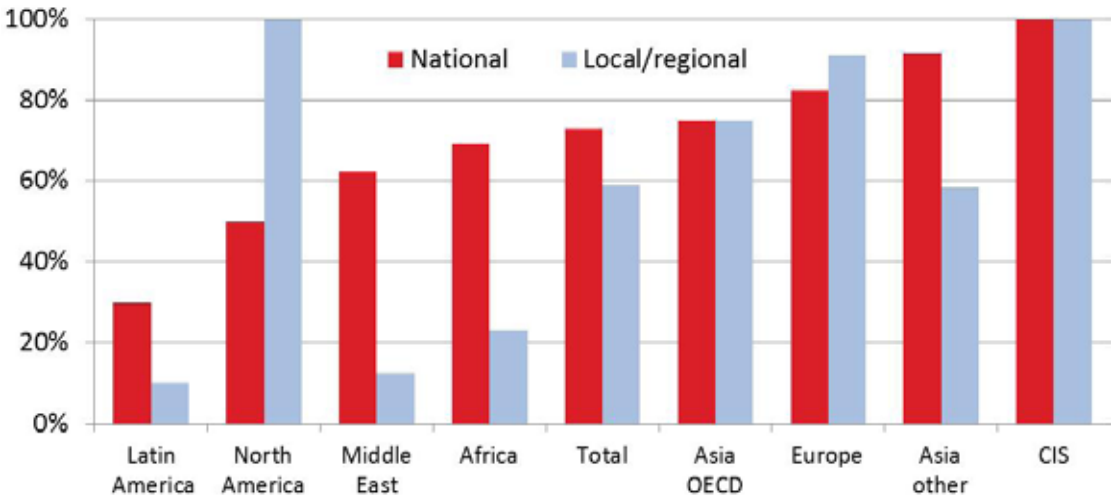
Three-quarters of countries have set up a national energy-efficiency agency

The implementation of energy-efficiency programmes 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. Energy-efficiency agencies are increasingly recognised as necessary instruments to foster energy-efficiency policies.

An energy-efficiency agency is defined here as a body with strong technical skills, dedicated to implementing the national energy efficiency policy.[36] Such agencies may be part of a ministry, as in Denmark, Canada, the United States (US) or the Philippines.

As a whole, three-quarters of surveyed countries (i.e. 62 countries) have a national energy agency (Figure 24). Since the last update in 2009, five agencies have been created in China, Chile, Indonesia, Senegal and Ukraine.

Figure 24
Countries with an energy-efficiency agency
Pays disposant d'une agence d'efficacité énergétique
Source: WEC ADEME survey 2012–2013



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

These agencies are usually public institutions funded by the state budget. In developing countries, they 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. Denmark, Norway, Spain, Switzerland, Thailand, Tunisia).Some countries have set up agencies with private sector participation (e.g. Morocco, Portugal), while others expect their agency to operate as a partially private body that has to earn income.

In countries with a federal or decentralised structure (e.g. Spain, Germany, Belgium, the US, Canada, Russia, China or India) energy-efficiency agencies have been set up by regional administrations. Many other countries have set up local or regional agencies,[37] especially in EU countries.[38] More than half of the surveyed countries have local or regional agencies. It is estimated from the survey that there are around 1,500 local or regional agencies glob-

36 In some countries energy-efficiency agencies have a broader scope and cover renewables as well as environmental policy (e.g. France, the Netherlands).

37 Some countries with a national energy agency have regional branches (e.g. ADEME in France with 28 offices).

38 These agencies are often established with the financial support of the European Commission's Intelligent Energy Europe programme.

ally, including more than 900 in Europe (against 600 in 2006 survey). These regional and local agencies aim to provide more targeted information and measures, as they are closer to consumers and better able to take into account regional circumstances (such as climate and energy resources.

The primary objective of all these institutions is to provide the technical expertise to governments and consumers, that cannot always be found in existing institutions. As 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 by certifying equipment that has 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 coordinator of all government 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, equipment producers or energy utilities to reach specific targets for efficiency improvements.

In countries that receive funding from international development assistance programmes, such agencies can also act as the national counterpart with whom investors can negotiate the implementation of financial packages for energy efficiency.

Energy-efficiency agencies serve to promote or act as a lobbyist for energy efficiency on a long-term basis.

4

Public policy measures on energy efficiency

Pricing and communications: key components of any energy-efficiency policy

Prices need to provide incentive signals to consumers

Many energy-importing, non-OECD countries are protecting their consumers from an increase in the oil price by maintaining subsidised price for some fuels. These subsidies represent a significant disincentive for energy-efficiency investments and limit the scope and profitability of ESCOs. In addition, they have a negative impact on public budgets, especially in recent years with the soaring oil price. Subsidies often lead to illegal trade, resulting in an artificially high energy consumption in the countries with low prices and an underestimation of the consumption in countries with higher prices.[39] As illegal trade is not recorded in statistics, this affects any attempt to monitor consumption or energy-efficiency trends in these countries.

The first step of any energy-efficiency policy for countries with subsidies should be to adjust energy prices to the energy supply cost to send the right message to consumers, to provide incentives for behaviour change or to encourage them to acquire energy-efficient equipment and technologies.[40] Although most energy policymakers 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. Also, energy is a basic commodity 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. There is, however, some good practice in countries that have successfully removed price subsidies and adjusted energy prices, such as new EU member countries with centrally planned economies, such as Ghana or the Philippines, and, more recently, China, India, Iran, Jordan and South Africa.[41]

Energy-producing countries often maintain a very low domestic price, which leads to intensive energy uses, and a loss of revenue (opportunity cost). 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.

In OECD countries, price signals are already significant with most prices being taxed, sometimes heavily, such as motor fuels in European countries for instance. In some of these countries, new taxes are implemented to increase price incentives, often labelled environmental, energy or carbon tax.

Independent of price levels, the way tariffs are set can also have an impact on energy efficiency, mainly for electricity and gas. Power tariffs are usually set in a way that encourages consumption: the higher the consumption of a given consumer category (e.g. household), the lower its average electricity price. However, some countries have implemented an inclin-

39 For example, Algeria and Tunisia, Morocco or Nigeria and neighbouring countries.

40 This means that prices should at least match the present cost of energy supply but exceed the future costs: the long-term marginal cost for electricity or the long-term price of oil products on international markets for fossil fuels.

41 Introduction of some adjustment mechanisms of some domestic oil prices to international prices in China and India since 2013 (-32% planned reduction in total oil subsidies in India for 2013–14 fiscal year); restricted sales of subsidised gasoline in Iran since January 2013; removal of subsidies for most fuels in Jordan since November 2012; planned 8% per year rise in electricity price over the next five years (IEA, 2013, WEO, special report).

ing block tariff which makes any marginal consumption more expensive and provides a good disincentive to consumers. This study shows that around 40 countries have some sort of progressive tariffs.[42] France is planning to implement an innovative approach, called bonus-malus, where large high-consumptionconsumers in a given category will pay a tax while those who consume less will get a discount. A benchmark volume of electricity and gas is assigned to each category (based on several parameters such as average size, heating fuel and geographical location to take account of heating needs) representing the first quartile of consumption in France. For each dwelling and each type of fuel, there are three levels of consumption: consumption below the benchmark will get a bonus (i.e. discount), while consumption above the benchmark will pay a tax.[43]

Box 3: Oil subsidy trends in selected emerging countries: impact on GDP and budget

Subsidies on oil products are strongly correlated to the crude oil spot price and can represent a heavy burden on public budgets in a high-price period, such as in 2008 when the international oil price jumped to a record high (Figure 25). The share of oil subsidies in GDP varies between 1% and 3% depending on the countries and years.

Energy subsidies have a strong impact on public budgets, diverting funds that could be invested in infrastructures or social expenses. Egypt and Ecuador spend around 20% of their budget on oil subsidies; Indonesia or Morocco between 10% and 15%; India, Tunisia and Bolivia between 7% and 10%.[44] In Tunisia, energy subsidies have been multiplied by a factor of five between 2010 and 2012, reaching 10% of the public budget in 2012.

According to the IEA, which considers both real subsidies and implicit subsidies due to the domestic price being lower than internatio nal prices (i.e. opportunity costs), total subsidies on energy will increase by 5% per year, from US$409 billion in 2010 to US$660 billion in 2020 in the business-as-usual scenario,[45] of which 50% is represented by oil products.)[46]

Many countries are trying to remove subsides but this is not popular and so is very difficult to implement. The easiest and best strategy is to increase energy efficiency, as saving energy also saves on subsidies.

42 See WEC energy efficiency database.

43 The measure was initially planned for households; in April 2013, the constitutional council censured the law that will have to be corrected, in particular to include the service sector. The planned bonus was €5/MWh in 2015 (€30/MWh in 2017). The malus (i.e. tax) was €3/MWh (€9/MWh in 2017) for consumption between 100% and 300% of the benchmark and €2€/MWh (€60/MWh in 2017) for consumption 300% above the benchmark.

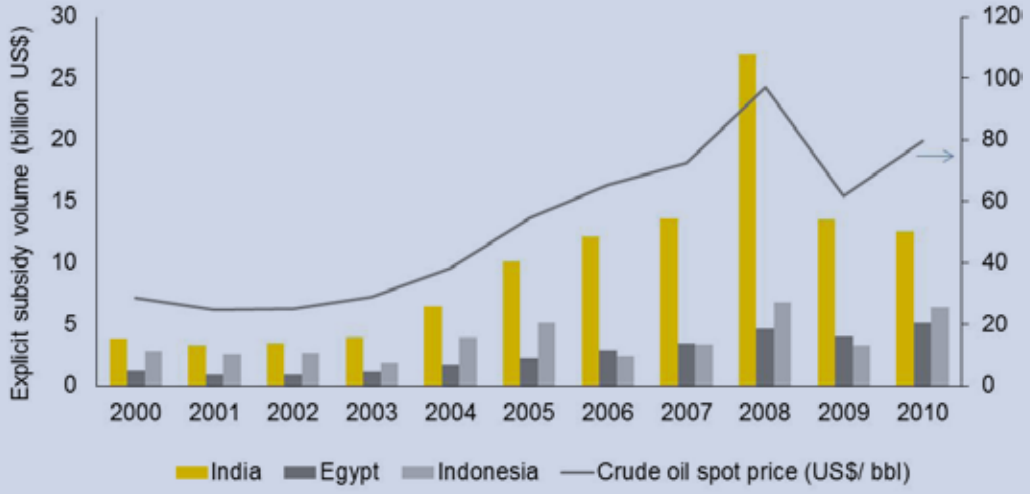
44 Enerdata estimates for 2010.

45 IAE, 2011, World Energy Outlook

46 The rest comprises subsidies for natural gas (e.g. in Russia), coal (e.g. in China) and electricity.

Box 3 continued:

Figure 25
Oil subsidies in India, Egypt and Indonesia
Subventions sur le pétrole en Inde, Egypte et Indonésie
Source: Enerdata



Information can motivate consumers

Public awareness and information campaigns are an important element of supporting energy efficiency and promoting energy-efficiency policies and programmes. Improvement of energy efficiency and the related market transformation requires informed consumers and raised awareness among all segments of society, as well as tailored information, education and training for selected stakeholders.

Information on energy efficiency can include different tools and activities, such as awareness campaigns, education and training programmes, labelling schemes, smart metering, information on 'best' products, information centres and demonstrations as well as governing by example.

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, either by highlighting capacity constraints, showing how to reduce the risk of power shortage (e.g. South Africa) or to attract new customers. In some countries, the government or regulator mandates companies to be active in that field.[47]

The planning phase is the most important part of an information campaign. The planners need to have a good understanding of market needs, driving forces and the context in which the campaigns are implemented. In this phase, attention needs to be focused on the appro-

47 In the EU, the new Energy Efficiency Directive mandates energy companies to provide energy-efficiency services to their clients.

priate timing of activities. Use of behavioural theories in campaign design can also help to enhance their effectiveness.

Communication campaigns have a greater impact if they are combined with other policy instruments (such as regulatory or financial measures).

Campaigns should be based on market segmentation which allows better focus, use of tailored instruments and more efficient use of resources. Campaign resources can be enhanced by cooperation with partners and other stakeholders.

When choosing the best methods of communication and combining them with other policy instruments, the planner needs to know the target audience and their needs. Communication channels need to be chosen and messages tailored accordingly. Attention also needs to be paid to media coverage and media access. Short-term campaigns seldom lead to long-term results. Multiple communication channels are generally used to reach all target groups and to take into account socio-economic factors, language, and access to media, and so on. The most frequently used instrument is television, followed by mass media and internet campaigns.[48]

Energy-efficiency campaigns which feature humour and 'ambassadors' can be effective in creating positive reactions among the public.

The planning phase should also include pre-empting monitoring and evaluation of the campaign. This includes defining evaluation objectives, choosing evaluation methods and deciding the data that will be collected. Often, information for evaluation is relatively straightforward to collect when it is planned from the outset but can be lost forever if this is not done. Monitoring also strengthens campaign management during the implementation phase. The usual methods for evaluation are surveys and interviews.

Transparent Clear, open reporting of monitoring and evaluation results enhances the learning process by showing the strengths and weaknesses of the campaign. This helps in the development of effective campaigns in the future.

While consumer motivation and action can be monitored and measureds, it is more challenging to estimate energy savings attributable to communication campaigns.

A more constraining regulatory framework

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

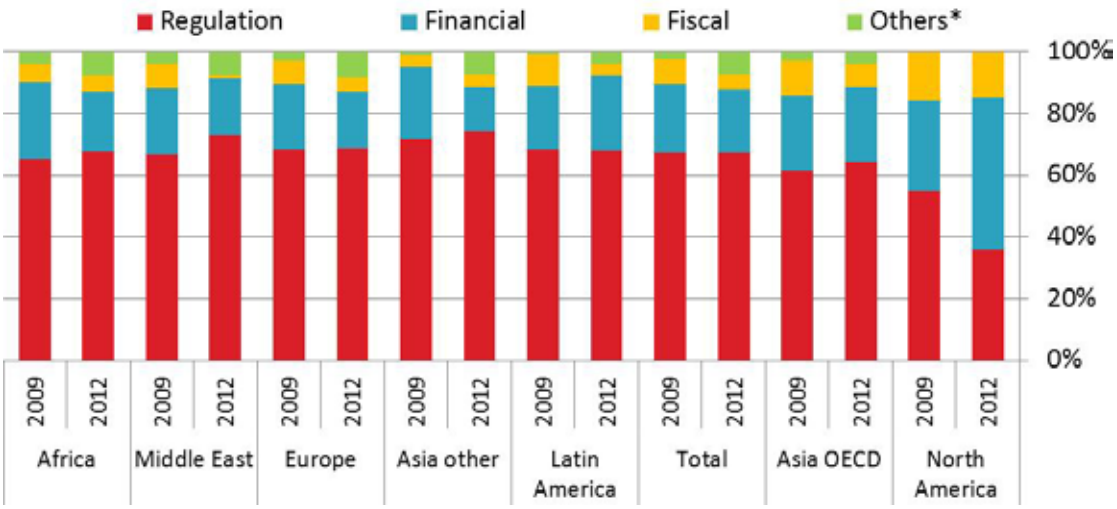
At world level, there is a predominance of regulations, representing around 70% of all measures in 2013 (Figure 26).[49] In most regions the role of regulation is increasing (e.g. Asia and the Middle East). This is not surprising as regulations are more powerful than traditional incentives to transform the market, because they do not leave any choice for consumers.

48 The 2010 country case studies looked at innovative approaches, such as the use of social media (US), road shows to supplement TV where access it is limited (South Africa); see WEC policy database (www.wec-policies.enerdata.eu).

49 Measures on information are not included.

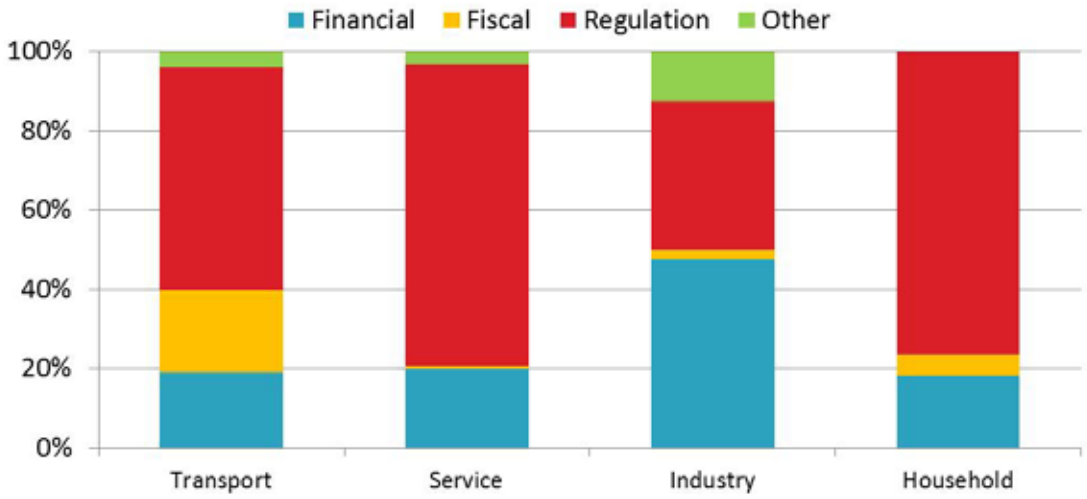
Incentives are often weak because they depend on the behaviour change of millions of consumers who essentially lack the information and resources to act. However, the impact of regulation depends on their effective enforcement.

Figure 26
Distribution of measures by type
Distribution des mesures par type
Source: WEC ADEME survey 2012–2013
Note: *Others correspond to voluntary agreements, ESCOs and certification



If regulation is important in the residential and service sectors (appliances, labelling, building codes and certificates), financial incentives are more important in industry where competitiveness should not be affected by regulation (see Figure 27).

Figure 27
Distribution of measures by end-use sector and type
Répartition des mesures par secteur et par type
Source: WEC ADEME survey 2012–2013



Various forms of regulation

In general, regulations aim either to impose minimum efficiency standards or energy-efficient practices (auditing, reporting, maintenance), as well as to provide systematic information to consumers (e.g. energy-efficiency labels). Regulations can therefore be classified into three main categories:[50]

- Mandatory labelling for new appliances, new cars and buildings[51]
- MEPS for new appliances and lamps,[52] new cars, new buildings and existing buildings[53]
- Other regulations, mainly mandatory requirements for designated high-volume consumers (in industry, large buildings or transport companies), as well as mandatory maintenance for selected end- user appliances (e.g. boilers, air conditioners, cars).

Obligations for energy utilities to make energy savings with their consumers (the 'energy savings obligation') are another form of regulation that is covered later in this report.

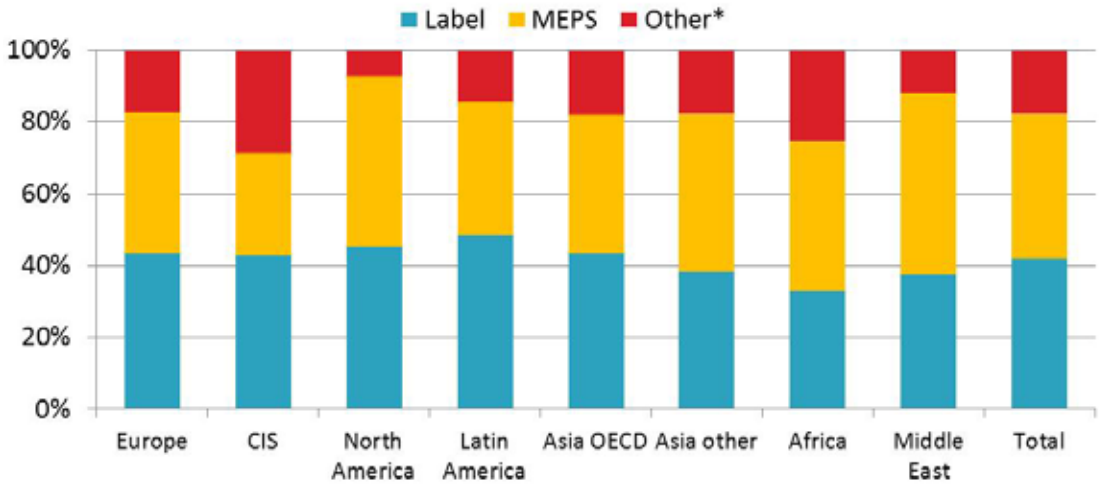
On average, labelling is the dominant regulation (included in 42% of regulations). MEPS are also important, with around 40% of total regulatory measures. Other measures represent 18% of all regulations. The distribution between the different types of regulation is similar across regions (see Figure 28).

Regulations can be set nationally, for a group of countries – e.g. Directives in the EU), or at sub-national, regional level (e.g. California in the US).

Figure 28
Distribution of regulation by type
Distribution des réglementations par type

Source: WEC ADEME survey 2012–2013

Note: *Other: mandatory energy audits, energy managers, energy consumption reporting, energy savings plans, energy training



50 There are also regulations which are not specifically targeted at energy efficiency, but which can influence energy efficiency (e.g. speed limits, maximum weight of trucks).

51 For buildings they are often called energy-efficiency certificates.

52 The prohibition of incandescent lamps falls into that category.

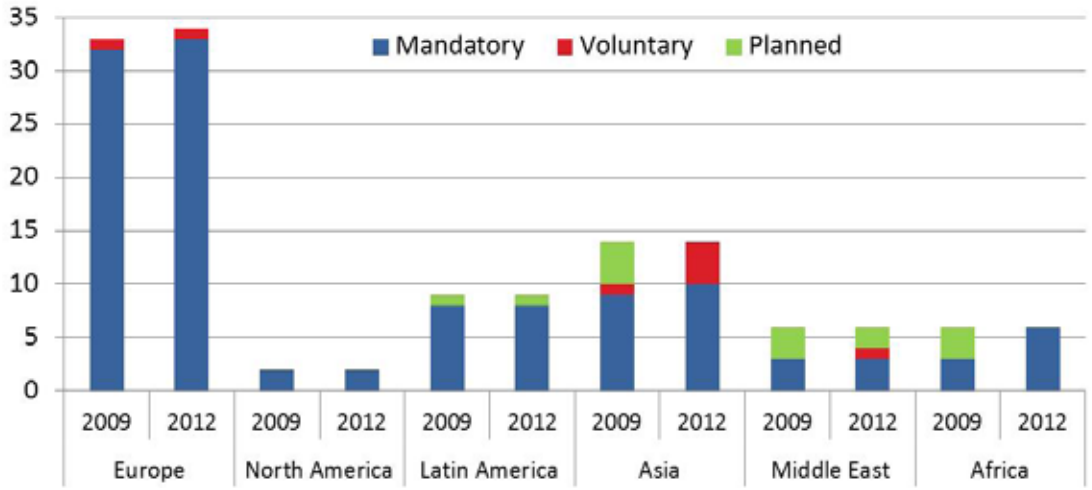
53 Usually they refer to maximum specific consumption for existing buildings (linked or not to renovation).

Labelling

LBecause Llabels help enable consumers to identify the energy efficiency performance (or CO_2 emissions) of new equipment and appliances, they are often among the first regulatory measures to be introduced. Labelling aims to encourage consumers to purchase more efficient appliances and persuade manufacturers to remove inefficient appliances from the market. Labels now cover new electrical appliances, cars and buildings.

Most surveyed countries (71) have label schemes (Figure 29).[54] These labels are mandatory in most countries (90% of countries); some countries, however, favour a voluntary approach which can be 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 widespread but is being planned.

Figure 29
Number of countries with labels[55]
Nombre de pays avec des labels
Source: WEC ADEME survey 2012–2013



Minimum energy performance standards (MEPS)

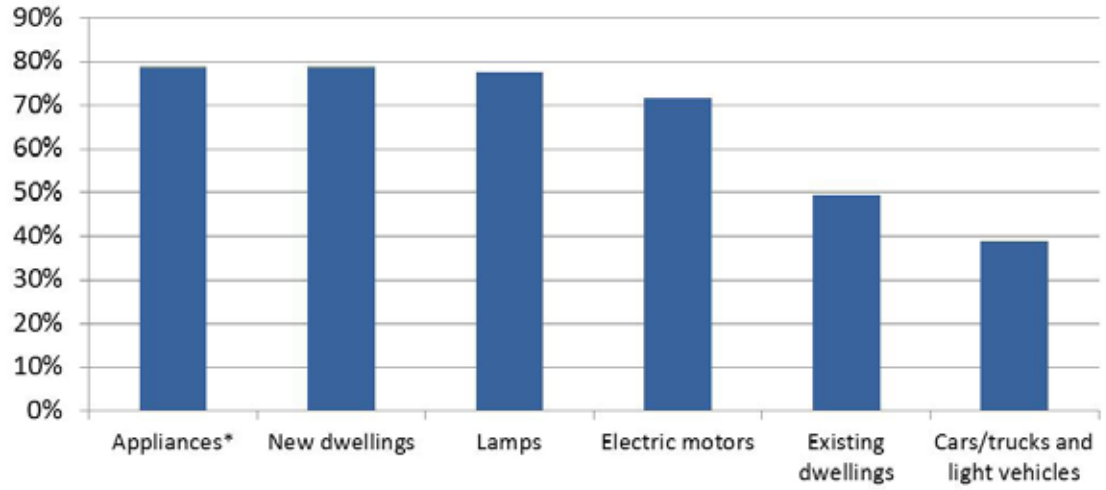
A majority of surveyed countries (76) have implemented at least one MEPS. Efficiency standards on lamps, appliances (refrigerators, washing machines and air conditioners) and new constructions[56] are implemented in 80% of surveyed countries (Figure 30). MEPS on vehicles are less common.

54 Four more countries have already planned the introduction of labels.

55 Labels for electrical appliances, buildings, dwellings, cars.

56 MEPs for buildings correspond to building codes.

Figure 30
Percentage of surveyed countries with MEPS by type of equipment
% de pays avec des normes de performances par type d'équipement
Source: WEC ADEME survey 2012–2013
Note: *refrigerators, washing machines and air conditioners



Other regulations

Other regulations include mandatory requirements for designated consumers, such as compulsory energy audits, energy consumption reporting, energy managers, energy-saving plans and, more recently, energy-savings performance monitoring. These designated consumers are usually high-volume consumers, identified from energy consumption thresholds, in selected sectors (e.g. steel, cement, public sector, large commercial buildings).[57]

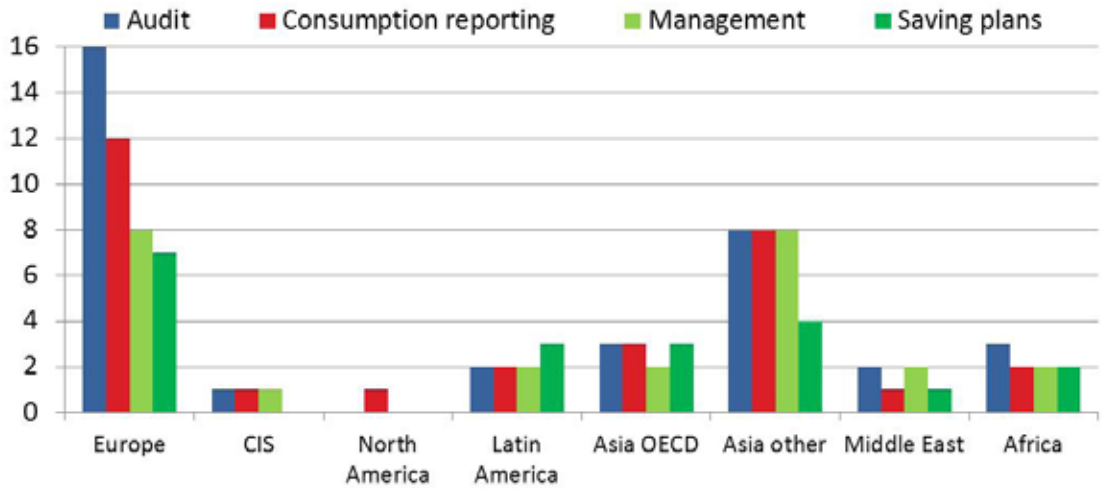
Energy audits, either in the form of walk-through audits[58] or detailed energy audits are necessary to gain a better understanding of the current status of energy use and to identify potential actions for energy savings. Mandatory energy audits are more popular in OECD countries.

Other regulations include mandatory maintenance, installation of solar water heaters and an energy-saving obligation for utilities (see Figure 31). Other regulations not directly linked to energy efficiency that can have a significant impact on the energy use (such as speed limits), are not included in this review.

57 In India, under the Energy Conservation Act, 2001, units in nine sectors (power, fertiliser, iron and steel, cement, pulp and paper, aluminium, chlor-alkali, textiles and railways) have been notified as 'designated consumers' with mandatory requirements on reporting, audits, energy managers and energy savings.

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

Figure 31
Countries with other types of regulation
Pays avec d'autres types de régulations
Source: WEC ADEME survey 2012–2013



Mandatory energy audits have been implemented, mainly in Europe and Asia. In Europe, there is a greater focus on commercial, public and residential buildings, with 12 countries having mandatory audits schemes, compared to five countries implementing mandatory energy audits in industry.[59] In Asia, audits are imposed in several countries, mainly in industry (in 10 countries including the largest ones) and to a lesser extent in commercial buildings (in seven countries). In Africa and the Middle East, few countries (around half a dozen) require mandatory energy audits and they apply to high-volume consumers in all sectors (e.g. Algeria, Tunisia). Mandatory energy audits for buildings, especially in the residential sector, are more widely spread and exist in many countries and regions (12 European countries, in Israel, and Tunisia).

Compared to voluntary audits, mandatory audits reach a substantial number of consumers more rapidly. However, there is always a risk that consumers will not comply with the regulation or comply formally but not take into account the conclusions and recommendations. Mandatory audits impose a certain quality standard and number of auditors as well as standards for energy managers. This can be assured by certification of auditors and training for energy managers.

Energy audits as such do not lead to energy savings: action on the measures proposed by the audit is critical, unless there is a legal requirement to carry out the recommendations (e.g. Bulgaria or Norway, for instance). Mandatory audits are often accompanied by supporting measures such as subsidies for the audits or for investments, training and seminars for the auditors and the management and technical company staff.

Mandatory energy-consumption reporting implies that designated high-volume consumers report their energy consumption, either directly to government or in their annual report. This measure is seen as an incentive to companies to closely monitor their energy performance. Such measures exist in about 30% of the surveyed countries and are more frequent

59 In EU countries, the new Energy Efficiency Directive makes it compulsory for large companies to undertake energy audits every four years. Companies with a certified system of energy management are exempted.

in Europe and other OECD countries than in other regions (see Figure 31). This measure is mainly applied in industry and for public buildings. It also exists for CO_2 emissions for all high-volume consumers in the EU.[60]

Mandatory energy managers are imposed in companies above a certain size in about 25% of the countries covered by the survey. This measure usually applies to high-volume consumers in industry (20 countries) and in the service sector (14 countries). In some countries, transport companies are also included (e.g. France and Portugal).

Mandatory energy-saving plans are required in slightly less than 20% of the surveyed countries for high-volume consumers, generally in industry (20% in OECD and 15% for non-OECD countries). This measure exists for several sectors, including in some countries' municipalities.

The **mandatory training of professionals** is something new that aims to increase the quality of audits or energy management: 16 countries have implemented mandatory training for professionals, more than half in the EU.

Mandatory maintenance of energy-consuming equipment is another important field of regulation. The concern is that, without a proper maintenance, the efficiency of some energy consumers' equipment (e.g. boilers, vehicles) decreases over time: the objective of the regulation is to maintain for as long as possible the initial efficiency of the equipment. This measure concerns mainly EU countries, as the Energy Performance of Buildings Directive (EPBD) makes the maintenance of heating boilers and air conditioners above a certain size mandatory. In a few countries (such as Italy and 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 energy savings, depending on the items that have to be controlled.

Regulation on quality standards (norms) of efficient equipment aims to guarantee or improve their quality. This is important for solar water heaters or compact fluorescent lamps (CFLs)as there have been many cases of poor-quality materials being subsidised with public money. Standards and quality labels can ensure that the expected energy-saving potential is clear. In addition, they avoid that the perceived quality of systems is an obstacle to a large dissemination of efficient equipment. In the case of solar, the quality issue does not only concern the manufacturer of the collectors but also the installer.[61]

Role and importance of compliance for regulations[62]

Regulations represent a powerful instrument to promote energy efficiency but their impact depends on good implementation and effective compliance.

Australia, Canada, the US and EU countries are very active in integrating compliance directly into their programmes. Canada integrated a compliance policy into its standards

60 In the EU, this measure is part of the Emission Trading Scheme that sets a quota of emissions to high-volume consumers and requires participants to report their emissions to the European Commission.

61 For instance in Europe, the Keymark certification scheme developed for solar heaters by European manufacturers with the European Solar Thermal Industry Federation (ESTIF) is now recognised and makes it easier to get financial incentives (www.keymark.org).

62 Analysis based on a report prepared by Rod Janssen for ADEME and WEC available at www.wec-policies.enerdata.eu/case-studies.php

development right from the start. Australia has a similar, rigorous approach. In the EU, the compliance for electrical appliances is built into the Ecodesign Directive[63] and procedures for compliance of the mandatory energy performance certificates and inspection reports for buildings is included in the Energy Performance of Buildings Directive.[64] The Australian Equipment, Energy, Efficiency (E_3) Committee provides a forum to exchange information on enforcement and compliance issues and community information and marketing initiatives.

For appliances and equipment, the absence of certification facilities in many emerging or developing countries makes it difficult or impossible to check the compliance of imported products with national standards; it may also be impossible for them 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 or solar water heaters.

A better understanding of 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 the Collaborative Labeling and Appliance Standards Program (CLASP), Asia-Pacific Economic Cooperation (APEC) and the European Committee of Domestic Appliance Manufacturers (CECED).[65]

For building codes, several problems arise. Their control is often decentralised at the level of cities that lack the resources and expertise maintain such controls. In addition, in several countries, buildings codes have been prepared but not officially implemented or, if they have been approved, are not applied, which of course limits their impact.

New forms of economic incentives

Economic incentives aimed at encouraging investment in energy efficient equipment and processes by reducing the investment cost, either directly (financial incentives) or indirectly (fiscal incentives). Financial incentives include subsidies for energy audits or investments and soft loans. Fiscal incentives include tax reduction, tax credit or accelerated depreciation, as well as tax on inefficient equipment (appliances and cars). Economic incentives 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.

Around two thirds of surveyed countries have implemented some kind of fiscal or financial measures (Figure 32). Financial incentives are dominant compared to fiscal measures in all regions (80%).

63 According to Article 3 of the EU Ecodesign Directive 2005/32/EC, member states have to 'designate the authorities responsible for market surveillance', which should 'organise appropriate checks on compliance, on an adequate scale, and oblige manufacturers to recall non-compliant appliances.'

64 Annex II of the 2010 Energy Performance of Buildings Directive states that the competent authorities shall make a random selection of at least 0.5% of all energy performance certificates and at least 0.1% of all inspection reports issued annually.

65 www.clasponline.org ; In Europe, CECED has established a protocol – bilateral verification procedure (BVP) – to accelerate the correction of inaccurate declarations on energy labels (www.ceced.org); the Energy Standards Information System of APEC provides information and links to experts on appliance standards and regulations (www.apec-esis.org)

Financial and fiscal incentives may be costly for the public budget if they concern a large volume of equipment or investments over a long period of time. However, the exact cost has to take into account other positive outcomes, such as increasing investment that will bring additional tax revenue for the state, as well as reduction in unemployment benefits and social expenses.[66]

To reduce the cost for the public budget, economic incentives are increasingly linked to energy or environment funds with diverse finance sources rather than coming from the public budget alone: funding from dedicated taxes, from international financing institutions, or from the banking system.

Economic incentives have several well-known drawbacks:

- They often attract 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 that are the target audiences for (small to medium industries, and low-income households) do not take advantage of the schemes because they are unaware of them. This demonstrates the challenges of informing a multitude of consumers ad quately about the existence of incentives.
- Subsidy schemes may have a negative impact on the market by leading to an increase in the cost of equipment, as a result of manufacturers or contractors raising their prices in anticipation of the rebates that purchasers will be granted.
- Economic incentives may result in the diffusion of poor-quality equipment (e.g. CFLs).

These drawbacks lead to regular adaptations of the schemes. Economic incentives are now better targeted to limit the number of beneficiaries (e.g. low-income households[67] and 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 or co-generation), or to innovative technologies (demonstrative or exemplary investments).[68] They are also increasingly linked to quality labels.

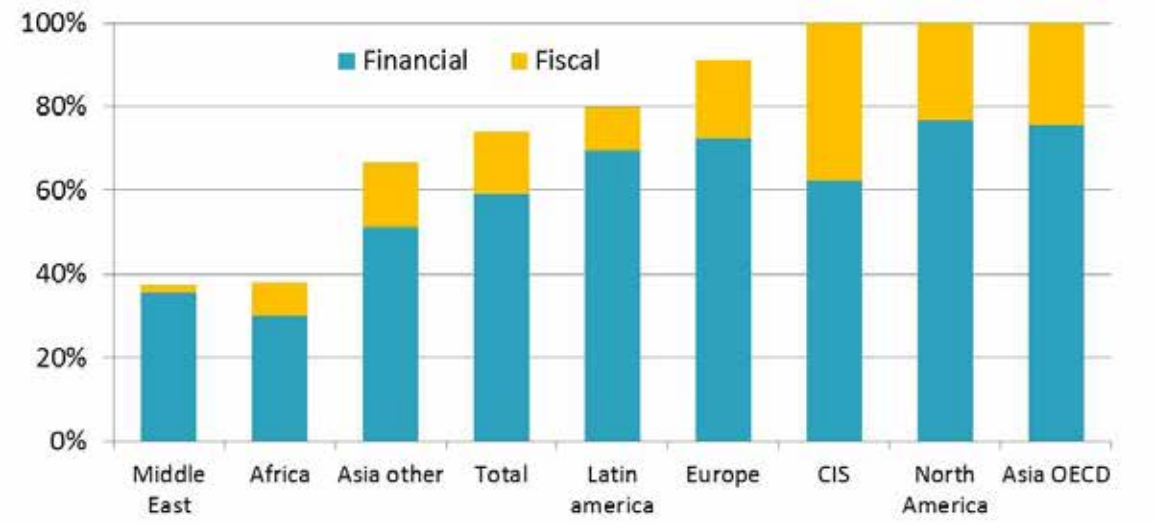
Subsidies are generally viewed as a temporary measure to mobilise consumers, to prepare for new regulations, or to promote energy-efficient technologies by creating a larger market than would otherwise exist, with the objective of reducing the cost of subsidised technologies. However, the experience of several countries (e.g. Tunisia and Taiwan) with subsidies for solar heaters shows that, if subsidies are discontinued prematurely, sales will drop suddenly when the market is not sufficiently mature. Once the critical mass has been reached, economic incentives can be reduced and even stopped without slowing down the diffusion dynamics. To limit these drawbacks, it is necessary to avoid changing the subsidy schemes too often and in an inconsistent way. Subsidies should also be reduced progressively as the market develops.

66 In Germany, it has been calculated that, with the KfW bank programme of financing energy-efficiency investments in buildings, for every one euro spent by the state in subsidies, it gets back 4.3 euros (3 euros from additional tax revenues and 1.3 euros from saving in employment benefits – Wolfgang Eichhammer, WEC, 27–28 May 2013, Paris). The multiplier effect is estimated at 18, i.e. 18 euros investment generated by 1 euro of public subsidies.

67 The UK has had for several years a very strong programme targeted towards low-income households.

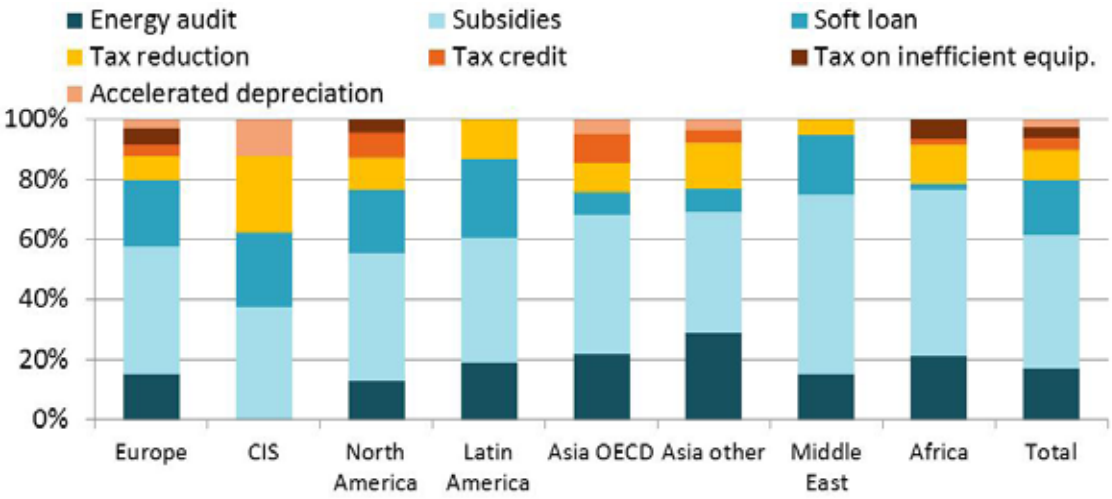
68 The approach used in Thailand is innovative, as the selection is not based on a list of equipment but on a criterion of cost-effectiveness (grants apply to investments that have an internal rate of return above 9%).

Figure 32
Countries with economic incentives
Pays ayant des incitations économiques
Source: WEC ADEME survey 2012–2013



Investment subsidies represent the core of all economic incentives with 44% of all financial and fiscal measures in the surveyed countries (Figure 33). Energy audit subsidies are popular measures in non-OECD Asia (30%).

Figure 33
Countries with economic incentives by type
Répartition des incitations économiques par type
Source: WEC ADEME survey 2012–2013



Financial and fiscal incentives are increasingly conditional upon the use of labels as a way to promote the use of high-quality equipment. In practical terms, this means that economic incentives are only granted for equipment that has an approved quality label.[69] These incentives can also encourage the use of qualified installation contractors.[70]

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 costs for the consumers.

Financial incentives

Financial incentives fall into three broad categories: subsidies for audits; investment subsidies; and soft loans. According to the survey, about half of financial incentives are given in industry and services, of which almost 48% are in industry (see Figure 34).

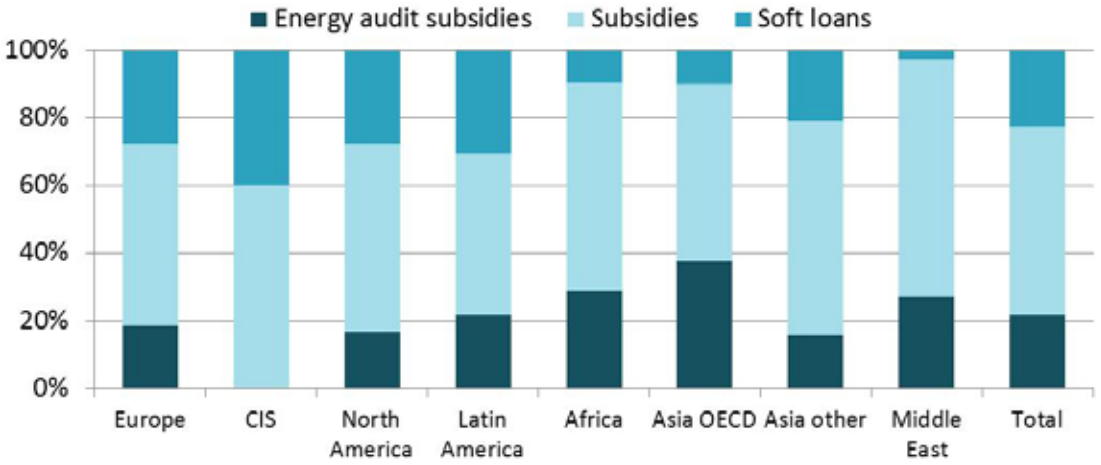
If audits are not mandatory, subsidies aim to make them more attractive to consumers. The subsidy is either a fixed amount or a percentage of the audit cost (e.g. 30%). About 40% of the surveyed countries subsidise audits (55% in Europe/OECD America-Asia). Audit subsidies are more frequently distributed in industry (37%) and public and commercial buildings (31%) than in residential buildings (22%).

Investment subsidies represent, on average, almost 60% of financial measures. They are implemented in almost 70% of surveyed countries. This measure is especially popular in OECD countries where more than 80% of the surveyed countries have subsidy schemes. Investment subsidies exist to retrofit existing buildings, dwellings or industrial facilities. They are also used to lower the price of efficient equipment that is usually more expensive than the market average price (e.g. CFLs, efficient motors or boilers, solar water heaters). Investment subsidies are mainly directed at appliances (56% of countries have such schemes). One-third of countries have subsidies in buildings, around 30% in industry and 27% in transport. Subsidies may also be given to equipment producers to encourage the development and marketing of energy-efficient equipment, to improve the quality and the cost of production.

69 In France for instance, the tax credits are only applicable to certified solar water heating equipment. Similarly, in India or Tunisia, only certified solar collectors are eligible for low-interest loans.

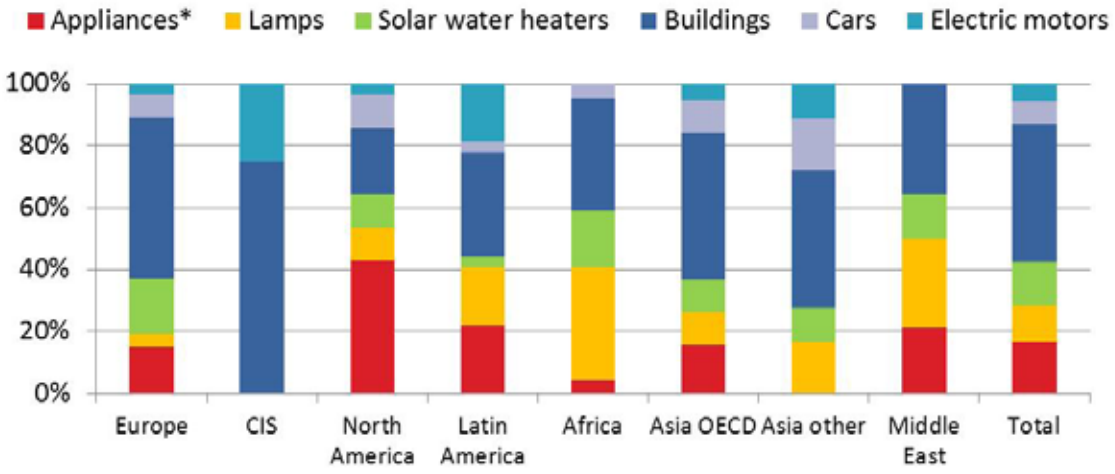
70 For instance, in the Netherlands, the amount of the subsidy is determined by the performance of the installation.

Figure 34
Financial incentives by type
Incitations financières par type
Source: WEC ADEME survey 2012–2013



Globally around 30% of the subsidies on energy-efficient equipment are dedicated to solar water heaters and CFLs (Figure 35). In OECD countries and Asia, more than 40% of the subsidies are directed to new clean and efficient cars. In Latin America, the Middle East and African countries, schemes have focused their subsidies on CFLs. Subsidies targeting solar water heaters are widely implemented in Europe and exist in 21 countries.

Figure 35
Financial incentives by type of equipment
Incitations financières par type d'équipement
Source: WEC ADEME survey 2012–2013
Note: *Includes air conditioning, wood stoves, refrigerators and other appliances



Financing the initial investment in energy-efficient equipment requires easy access to credit with appropriate finance conditions. Overcoming any initial cost barriers is achieved by making soft loans available to consumers who invest in energy-efficient technologies and equipment. Soft loans have the advantage of being easily implemented by banking institutions. Specific credit lines with the help of investors and state credit guarantee schemes will encourage banks to be more active by providing soft loans to finance energy-efficiency investments.

Soft loans are less popular than subsidies: 20 % of all surveyed countries had such schemes (about 50% of them are European countries and OECD countries). Soft loans are distributed almost evenly between industry, residential buildings, appliances and commercial orpublic buildings.

Fiscal incentives

Fiscal incentives include 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).[71] Another form of fiscal incentive is to reduce the tax on 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). Incentives also include tax reduction for the use of efficient cars (annual registration tax). Taxing inefficient equipment (appliances and cars) can discourage their use and move consumers towards use new, more efficient models. And, although their primary goal is to reduce congestion and pollution, road charges are also considered to be a fiscal measure that affects energy use. Several cities have implemented such schemes.[72]

Fiscal measures on income tax or company tax work well if the tax collection rate is sufficiently high. They 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.

Tax reduction represents, on average, more than half of total fiscal measures and tax credits 20%. In Africa, 50% of fiscal measures are taxes on inefficient appliances or cars. Tax reduction for energy-efficient investments and equipment exist in around 40% of surveyed countries (see Figure 36). Tax reductions apply either to selected equipment[73] or to building retrofitting. Reduction on VAT and on import tax on energy-efficient equipment (e.g. CFLs, efficient motors) is mostly used in emerging and developing countries in Asia, Africa and the Middle East. 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, and Columbia).

71 With tax credit, households can deduct part of the purchase cost of equipment from their income tax. With tax deduction they reduce the cost of equipment from their taxable income.

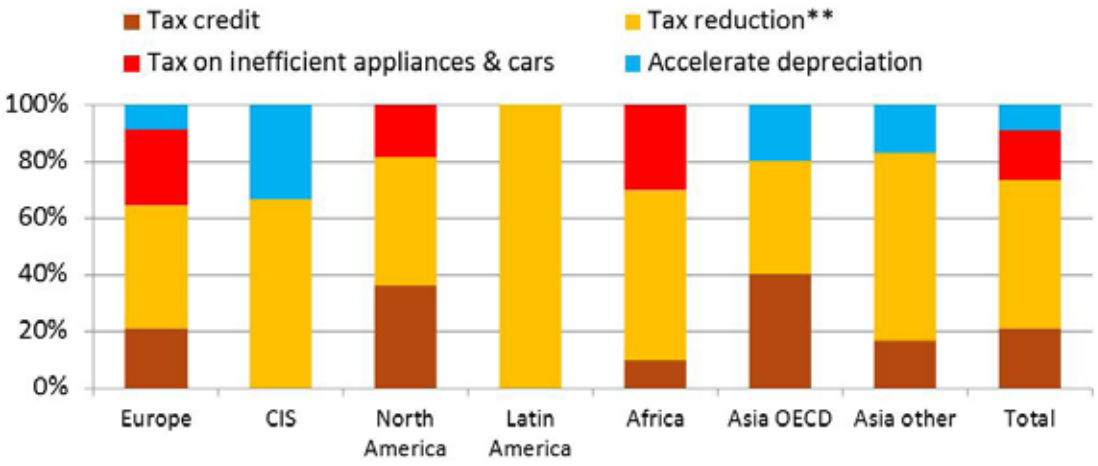
72 Singapore, the pioneer since 1975, has several schemes. Others are in Norwegian cities (e.g. Oslo, Trondheim and Bergen), London in 2003 and Stockholm in 2006.

73 Many countries have implemented tax credit schemes for solar waters.

Figure 36
Distribution of fiscal measures by type[74]
Répartition des mesures fiscales par type

Source: WEC ADEME survey 2012–2013

Note: **Tax reduction: Import tax for energy-efficient equipment; purchase tax for cars; annual registration tax for cars; value added tax VAT.



Reductions on purchase tax and/or annual registration tax for cars have been introduced in several European countries to promote the diffusion of efficient cars: they are usually linked to CO_2 emissions and therefore indirectly to energy efficiency. The objective is to give incentives to consumers to buy more efficient cars.[75]

VAT reduction on labour costs to reduce the investment cost in building renovation exist in several European countries. Accelerated depreciation is used mainly in industry and concerns less than 7% of countries.

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

Tax credits exist only in 16% of surveyed countries and are more common in OECD countries: they apply either to selected equipment (e.g. solar heaters) or to building retrofitting.

Energy-efficiency funds

Energy-efficiency funds aim to provide resources to support economic incentives. The geographical scope of implementation is mostly national; it may be supra-national or trans-national (revolving funds created in Eastern Europe from development aid), but it may also be regional or local.[76] These funds are implemented by energy-efficiency agencies, financial institutions or dedicated institutions.

74 Energy taxes are not included.

75 16 EU countries have a car purchase tax linked to energy efficiency or CO_2 specific emissions; in seven countries the annual registration tax is also based on emissions or efficiency.

76 For example, Fonds – Hannover. Only national initiatives are identified in the WEC policy database.

Different types of funds can be identified (see Figure 37). Funds can be supplied partially or in total from dedicated taxes to have a more stable funding and to be less dependent on annual budget allocations. Funding from energy tax exists in different countries. For instance, in Spain, a levy equivalent to 1.5% of fuel bills is raised on electricity and gas distribution companies to provide a resource to which funds are added from the central government and European regional development funds.[77] In Uruguay, the government has adopted an energy-saving obligation scheme for utilities with annual energy savings targets and the creation of the Uruguayan Saving Trust for Energy Efficiency, or Fideicomiso Uruguayo De Ahorro y Eficiencia Energética (FUDAEE), to manage the energy-efficiency certificate mechanism. A key source of funding for FUDAEE comes from a 0.13% levy on total sales from energy suppliers.[78] Another example is in Denmark which has the Danish saving trust.

Figure 37
Energy-efficiency funds implemented worldwide
Fonds dédiés à l'efficacité énergétique dans le monde
Source: WEC ADEME survey 2012–2013

Energy-efficiency funds can also be supplied partially or totally from international financing institutions (i.e. multilateral funds). Developing countries and economies in transition mainly benefit from external finance in the form of incentives, grants and soft loans. The World Bank, Global Environment Facility, the United Nations Development Programme (UNDP), regional development banks (such as the European Bank for Reconstruction and Development, Asian Development Bank, African Development Bank), national development banks (e.g. KfW, AFDgence Française Développement) and national aid agencies (GIZ, USAID) are very active in financing energy-efficiency programmes. Although a large volume of external finance to date has been invested in increasing the efficiency of energy supply and distribution (e.g. upgrading district heating networks, reducing transmission and distribution losses), an increasing share is now going to consumers.

Energy-efficiency funds can be entirely supported by the state budget, as in India where the government has launched a new fund aiming to provide state governments with financial

77 The levy on energy customers raises 70% of the 0.47 billion per year [what currency?] to be used as public funding of the initiatives in the five-year period of the Spanish Energy Action Plan.

78 The envisaged share of the funding of FUDAEE is 60% for the energy-efficiency certificates scheme, up to 15% for national promotions and up to 7% for the guarantee fund.

help to promote energy efficiency. The Energy Conservation Fund will be formed by contributions from the state governments which can later request grants to promote energy-efficiency programmes.

Increasing private sector involvement

Because of tensions on public budgets, there is an increasing involvement of the private sector in supporting investments in energy efficiency, through ESCOs and energy utilities.

ESCOs and public private partnership

ESCO activities exist in many countries to different degrees and had been introduced in 60% of the surveyed countries. For example, there are more than 250 ESCOs in Germany and less than 100 in France.

ESCOs are companies that develop, install, and arrange financing for projects designed to improve the energy efficiency of facilities. Remuneration of the performance contractor is through participation in the energy cost savings resulting from the energy-efficiency measures. ESCOs usually operate through Energy Performance Contracts (EPCs). EPCs are a contractual arrangement between the beneficiary and the provider (e.g. an ESCO) of an energy-efficiency improvement measure, where investments are paid for in relation to a contractually agreed level of energy-efficiency improvement.[79]

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.

ESCOs are widely promoted by the European Commission, the European Investment Bank, the European Bank for Reconstruction and Development and the IEA, as it provides a framework to encourage private funding to support energy-efficiency investments with a minimum role for governments. Article 18 of the EU Energy Efficiency Directive contains a list of measures that member states should adopt in order to promote energy services, including the ESCO market.

Innovative packages have been implemented, mixing the involvement of ESCOs to share the burden and the risk (e.g. Green Deal in the UK) or the combination of ESCOs with public subsidies (e.g. Salix Finance in the UK) or even an ESCO-type approach within public administrations (e.g. Public Internal Contracting – PICO – in Germany).[80] The China Energy Conservation Project of the World Bank ran a loan guarantee programme to support the development of the Chinese ESCO sector.[81]

79 Definition given in the 2006 EU Energy Services Directive (Directive 2006/32/EC).

80 Under the PICO framework in Stuttgart, the role of the ESCO is taken by a unit of the public authority itself, e.g. the technical department of a municipality. It acts like the ESCO, delivers the financial and technical service, and the remuneration takes place through cross payments of budgets between the public administration units. PICO is establishes cooperation between two separate organisational units of the same public administration.

81 Running from 2003 until 2010, the China Energy Conservation Project of the World Bank aimed to enable ESCOs to access finance through regular commercial banking channels, in recognition of the large role ESCOs can play in capturing China's considerable commercially viable, energy-saving potential.

Public-private partnerships include the private sector management of some government services, normally coupled with public oversight of the contracted entity. This way, private money is used for investments and operational budgets. The main area where public-private partnerships have been used is in utilities provision where energy-efficiency opportunities are often substantial.

Energy saving obligations[82]

Energy-efficiency obligation is a recent and innovative measure in which energy companies (suppliers and retailers or distributors) have a legal obligation to undertake energy-efficiency activities with their customers. In some cases, this obligation can be met by trading energy-saving certificates, usually called 'white certificates'.

Energy companies in seven EU countries currently have energy-saving obligations: Belgium (Flanders region), France, Italy, UK, Denmark, Ireland and Poland. Energy-saving obligations also exist for electricity suppliers in Brazil, Uruguay and Australia.

The characteristics of schemes to meet energy-savings obligations depend on several factors:

- Who are the obliged parties? And in the case of trading, who can participate in the trading?
- Who are the eligible consumers?
- What is the volume of the targets and how is it expressed?
- What are the eligible energy-saving measures?

The obliged parties are usually electricity and gas utilities; they also include district heating in France, Denmark and Poland, as well as the distributors of motor fuels in France.

The eligible consumers are only households in UK, but cover all end-use sectors in other countries (including transport in France).[83] In Poland, energy producers, and distributors are also included (mainly for district heating). The energy-intensive industries under the Emission Trading Scheme (ETS) in EU countries are excluded. In Flanders and the UK, the obliged energy companies are required to ensure that there are savings with low-income households.

Usually the size of the target and the sectors to be covered are decided by government. The targets are allocated by companies in relation to the volume of energy supplied or distributed. The targets are either expressed in lifetime savings or annual savings and in different units: final (e.g. France) or primary energy[84] (e.g. Italy), $MtCO_2$[85] (e.g. UK), dollars (e.g. Brazil).[86]

82 This section is partly updated from a report prepared for WEC and ADEME by Eoin Lees including several country case studies (see www.wec-policies.enerdata.eu/case-studies.php).

83 ~ 60% mandated for households in Flanders.

84 Primary equivalent is usually taken to be 2.5 times final energy for electricity with the other fossil fuels being taken as equivalent to the final energy. For countries concerned about reducing their energy imports, the use of primary energy is often preferred.

85 For the UK, since 2008, the target is explicitly set in CO_2 savings.

86 In Brazil the target is in terms of annual expenditure; each distribution company submits proposals to the national energy agency, Agência Nacional de Energia Elétrica (ANEEL) with estimates of the expected energy savings.

The savings are even discounted in some countries (e.g. France) to account for the decrease of the economic value of the certificate and the gradual decrease of savings over time. The discount rates are currently 3.5–4%. Because of all these differences, it is difficult to compare the targets and to appreciate their relative size (there is a summary in Table 1).

The eligible measures are only actions or equipment better than the market average and/or the performance level required by legislation (e.g. installation of refrigerators or freezers with an A+ or A++ energy label).

Table 1
Targets of energy-saving obligations in Europe
Objectifs des certificats d'économie d'énergie en Europe
Source: Enerdata

Country	Saving target	Target	Discount
Belgium	Annual primary energy	2.6 TWh/year (2009) (+30% increase since 2008)	No
France	Lifetime final energy (up to 20 years for insulation)	54.7 TWh over 3 years 2006-2009 (phase 1) 345 TWh over 3 years 2010-2013 (x by 6 compared to phase 1) (~1.8% of eligible consumption)	Yes (4%)
Italy	Cumulative primary energy (over 5–8 years)	Annual target increasing from 4.3 Mtoe in 2010 (23 TWh) to 6 Mtoe in 2012 (32 TWh)	No
UK	Lifetime final energy Lifetime CO_2	62 TWh over 4 years (2008-2011) 293 $MtCO_2$ (2005-2012) (twice EEC2)*	Yes (3.5%)
Denmark	Lifetime final energy	1.7 TWh/year (2009)	Yes
Ireland	Annual primary energy	200 GWh in 2011; 375 GWh in 2012 & 2013	No
Poland	Final energy	2 to 2.2 Mtoe/year (~24 TWh) in 2016	No

Most countries have penalties for those energy companies that do not fulfil their energy-efficiency obligations. In practice, no penalty has been issued as virtually all the obligated energy companies have met their targets.[87]

The energy savings are evaluated ex-ante for standard operations and equipment ('deemed 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 random sampling controls. To make the deemed energy savings or engineering estimate approach work successfully, there needs to be transparent and public information of the energy saving values, published well in advance of the start of the obligation.[88] With this approach, it is difficult to assess the reality of savings.

87 The targets have been exceeded by 60% in France over 2006–2009; by 40% in the UK for Energy Efficiency Commitment (EEC) initial targets; by 25% in Italy over 2005–2009; and by14% in Denmark over 2006–2009.

88 In France, standardised technical files have been prepared to specify the amount of savings linked to all eligible energy savings actions or equipment. See (in French) (www.industrie.gouv.fr/energie/sommaire.htm).

The targets have been increasing over time and are becoming more ambitious;[89] the initial targets were low to leave time for markets to become familiar with the schemes.

These schemes are just one component of the policy: most of the equipment and operations benefit from various financial or fiscal incentives (e.g. in France). The scheme acts as an accelerator of decisions that households or other consumers are always hesitant to undertake. Utilities also contribute to informing consumers about actions they can take and about the existence of incentives.

The impact of the schemes, and other incentives, is significant in terms of economic impacts: induced investments,[90] employment, reduced imports (balance of payment) and lower expenditure for consumers.

The savings have been gained mainly in the household sector (~ 90% in France, ~ 80% in Italy, ~ 40% in Denmark), from actions with low investment cost or taking advantage of existing financial incentives: simple insulation (about three-quarters of energy savings with cavity wall insulation in UK), CFLs (about three-quarters of energy savings in Italy), heating appliances (efficient boilers) (about two-thirds of energy savings in France and Denmark).

The cost is shared by consumers, companies and the public budget, as these obligations are combined with other measures (such as incentives).[91] The cost for companies may be passed to end-use customers in liberalised markets; for regulated consumers, the cost may be passed to the regulated tariff (planned by most laws but not effective as long as costs are low for companies).

Clearly the UK, with its long experience and improvement of the scheme over time, is among the best practices; in particular, the obligation to get half of the saving obligation for low-income households is quite innovative, as these households do not take advantage of the usual financial incentive schemes and have a strong upfront cost constraints. Its combination with a financial scheme (the Green Deal), as planned from 2013 with the new Energy Company Obligation (ECO) will enable the UK to tap more expensive investments.

The contribution of energy saving obligations to the EU 2020 target is significant in most EU countries: 30% in UK, 22% in France[92] and 40–50% planned in Poland).

89 The present targets have been multiplied by six in France and by two in the UK compared to the previous, target.

90 For instance: around €4 billion estimated in France for 2006–2009.

91 In France it is estimated that for 2006–2009 around 70% of the cost was paid by consumers, 5% by companies and 15% by the public budget.

92 Assuming the renewal of existing targets up to 2020.

5

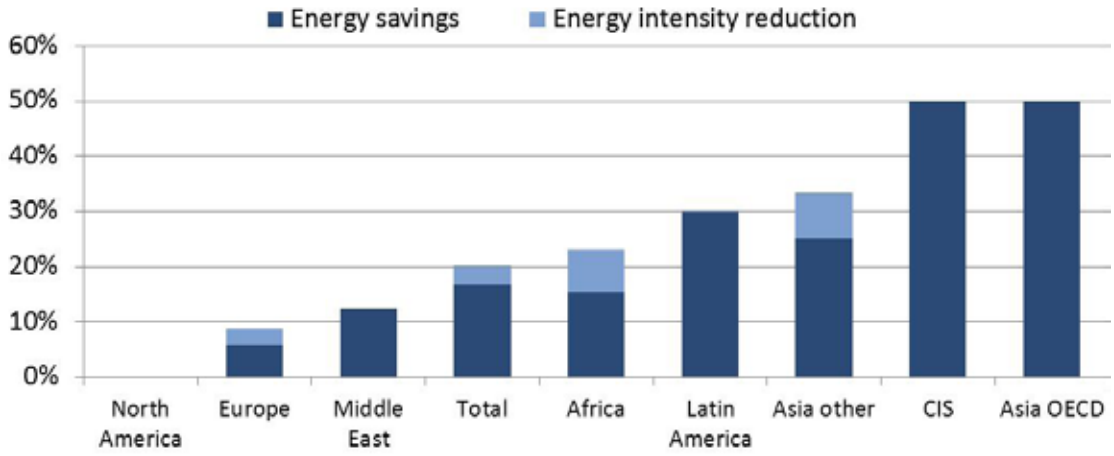
Energy-efficiency achievements in industry

Policy measures in industry

Energy-efficiency targets in industry are usually set in the framework of a national plan such as National Energy Efficiency Action Plans (NEEAPs) or national strategies (e.g. Albania, Algeria, Argentina, Colombia, Indonesia, Israel, Japan, Mexico, Republic of Korea, Russia and South Africa).

Few surveyed countries (20% on average or 17 countries) have set quantitative targets in industry: most of these targets concern energy savings (see Figure 38). In addition, EU countries have quotas on GHG emissions in industry, with the EU ETS, implying strong commitments to improve energy efficiency.

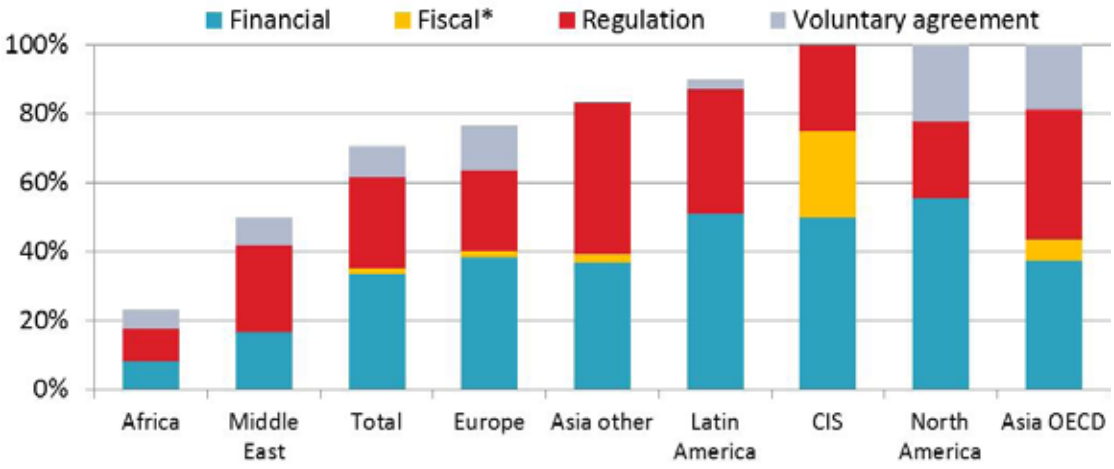
Figure 38
Countries with quantitative targets in industry
Pays ayant des objectifs quantifiés dans l'industrie
Source: WEC ADEME survey 2012–2013



Various measures and programmes have been implemented throughout the world in an effort to improve energy efficiency in the industrial sector. As this sector spans a wide variety of sub-sectors, all with different energy consumption profiles, policies to improve energy efficiency in industry are designed to allow flexibility. They include subsidies for energy audits that help industries identify which investments are cost effective, as well as soft loans and grants to reduce the payback time of these investments and make them more attractive to industrial consumers. Potential actions include changing equipment, processes or upgrading equipment.

As industrial companies are subject to international competition, the implementation of energy-efficiency measures in this sector has to take into account this dimension by avoiding implementation of stringent and costly measures which major competitors are not subject to. As a consequence, regulations are not dominant and represent, on average, less than 40% of the measures implemented in industry worldwide (Figure 39).

Figure 39
Energy-efficiency measures in industry by type
Mesures d'efficacité du secteur industriel par type
Source: WEC ADEME survey 2012–2013
Note: *Accelerated depreciation



Around one-fourth of surveyed countries have implemented regulations, such as mandatory energy audits, energy managers or energy consumption reporting. India and China have set sectoral energy-saving targets for high-volume consumers: in India with the Perform, Achieve and Trade (PAT) scheme and in China with the Top 1,000 Energy-Consuming Enterprises Program (see Box 4).

Labels on electric motors are rarely implemented, except in Europe, while MEPS are implemented, on average, in two-thirds of surveyed countries (Figure 40). MEPS on electric motors are implemented in half of surveyed countries, and 40% of countries have implemented labels on electric motors.

Grants for energy audits are implemented in one-third of surveyed countries; they are followed by investment subsidies (27%) and soft loans (21%) (see Figure 41). Subsidies are used to support investments in energy efficiency, as well as innovative or demonstration projects to accelerate the penetration of advanced technologies.

Industrial energy-efficiency policies also prefer flexible instruments such as voluntary agreements as an alternative to regulation. By signing such agreements, manufacturers agree to set targets and undertake to implement an action plan to achieve these goals.

To encourage companies to sign a voluntary agreement, tax benefits (tax exemptions) are sometimes granted to companies in return for their commitment (for example, in Denmark, Norway, Sweden, Switzerland or UK).[93]

93 In the UK, the new Climate Change Agreements implemented in April 2013 provide an extension to the Climate Change Levy rebate for energy-intensive industries until 2023 in return for meeting energy-efficiency improvement targets. This will deliver 11% energy savings across all sectors by 2020 against agreed baselines through cost-effective measures such as high-efficiency motors, variable-speed drivers, energy-efficient boilers, improved energy management systems and process optimisation.

Figure 40
Regulation by type in industry sector[94]
Réglementations du secteur industriel par type
Source: WEC ADEME survey 2012–2013

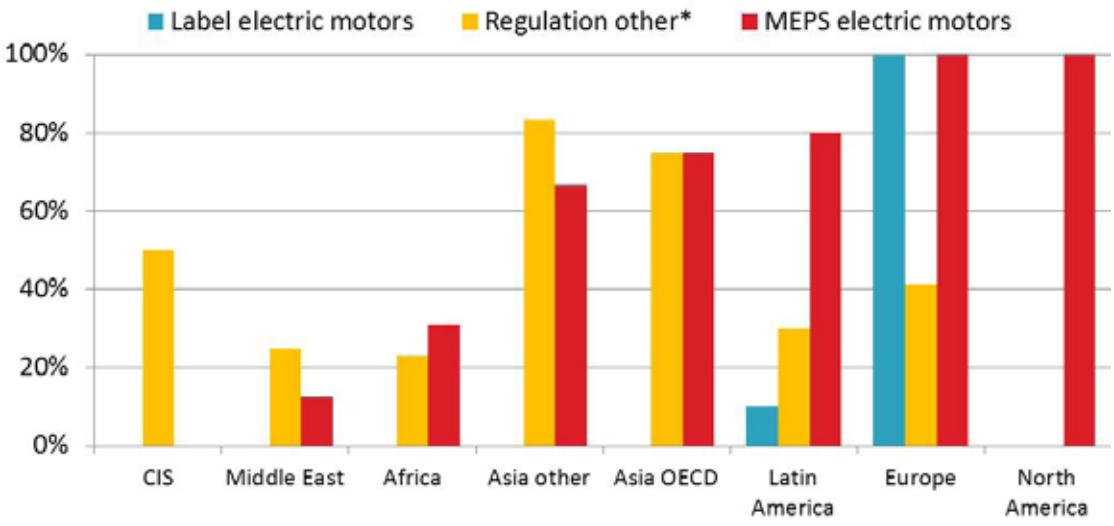
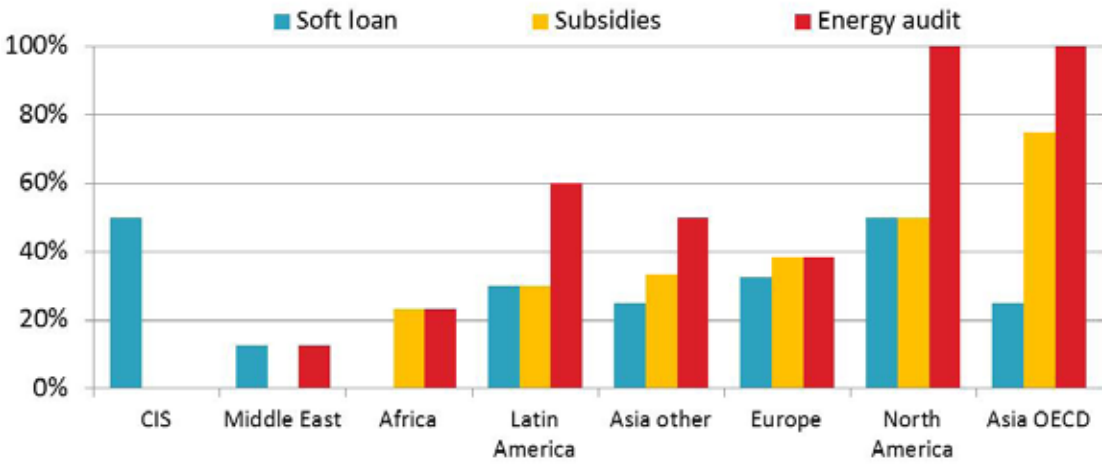


Figure 41
Distribution of financial measures in industry by type
Distribution des incitations financières de l'industrie par type
Source: WEC ADEME survey 2012–2013



In Europe, there is a large number of medium-sized companies that are not covered under the ETS that enter into such voluntary agreements. For instance, the Learning Energy Efficiency Networks (LEEN) implemented in Germany aims to promote energy efficiency in this category of enterprises. Under this measure, the companies in each group are given individual energy saving targets for a period of four years. A monitoring system is in place

94 Other regulations: mandatory energy audits, energy managers, energy consumption reporting, energy savings plans, and energy training.

to measure the actual energy savings achieved. The main objective is to encourage communication and collaboration among companies to help them identify collective solutions to reduce energy consumption.

Some countries are also organising energy awards to encourage companies to be active in energy-efficiency actions.[95]

Box 4: Energy savings targets for large industrial consumers

Although China has greatly improved its energy efficiency in industry, the average specific energy consumption of key industrial processes is still about 15–20% higher than international best practices. One of the greatest successes during the 11th Five-Year Plan period was the Top 1,000 Energy-Consuming Enterprises Program. Under this programscheme, the government set up energy-saving commitments with the nation's largest industrial firms, which account for almost one-third of the country's overall energy use. The manufacturers were given energy-monitoring tools, technical advice, and incentives to fulfil their goals. The programscheme achieved its target ahead of schedule. From 2006–2010, the Top 1,000 Program saved almost 400 Mt CO_2 emissions. Encouraged by this success, the central government has expanded the coverage from 15,000 to 16,000 firms with the Top 10,000 Programs. These enterprises account for almost 85% of the energy used by China's industrial sector, or about 60% of China's overall energy consumption.

In India, Perform, Achieve and Trade (PAT) is a trading scheme with mandatory targets for large industrial consumers using market-oriented mechanisms, similar to energy-saving obligations for energy utilities in Europe. The eight targeted industries that fall under the PAT scheme, which accounts for roughly 60% of India's total energy consumption, are cement, iron and steel, textiles, pulp and paper, aluminium, chlor-alkali, fertiliser and thermal power plants.

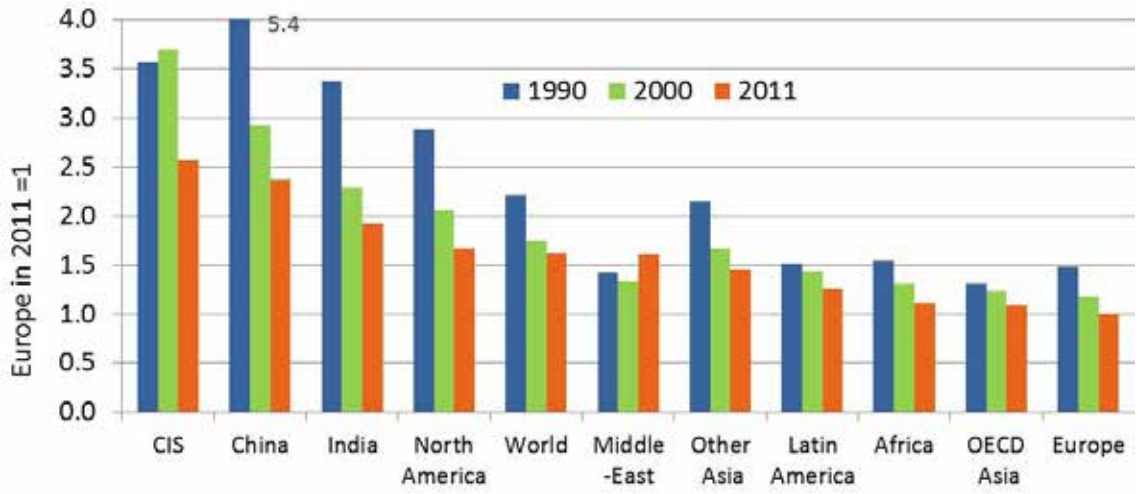
Energy-efficiency trends in industry

Overall energy-efficiency trends

Since 1990, the general trend in industry, except in the Middle East, is towards a decrease in the energy required per unit of value added (industrial intensity). However, since 2000, because of the global crisis, there is a net slowdown in the intensity reduction in most regions and at world level (Figure 42).

95 Chile has recently implemented the Sello Eficienci Energetica (SEAL) programme that identifies and rewards the leading companies in the development of energy efficiency nationwide.

Figure 42
Energy consumption of industry per unit of value added
Intensité énergétique de l'industrie par unité de valeur ajoutée
Source: Enerdata (index based on intensities at purchasing power parities in koe/$2005p)



Trends in these energy intensities are influenced by energy improvements at the level of each individual branch of industry (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. the Middle East), such a trend will, all things being equal, contribute to increasing the energy intensity of industry. However, greater specialisation of industrial activities 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 industry branch, the effect of changes in the structure of industry has not been considered here.[96]

Even if these intensities are converging because of the globalisation of industrial activities, there are still large discrepancies among regions due to differences in energy efficiency and industry specialisation: for instance intensities are around 2 to 2.5 times higher in CIS, China or India than in Europe.

Benchmarking energy-intensive industries

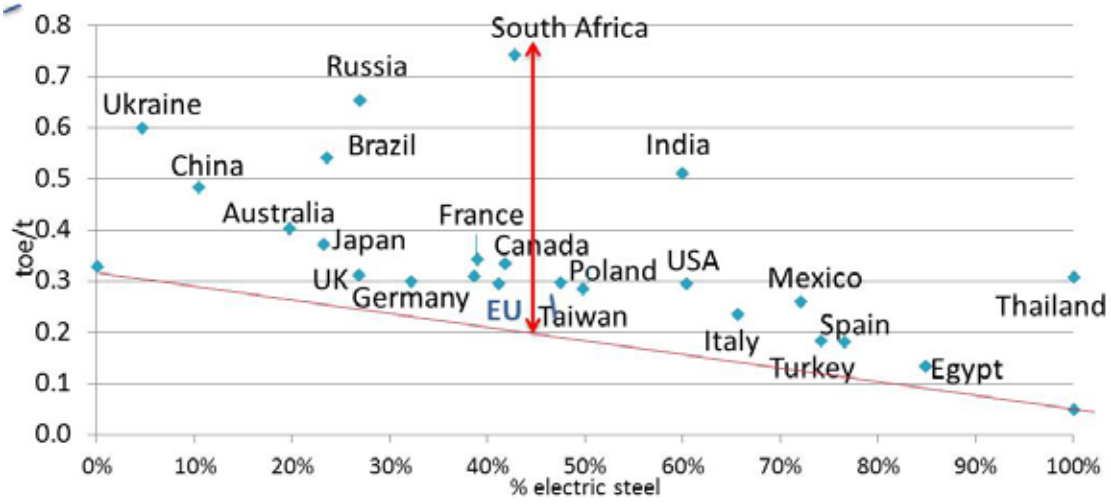
To compare the countries' energy-efficiency performance in steel production, it is necessary to account for the differences in the process mix: countries with 100% production from the electric furnace process will have a much lower specific energy consumption than countries with a large proportion of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

Figure 43 indicates for a selection of countries the average consumption per tonne of steel in relation to the share of the electric process. Only groups of countries with a similar process mix can be compared. There are large gaps between countries with a similar process mix: for instance, South Africa, Canada, EU and Taiwan can be compared, with the EU average turning out to have the best performance; similarly Russia, Brazil, Japan, Australia and UK

96 In the EU project ODYSSEE-MURE, these structural changes are assessed and vary strongly from one country to the other, depending strongly on the time period www.odyssee-indicators.org/reports/industry.

can be compared, with the UK having the lowest specific consumption. Best practices are not always in OECD countries because of globalisation. The distance of each country to the world best practice (red line) gives an estimate of the potential energy-efficiency improvement that can be achieved with the existing process mix. An additional energy-saving potential can be achieved by increasing the share of the electric process.

Figure 43
Average energy consumption per tonne of steel (2011)
Consommation unitaire par tonne d'acier (2011)
Source: Enerdata

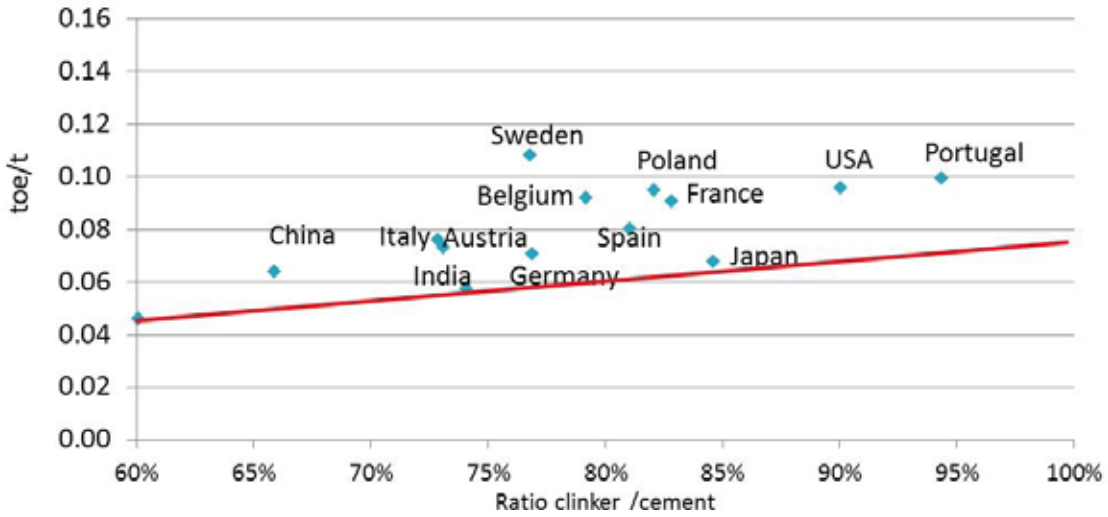


For cement, most of the energy consumption (more than 80%) goes to the fabrication of clinker. The energy performance of cement production is therefore mainly linked to the efficiency of clinker production. As cement is produced by mixing clinker and additives (e.g. ashes), the performance of cement production will also depend on the composition of cement (share of additives) and on the share of clinker produced in the country, thus on the ratio of clinker to cement production: the lower this ratio, the lower the specific consumption.[97] Comparisons should be made at similar values of the ratio.

Figure 45 displays the specific energy consumption of cement as a function of the clinker:cement ratio. Distance to the red line on the graph (world best practice) indicates the potential of energy savings. Again, only countries with a similar clinker:cement ratio can be compared. For instance, for countries with a ratio around 80%:85% (i.e. Poland, France, Spain and Japan), Japan has the best performance.

97 For instance, countries with a high proportion of additives and/or which import part of the clinker.

Figure 44
Energy consumption per tonne of cement
Consommation unitaire par tonne de ciment
Source: Enerdata, based on the ODYSSEE-MURE database, IEA



6

Energy-efficiency achievements in transport

Policy measures in transport

Transport is widely recognised as one of the most difficult sectors for improving energy efficiency and slowing energy demand growth. Despite strong measures, especially on cars in most OECD countries, transport energy demand is still growing, driven by the increase in movement of goods and passengers and the shift to road transport, due to a strong preference for individual mobility for passengers and flexibility for goods.

To improve energy efficiency in transport, policymakers rely on a range of tools:

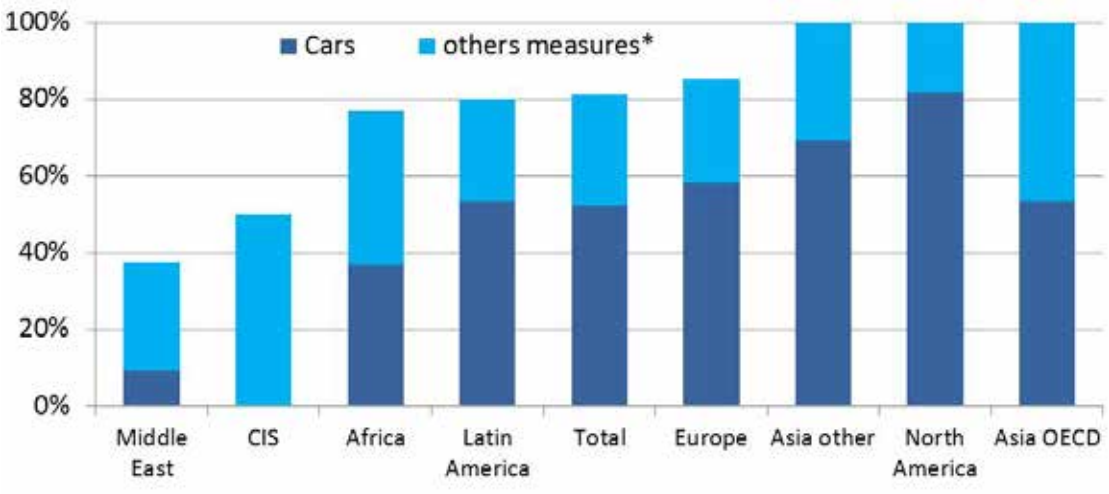
Energy-efficiency improvement/fuel shift MEPS, labels, promotion of alternative fuels

- Shift to more sustainable modes (e.g. from cars to public transport and from trucks to rail and water transport)
- Reducing transport demand (spatial planning and other multi-sectoral policies).

Apart from the first set of measures, the others go beyond energy and depend on policy measures in other sectors, such as transport or land use planning, which is one reason for the difficulty in tackling this sector. Popular measures being developed in OECD countries and emerging countries to reduce the use of cars include bicycle lanes and lanes reserved to car sharing.

On average, 80% of surveyed countries have implemented measures on transport, but this varies significantly across countries, from 38% in the Middle East to almost 100% in OECD countries. Measures targeting cars (mainly new cars) are dominant (see Figure 45).

Figure 45
Countries with measures on transport sector
Pays ayant des mesures dans le secteur des transports
Source: WEC ADEME survey 2012–2013
Note: *Others correspond to measures targeting other types of vehicles and transport companies



Policy measures for cars

A combination of measures are increasingly conceived as packages to improve the energy efficiency of new vehicles, most often cars.

Regulations (e.g. labels and MEPS) represent, on average, more than 50% of measures implemented on cars, with fiscal measures representing around 35% (Figure 46).

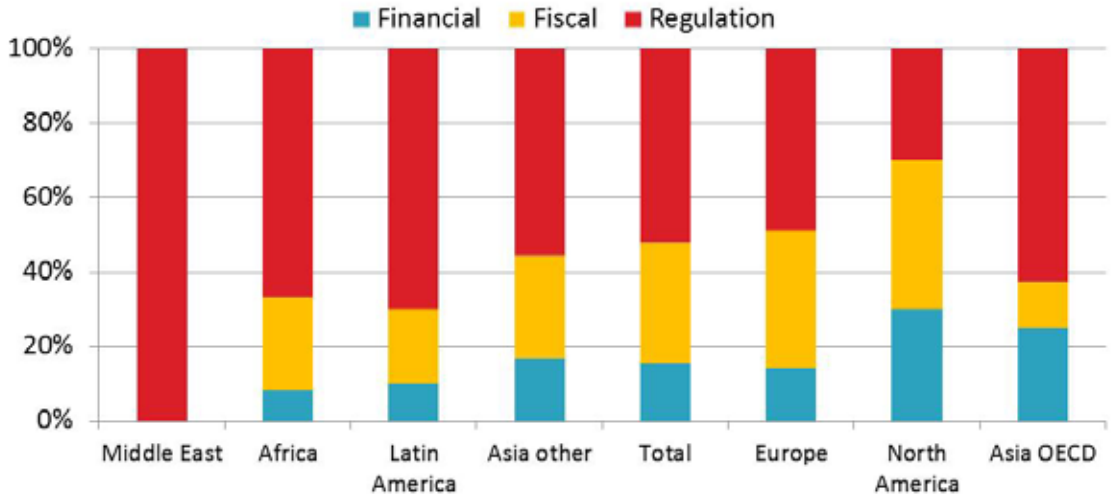
Regulations imposing car label and fuel-efficiency standards are now common in several countries: both car labels and fuel/CO_2 efficiency standards exist in the US, Canada, Japan, Korea, China, Australia, EU countries; in other countries, only car labels have been introduced so far (e.g. Chile, India, Brazil and South Africa).

Fiscal measures, mainly related to car purchase taxes or annual circulation taxes based on energy/CO_2 emissions, are now common in many countries: in Japan, China and North American countries and in many EU countries.[98] Some countries even combine subsidies for the purchase of efficient cars and a tax for inefficient cars (e.g. the bonus-malus system in France).

Financial measures are less popular than fiscal measures: they include subsidies for purchasing new, efficient cars and new cars with alternative motorisation (mainly hybrid and electric vehicles), as well as incentives for scrapping old cars.

In Europe, new types of measures or incentives to promote car-sharing and eco-driving are also becoming important. In some countries there are regulations on mandatory training on eco-driving (e.g. Switzerland).

Figure 46
Distribution of measures on cars by type
Répartition des mesures ciblant les voitures par type
Source: WEC ADEME survey 2012–2013

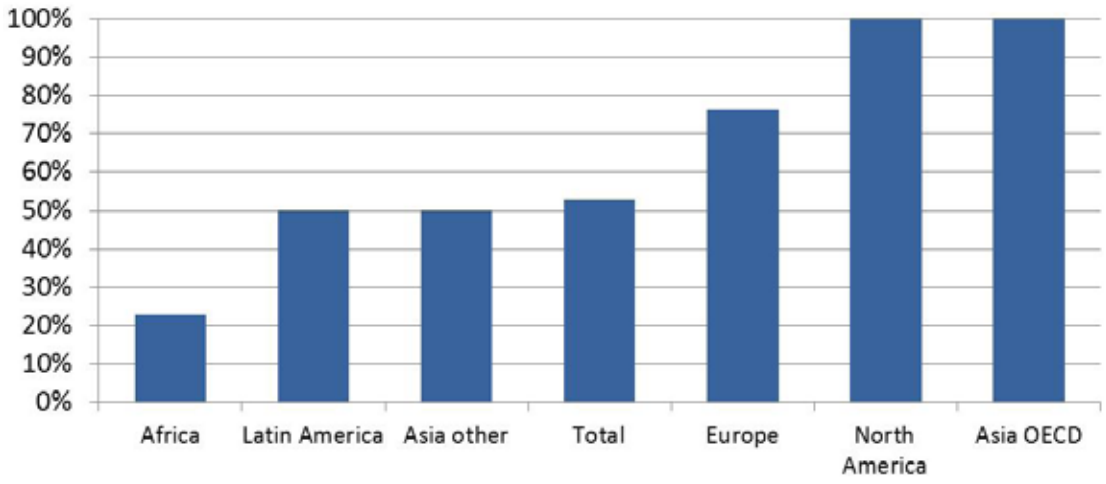


98 In the EU, car purchase taxes and annual circulation taxes function of energy/ CO_2 performances exist respectively in 16 and seven countries.

Labelling informs consumers on energy efficiency and/or CO_2 emissions of new vehicles. It can be represented by comparative or classified labels (e.g. with band A, B, and so on) and the display of specific consumption or emission values (l/100 km or km/l).

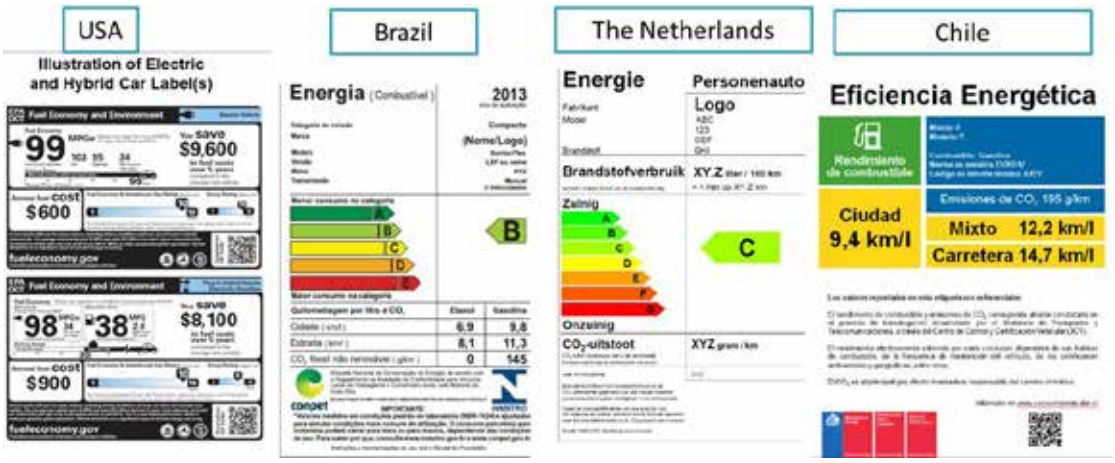
In EU countries, a law obliges car manufacturers and distributors to display information on fuel consumption and CO_2 emissions of new passenger cars in showrooms and in marketing materials.[99] It also makes it mandatory to publish annual guides on fuel economy and CO_2 emissions for all new car models available on the market. Labels for new cars are also mandatory in 12 other surveyed countries: Australia, Bolivia, Canada, Chile, Japan, Mexico, New Zealand, South Korea, Singapore, South Africa, Taiwan and the US (Figure 47 and Figure 48). Labels are voluntary in other countries such as Brazil, India, Morocco, Nigeria and Philippines. In some countries labelling has been extended to vans (e.g. Denmark and planned in France), to used cars (e.g. voluntary in the UK, Finland), to car rental (considered in France), or to car components (e.g. tyres in the EU from 2012).

Figure 47
Countries with labels on cars
Pays ayant des labels sur les voitures
Source: WEC ADEME survey 2012–2013



99 EU Directive 1999/94/EC.

Figure 48
Examples of car labels
Exemples de labels pour les voitures
Source: WEC ADEME survey 2012–2013



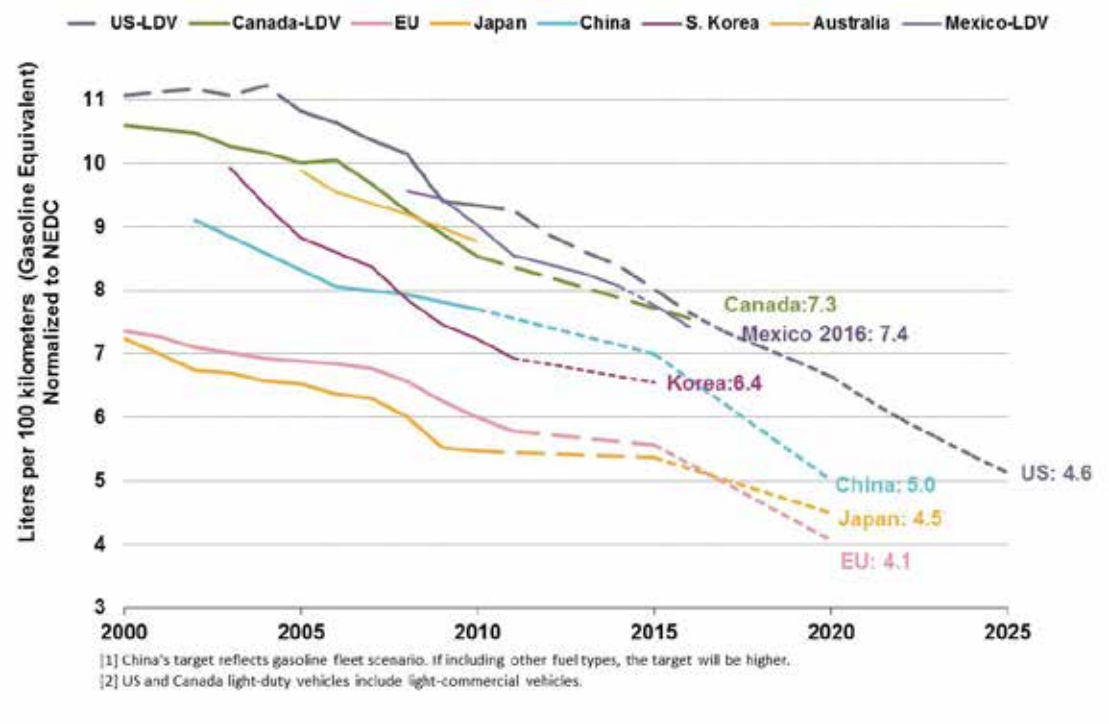
Since November 2012, labels have been introduced to gauge the efficiency of car tyres across Europe. The label provides information on fuel efficiency, wet grip and external rolling noise through clear pictograms. The accurate measurement of car tyre performance is crucial, as an increased rolling resistance may increase fuel consumption by as much as 25%.

Mandatory fuel efficiency and CO_2 standards for light-duty vehicles are currently in effect for more than 70% of the global new vehicles market, driving development and introduction of new energy-efficient technologies, smaller engines, and lighter vehicles. More than 30 countries worldwide – including Japan, the EU, US, Canada, China, Australia and South Korea – have set up fuel economy or CO_2 emission standards for light-duty vehicles. MEPS either apply to all light vehicles or are differentiated between cars and light-duty vehicles, such as in Europe (standards for cars for 2015 and for vans for 2017 in EU countries).[100]

Thanks to this policy, there have been significant improvements in the efficiency of new cars: for instance, a net acceleration can be observed in EU countries since 2007, with a doubling of annual energy efficiency gains. Figure 49 shows the expected changes in the fuel efficiency of new light vehicles in the main vehicle markets, based on regulations that have either already been adopted (solid lines) or are planned (dashed lines). While Japan and Europe currently lead the world in terms of fuel efficiency of passenger vehicles, the US is expected to achieve the highest reduction in the specific fuel consumption by new light vehicles (by 56% from 2000 to 2025).

100 The regulation was introduced in December 2009 for cars in the EU and replaced the voluntary agreements signed with car manufacturers' associations that failed to reach the target of 140 g of CO_2 per km for the average emissions of all new cars sold in 2008 at EU level; the regulation fixed a limit for each manufacturer of 130 g of CO_2 per km for the average of its sales to be achieved in 2015.

Figure 49
Expected specific consumption by new light vehicles
Baisse attendue de la consommation spécifique des véhicules légers neufs
Source: ICCT, NEDC: New European Driving Cycle[101]



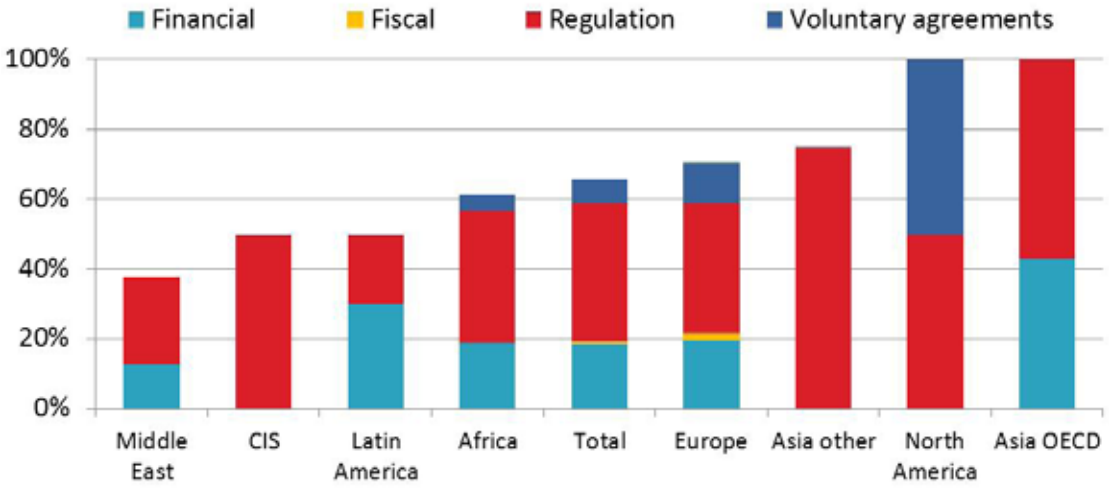
However, energy efficiency will not offset the impact of the increased diffusion of cars in emerging countries. Even if the average fuel efficiency of passenger vehicles is expected to increase,[102] these gains will be offset by the increasing stock of cars. The total consumption by cars will increase significantly between 2010 and 2030 by more than 70% (or more than 100 Mtoe) in China, by 60% (or 40 Mtoe) in India and by 40% in Brazil.[103] However, in OECD countries, the consumption will decrease: by 6% in the US and EU, and by up to 26% in Japan.

Policy measures for trucks and transport of goods

Heavy-duty vehicles account for about 26% of CO_2 emissions from road transport in the EU, and they are the second-largest transport source of CO_2 emissions, roughly equivalent to the sum of air and water transport emissions (international and domestic aviation and shipping). In addition, the demand for freight transport is growing continuously and measures targeting transport companies are insufficiently addressed by policies: although two-thirds of surveyed countries have implemented measures targeting transport companies or trucks (Figure 50), the measures have been much less ambitious than for cars. Regulations (MEPS for light commercial vehicles and regulations for transport companies like mandatory energy audits) are largely dominating measures on trucks.

101 The New European Driving Cycle is a series of data designed to assess the fuel economy and emission levels of passenger cars. It is also referred to as the Motor Vehicle Emissions Group (MVEG) cycle.
102 By 35% in China and by 23% in India over 2010–2020.
103 Source: Enerfuture scenarios, Enerdata forecasts 2012.

Figure 50
Measures on transport companies and other vehicle types*
Mesures ciblant les compagnies de transport et les autres types de véhicules
Source: WEC ADEME survey 2012–2013
Note: *Excluding cars



Measures addressing road freight transport can be split in two types:[104] measures to improve truck energy efficiency; and measures supporting modal shift to rail and water transport.

Measures to improve the energy efficiency of trucks

MEPS are only implemented in Japan for heavy trucks through the 'top runner' programme. Japan developed in 2006 the first fuel economy standard for heavy-duty vehicles with penalties that take effect in 2015. Labelling and MEPS for heavy trucks are not implemented elsewhere because of the diversity of vehicles, but they do exist for light-duty vehicles (e.g. EU, US, Canada). Other regulations target truck components, e.g. speed regulator, tyre pressure monitoring systems (e.g. US since 2007).

Several countries have implemented regulations for transport companies such as mandatory audits, energy managers, energy consumption reporting, energy-savings plans or mandatory eco-driving (e.g. Austria, Switzerland).

Financial incentives are less common. In Colombia there are subsidies for scrapping old trucks (the Colombia fleet renewal programme). Since the programme began in 2008, around 6,000 trucks have been scrapped.[105]

Voluntary agreements for CO_2 reduction have been implemented in France (The Objective CO_2 programme) since 2008, when industry representatives signed the agreement with the

104 This section is adapted from a report prepared for ADEME and WEC by Riccardo Enei, Giovanna Giuffrè and Andrea Ricci from the Institute of Studies for the Integration of Systems (ISIS) (see www.wec-policies.enerdata.eu/case-studies.php). Country case studies: France, China, India, Columbia, Japan, Switzerland, Thailand, US.
105 There are several requirements for applying to the scheme: regular payment of taxes; no change of motor in the past four years; no pending judicial or pledges in transit agencies; vehicles in the range of 25 years life; a valid certificate history; and that the vehicle is in good working order. [Why would the vehicle need to be in good working order if it is being scrapped?]

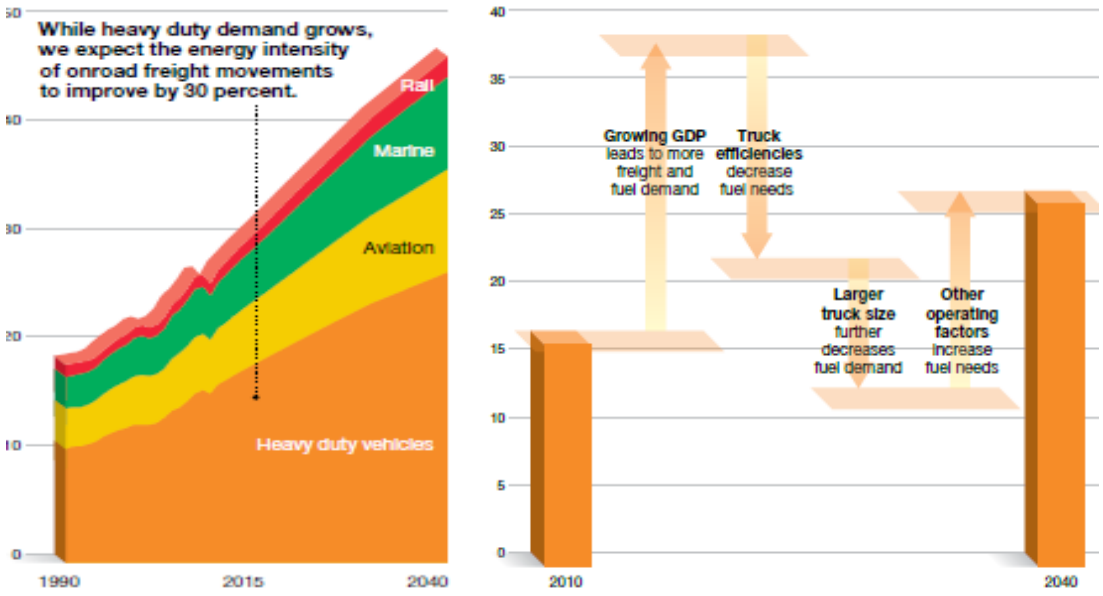
Ministry of Environment. The objectives of the programme are to improve the energy performance of the sector, in particular road freight transport, and to limit CO_2 emissions. The participating companies commit to a three-year action plan of concrete measures to reduce their fuel consumption and CO_2 emissions. Companies are provided with tools and guides to help them implement the scheme through their regional directorate for environment or ADEME regional branches.

Other interesting initiatives are the Green Trucks Pilot Project in China that started in 2009 with the aim to analyse the truck sector through surveys and technological pilot, and the introduction of compressed natural gas in Thailand since 1984, mainly for reducing emissions in the Bangkok area.

Measures to shift part of road traffic to rail and water transport

In the long term, energy demand for trucks will depend not only on energy-efficiency progress (estimated at 50% over the next 30 years by ExxonMobil) but also on operating factors (traffic congestion and delivery trends) showing again that a significant part of the problem is beyond the usual energy-efficiency policy measures (see Figure 51).

Figure 51
Drivers of transport energy demand growth for trucks at global level
Demande d'énergie pour les camions et ses déterminants
Source: ExxonMobil Outlook 2012; unit Mboe/d



As a result, measures to promote modal shift will be increasingly important, such as subsidising infrastructures for combined transport (e.g. rail/road, road/water, rail/water),[106] developing sea motorways (e.g. France, Spain, Portugal and Italy) or implementing tolls for trucks.

Tolls for trucks improve the competition of rail transport and also finance for public transport infrastructures. They also have an impact on the efficiency of trucks. In Germany,

106 For instance, rail lines from ports.

with the introduction of the distance-based truck toll, a number of key requirements for the usage-based financing of infrastructure, efficient traffic control and enhanced environmental protection were met: for instance eight years following the start of toll collection, modern trucks weighing over 12 tonnes with low-emission exhaust gas technology dominate the fleet of national and international transport and logistics companies. This is also the case in Switzerland where a distance-related fee was introduced for heavy goods vehicles (January 2001).

Incentives to promote modal shift include subsidies to intermodal transport. In India, the infrastructure provision programme is rooted in the policy statements and documents in which government has recommended that railway should be given the lead role because of its greater energy efficiency, eco-friendliness and relative safety. The US Environmental Protection Agency (EPA) launched a programme in 2004 that reduces transportation-related emissions by creating incentives to improve supply chain fuel efficiency.

The main recommendations stemming from the case studies on trucks are:

- Measures which require the presence of an efficient institutional sector are needed in context, like India and Colombia, characterised by lack of transparency (the efficient administration of the renovation truck fleet programme in Colombia) or market competition (modal shift policies in India).
- Measures supporting market development, in terms of actors and competition, are required in the presence of policies aimed at favouring the uptake of new fuels and technological upgrade (Thailand and China).
- Administrative accompanying measures, e.g. presence of independent agencies, are necessary where market competition and efficient regulation exist, together with a network of transport operators and truck manufacturers with a strong technological and financial basis (e.g. case of France, US and Japan).
- The presence of an efficient administrative sector is also important when extensive national pricing schemes are applied (Switzerland).

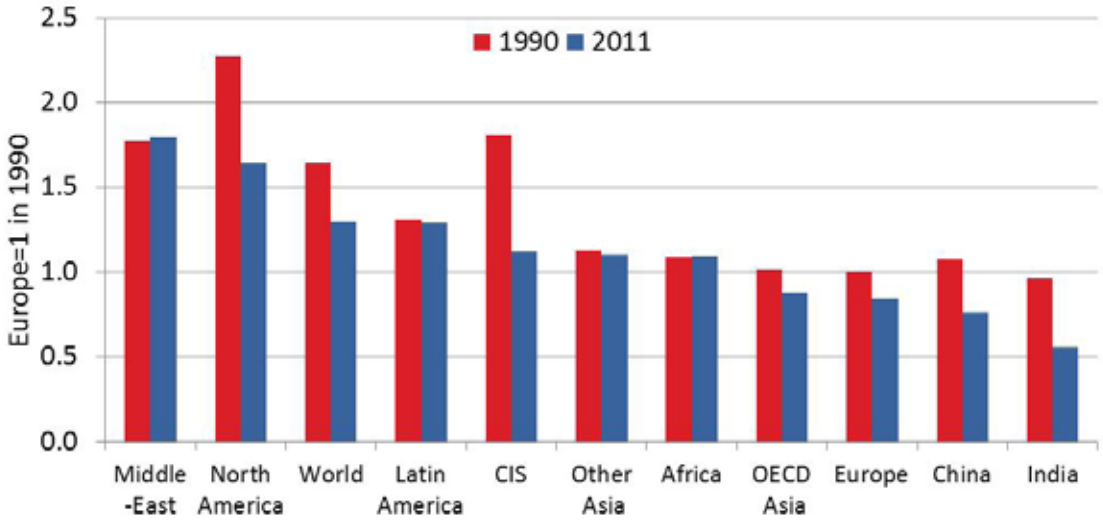
Energy-efficiency trends in the transport sector

The energy intensity of the transport sector[107] appears to be quite similar in Europe, OECD Asia and other Asia, while North America and the Middle East stand at a level at least 75% higher (Figure 52). In China and India, because of the 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.

107 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 intensity, i.e. the energy consumed in transport per unit of GDP, as transport activities take place in all sectors. In the ODYSSEE-MURE 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).

In most world regions this energy intensity is decreasing over time, which means that the energy consumption of transport is growing much slower than the GDP. This decoupling of transport consumption and GDP is strong in China and India: this is due to the dominant role of rail transport and the lower diffusion of cars. 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.

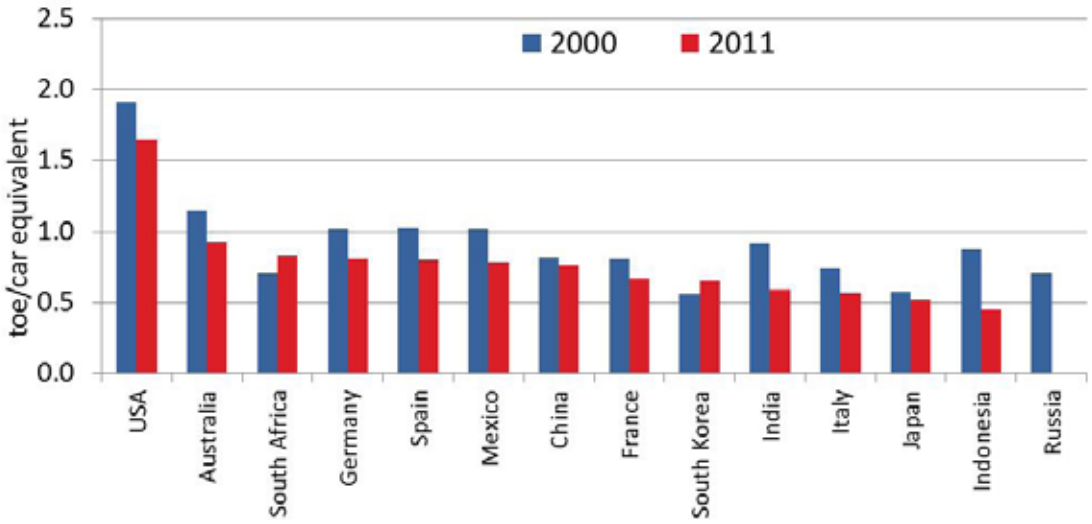
Figure 52
Energy intensity of transport
Intensité énergétique du transport
Source: Enerdata



For road transport (i.e. cars, bus, trucks, light vehicles, and two-wheelers) there is a decreasing trend of the unit consumption per car equivalent[108] in most countries due to the energy-efficiency improvement of vehicles (Figure 53).

108 The consumption per car equivalent relates to the total consumption of road transport to the fleet of vehicles measured in car equivalent. If a bus consumes on average 15 times more fuel than a car in one year, it is equivalent to 15 cars. Variation in consumption per car equivalent will be driven by technical efficiency.

Figure 53
Consumption of road transport per car equivalent*
Consommation du transport routier par équivalent voiture
Source: Enerdata
Note: *1 bus = 15 cars; 1 truck and light vehicle = 4 cars; 1 two-wheeler = 0.15 car



There is a global decrease of the specific consumption of new cars thanks to the measures implemented (Figure 54). In EU and Japan, the specific consumption of new cars has decreased regularly since 1995 (by about 20%) thanks to labelling, fiscal and financial incentives and voluntary agreements programmes. In the US, the reduction was significant in the 80s because of the Corporate Average Fuel Economy (CAFE) standards but there was slight progress in the 90s. This trend will continue with the renewal of existing vehicles and because of the ambitious targets set for 2020 (Figure 49).

Due to their low-carbon performance, railways are an important means to reach sustainable mobility and energy-efficiency gains. Thus, the promotion of rail transport around the world to meet current and future transport needs is becoming important.

Today, there are large discrepancies among countries in transport by train, reflecting the different priorities given to the development of rail infrastructures and diffusion of high-speed trains. The highest mobility by rail is recorded in Japan with 3,000 km/year per capita on average, followed by France, with 1,500 km per inhabitant (Figure 55).

Figure 54
Specific consumption of new cars (litres/100km)[109]
Consommation spécifique des automobiles neuves
Source: Enerdata
Note: *China 2002 and 2010

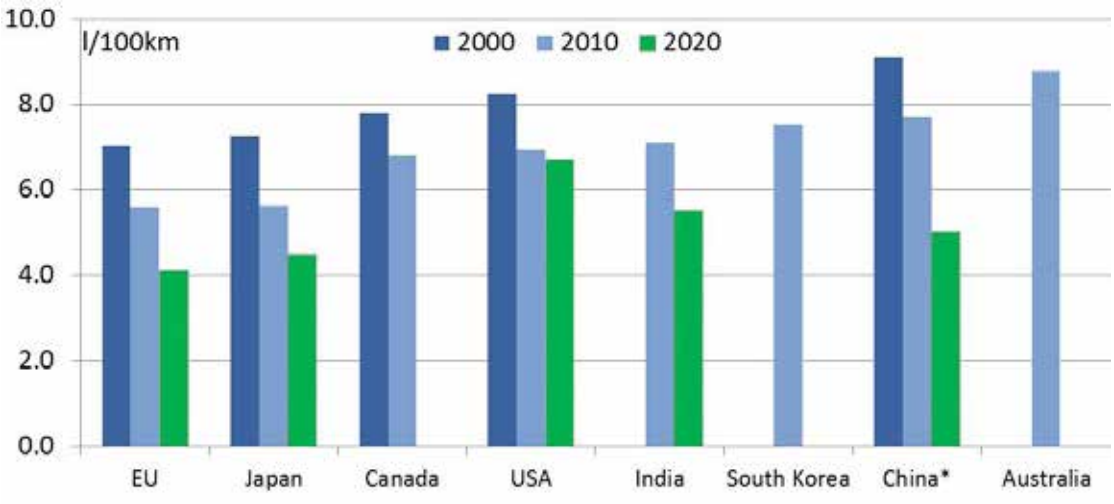
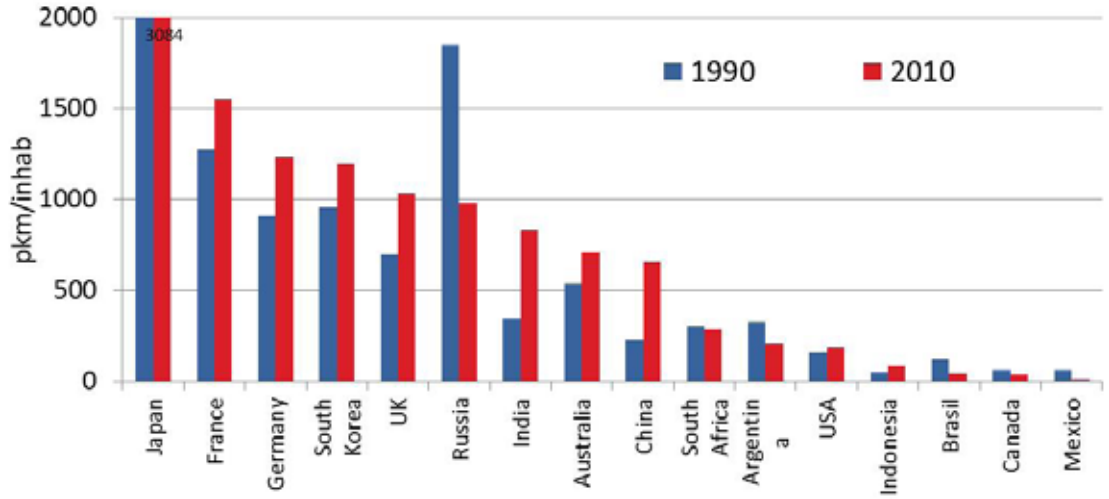


Figure 55
Per capita rail mobility[110] (km per inhabitant)
Mobilité ferroviaire par tête (km par habitant)
Source: Enerdata



109 Test values.
110 This indicator corresponds to rail passengers transport in passengers-km [passengers per km?] divided by the population.

7

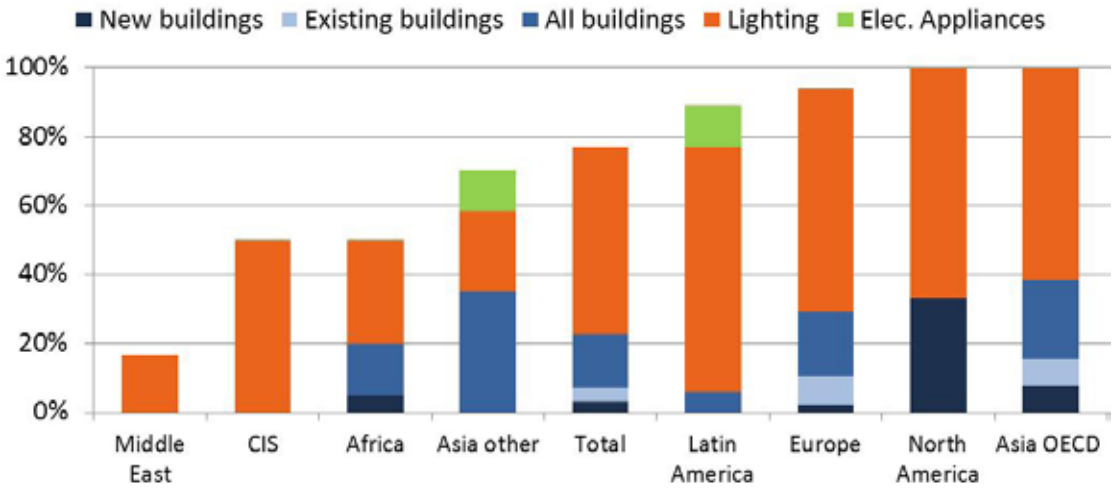
Energy-efficiency achievements in buildings

Policy implemented in the building sector

Overview

Residential and non-residential buildings consumed about 35% of total final energy requirements in the world in 2011.[111] It is the largest end-use sector, followed by industry (33%), transport (29%) and agriculture (3%). Final energy consumption of buildings has increased at world level by around 1% per year since 2005 and around 3% per year for electricity (3.3% per year since 1990). In addition, the sector has the largest potential for energy-efficiency improvements. Thus many countries have set quantitative targets on energy-savings or energy-efficiency improvements in buildings. The banishment of incandescent lamps is widely applied: in 70% of surveyed countries. Targets on energy efficiency of buildings are significant in Asia, North America and the EU. Most targets concern the residential sector (83%), with 13% in the public sector and 4% in commercial services (Figure 56).

Figure 56
Countries with energy-efficiency targets for buildings
Pays avec des objectifs d'efficacité dans les bâtiments
Source: WEC ADEME survey 2012–2013



One of the most recent targets implemented concerns the diffusion of very low-energy new buildings. For instance in EU countries, the EPBD[112] has set that, by 31 December 2020, all new buildings should be Nearly Zero Energy Building (nZEB).[113]

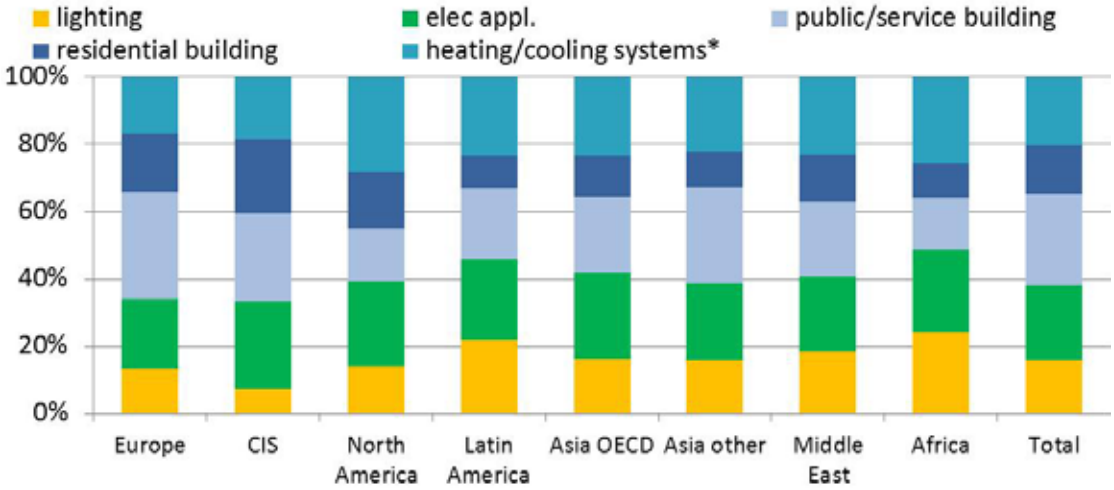
Measures targeting buildings and heating/cooling systems are predominant and represent, on average, 60% of the measures implemented for buildings (Figure 57). The rest correspond to measures on electrical appliances and lighting. The distribution of these measures by end-use is quite similar among countries.

111 Enerdata 2013, Global Energy and CO_2 database.

112 The EPBD defines nZEB as buildings that have a very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by renewable sources.

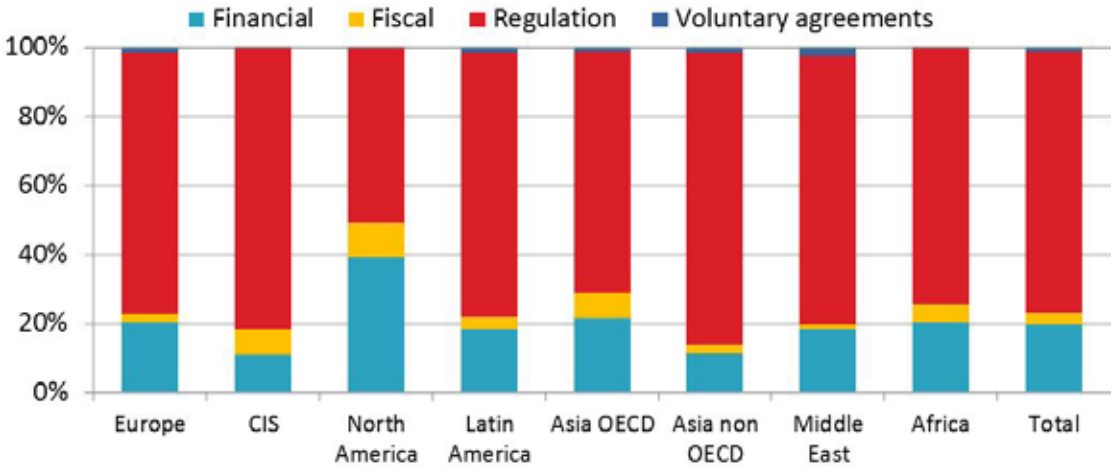
113 There are specific targets for public buildings, as explained in the section in this report on the public sector.

Figure 57
Measures on buildings by target
Mesures pour les bâtiments par cible
Source: WEC ADEME survey 2012–2013
Note: *Solar water heating; air conditioning; wood stove



Regulations are dominant in buildings: they include the labelling of electrical appliances, MEPS for new buildings and appliances and the banishment of incandescent lamps (Figure 58). Financial measures are in second position and include subsidies and soft loans. Fiscal measures (e.g. tax on inefficient appliances, or tax reductions) are marginal, and very few voluntary agreements in commercial or public buildings are implemented. An interesting new measure is the promotion of benchmarking of the energy performance of buildings (e.g. as seen in Mexico).

Figure 58
Measures on buildings by type
Mesures pour les bâtiments par type
Source: WEC ADEME survey 2012–2013

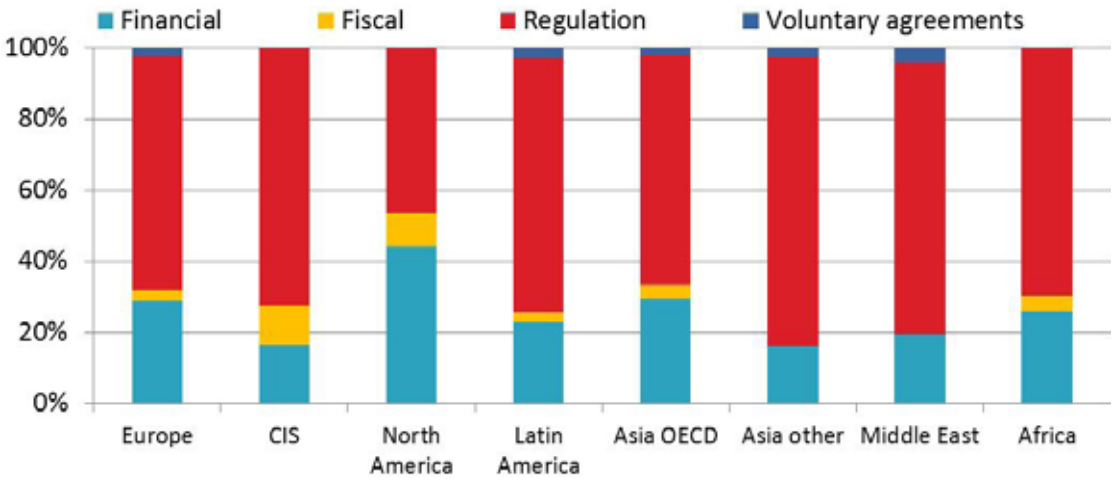


Thermal uses[114]

This section focuses on policies addressing energy efficiency for space and water heating. Although cooking is a dominant use in developing countries, very few measures target this end use.[115]

The most common measure is regulation, mainly building codes, except in North America where financial incentives are significant (Figure 59). Labelling of buildings is a new approach that has been implemented recently in EU countries and is spreading to other regions (e.g. Chile). Financial or fiscal incentives (i.e. subsidies or tax reduction) for efficient heating and cooling equipment and building retrofitting are less common in non-OECD countries. Emerging countries focus more on new dwellings (in particular on multi-family dwellings and commercial buildings), compared to Europe or the US where the existing stock in the residential sector is the key target for energy-efficiency policies in buildings. On average, three labels and three MEPS are implemented by country for thermal uses.

Figure 59
Measures on thermal uses by type
Mesures sur les usages thermiques par type
Source: WEC ADEME survey 2012–2013



Building codes

Building codes are becoming widespread, with 60 countries (~70% of surveyed countries) having implemented building codes for new dwellings or buildings in service sector, with 90% of them mandatory.

European countries have set up mandatory energy-efficiency standards for new dwellings and service sector buildings. The EPBD (2002/91/EC) was the first major attempt requiring all member states to introduce a general framework for setting building energy code requirements based on a 'whole building' approach (so-called performance based).

114 Heating, water heating and cooking.

115 There are, however, some measures for the promotion of efficient cooking stoves.

In almost all the other OECD countries in Asia and America, there are mandatory standards[116] (Figure 60). Some non-OECD countries outside Europe have recently established mandatory or voluntary standards for service buildings: Singapore and the Philippines were among the first. Other countries with standards are Algeria, Tunisia, Taiwan, Malaysia, Egypt, South Africa, Saudi Arabia and Indonesia. In several countries these standards are not yet enforced.

Figure 60
Countries with efficiency standards on new buildings
Pays ayant des normes sur les bâtiments neufs
Source: WEC ADEME survey 2012–2013

Thermal building codes have been changing over time, from simple standards on building components to more complex requirements, including the most advanced countries' energy-performance standards. These performance standards consider the whole building as a system and integrate building equipment such as heating and air conditioning systems, ventilation, water heating, and, in some countries, pumps and elevators. A maximum energy consumption per m^3 or m^2/year is then set corresponding to all these uses. Most building codes are performance based (e.g. California, all EU countries). These types of standards can be jointly implemented 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 of thermal building codes have become increasingly regular. For instance, over the past 30 years, standards have been reinforced three to five times in most EU-15 countries and independent from the oil price level. Most EU countries have reinforced their standards since 2000, with the implementation of the EPBD. In addition, this directive has, for the first time, provided for 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 is below what could be expected from building regulations. This can be explained by behavioural factors (such as higher heating temperatures, more rooms heated, or longer heating

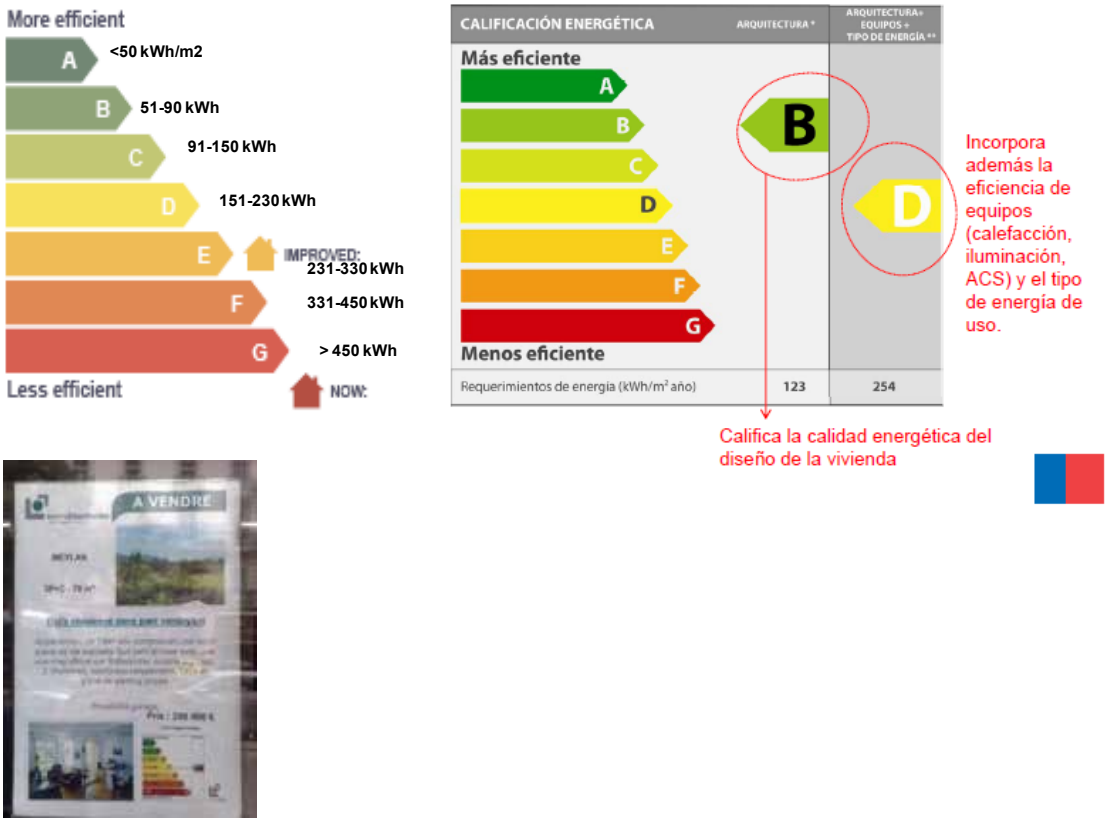
116 In the US, a new standard has been released in 2010 that is 30% more energy efficient than the prevailing building codes. Each states has its own residential/commercial code (mandatory or voluntary). For Canada the standards are voluntary.

period over the year) and by a non-compliance with building regulations. Another issue is that several emerging countries have implemented building regulations that are not really enforced and controlled.

Energy-efficiency labels

Measures on buildings have mainly focused on new buildings. As this represents a small share of the existing stock in OECD countries,[117] building standards can only have a slow impact in the short term. A more recent trend is to extend regulations to existing buildings, by imposing minimum standards in the case of renovation (e.g. in the EU) and energy-efficiency labels for existing buildings (often called energy certificates); such certificates are mandatory in EU countries each time there is a change of occupant or a sale.[118] These certificates enable consumers to obtain information about the energy consumption of the dwelling they are going to buy or rent and are differently implemented within the boundaries set by the EBPD. Most countries have chosen to include an energy-efficiency class system in their certificates (as for appliances), which makes the information more transparent to end users. For example, these labels have to be used in real estate advertisements in France. Also, an energy-efficiency label for new buildings has been introduced in Chile, including a double label on the building shell and heating appliances (Figure 61).

Figure 61
Energy-efficiency certificate for buildings: France and Chile
Certificat de performance énergétique : cas de la France et du Chili



117 New dwellings only represent around 1% of the stock in industrialised countries.

118 Energy-efficiency certificates were introduced in Denmark in 1999 and extended in 2006 to all EU countries with the EBPD.

Financial measures[119]

Countries that have introduced financial incentives offer subsidies and **loans at low interest**[120] (i.e. soft loans) or, most often, a combination of both systems. Apart from the different subsidy volumes available, the systems differ in the conditions that need to be fulfilled to receive support, and in the case of loans, on the period of the loan and on the method of reimbursement. The grants usually cover a percentage of the total investment for energy savings, generally varying between 15 and 40%.

Most programmes require implementation of certain technical actions to qualify for a grant and the level of support (rate of subsidy, interest rate) depends on the actions implemented. In Germany, the well-known programme of the public bank, KfW, supports the energy-efficient refurbishment of existing buildings by offering home owners low-interest loans with a range of subsidies linked to the energy performance of the refurbishment.[121]

As the loan repayment time for renovations can be quite long, a new approach is to offer loans on a period long enough to have a monthly reimbursement similar to the monetary savings in the energy bill. This was the original approach developed with the Green Deal in the UK. In Japan, the Flat-35 Mortgage Programme is a state-run mortgage scheme encouraging energy efficiency in buildings with long-term loans. The basic offer is a 35-year, fixed-rate mortgage with a relatively low interest rate, available to buildings achieving an overall thermal efficient standard.

Another new approach is the mode of loan reimbursement through the existing electricity bill – for instance in the Green Deal in the UK,[122] Prosol in Tunisia, or via property tax as in New Zealand or in the US. In New Zealand, the Heat Smart project is a state-run loan scheme with grants, promoting insulation and clean heating for home-owners and landlords. It offers either loans from the local council to be paid back through an additional charge on the council tax or a commercial loan from a bank. In the US, local authorities offer upfront financing to eligible property owners to fund energy-efficiency measures through the Property Assessed Clean Energy schemes with repayment via property tax.[123]

Other original incentives are to allow an increase in the maximum authorised floor area to be built in new construction for efficient buildings (e.g. Lebanon) or to reduce the property tax (e.g. France).

Other measures

Voluntary agreements between government and key players also exist to reduce energy consumption in existing buildings. The More with Less programme in the Netherlands reduced barriers for owners of buildings and stimulated them to invest in energy-saving measures, which led to over 200,000 buildings being refurbished annually (~3% per year). The programme relied on energy certificates to identify the energy-saving potential and

119 More information on innovative financing schemes in buildings can be found in a separate report prepared for ADEME – Financing Energy Efficiency in Buildings: an international review of best practice and innovation by Pedro Guertler and Sarah Royston of the Association for the Conservation of Energy and Dr Joanne Wade. Country case studies: India, China, Japan, Germany, Estonia, Kenya, US, New Zealand.

120 In France, zero interest loans are implemented under specific conditions.

121 The measures are also applied to new buildings.

122 In UK, with the Green Deal programme, repayments are made through electricity bills. This provides assurances that the cost of the measures should be covered by savings on the electricity bill. In addition, the loan is linked to the property, which limits the constraints on the owner.

123 See the example of the Palm Desert Energy Independence Program.

monitor progress. In France, the Energies POSIT'IF programme is dedicated to the retrofitting of Paris condominiums with collective heating, which are usually less energy efficient. It offers tailor-made financing solutions.

Energy-savings obligations for utilities in EU countries have been mainly used in the building sector, especially for households. Actions with low investment cost or that take advantage of existing financial incentives have been implemented through these obligations: simple insulation (about three-quarters of savings with cavity wall insulation in the UK) or efficient heating boilers (about two-thirds in France and Denmark).

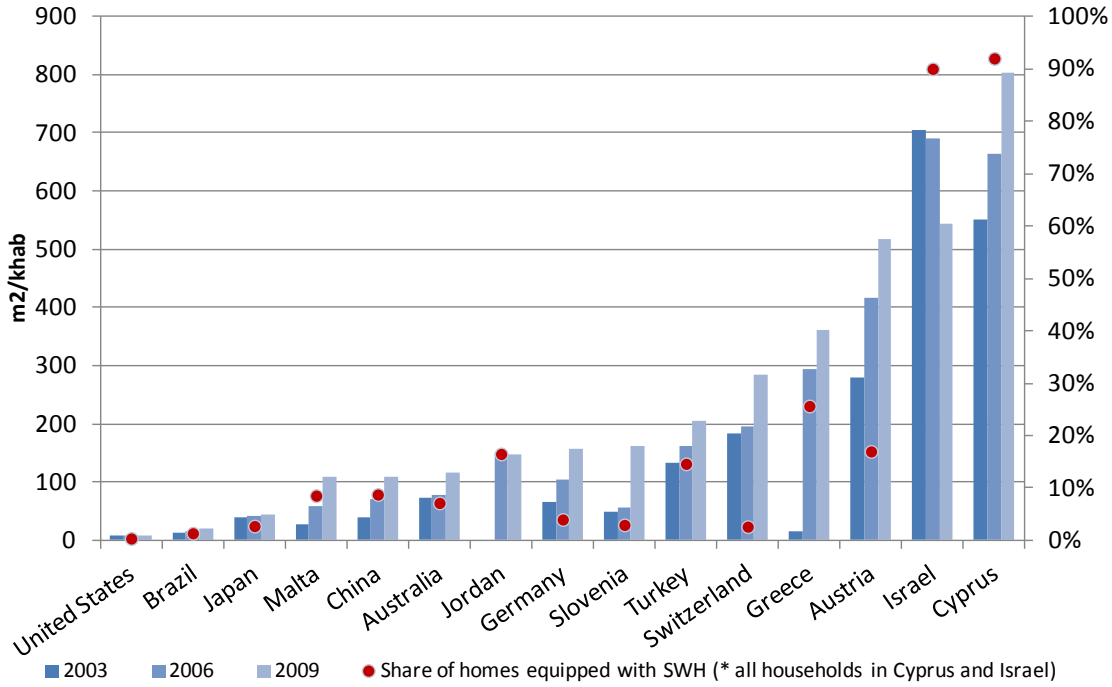
Solar water heaters

The installation of solar water heaters[124] has increased four-fold since 2000 at world level, with two emerging country profiles. Countries with a long-term promotion policy have a high share of systems installed per capita (including Austria, Germany and Turkey, in some cases reaching saturation (as in Cyprus and Israel). At the same time, a new market for solar water heaters is developing in many countries, in particular in emerging countries, such as China and Brazil (Figure 62).

Figure 62

Installed area of solar heaters per inhabitant and share of homes equipped

Source: Global Energy Data – Enerdata , from the IEA



The main constraint in the adoption of solar water heaters is purely economic. With its high initial investment costs and long payback time, the adoption rates are closely linked to promotional policies and regulations. The countries with the largest area per capita are Cyprus (high subsidies) and Israel (where solar heaters are mandatory on new buildings). Tax

124 Excluding unglazed water collectors used to heat swimming pools and air collectors.

credits and direct subsidies are an efficient way to promote solar water heaters. In Greece, tax reductions contributed in raising the area from 20m² in 2005 to 360m² in 2009 per 1,000 inhabitants. In Spain, subsidies and mandatory solar water heaters on new buildings raised this area from 13 m² in 2005 to 47 m² per 1,000 inhabitants in 2010.

Outside Europe, China and India are implementing ambitious solar thermal policies, currently setting the main lever to promote solar water heating, but other incentives are under consideration.[125] In the US, where the market is still underdeveloped, solar water heating systems benefit from a 30% federal tax credit, while some states have also implemented credits and rebates.

The influence of promotional tools on the development of the solar water heater market is particularly noticeable in Australia, where a policy was launched in 2000 that created tradable renewable energy certificates linked to solar systems.

The current installed capacity allows energy savings of around 13 Mtoe per year and savings should double in 2020 thanks to targets set by countries (Table 2).

Table 2
Promotional policies for solar water heating in selected countries

Source: Enerdata, from National Renewable Energy Action Plans, IEA and Renewable Energy Policy Network for the 21st Century (REN21)

Country	Type of measures	Target
Austria	Rebates, subsidies	169 ktoe by 2020
Cyprus	Subsidies	90 ktoe by 2020
France	Tax credit, investment grants	4 million homes with solar water heaters and 0.9 Mtoe by 2020
Germany	Preferential loans, subsidies	1.25 Mtoe savings by 2020
Greece	Tax reductions, minimum solar contribution to hot water supply	355 ktoe by 2020 60% of hot water needs from solar
Italy	Tax credit, subsidies	1,586 ktoe by 2020
Portugal	Subsidies, tax reductions, preferential Loans Mandatory solar water heating systems on new buildings	160 ktoe by 2020; 100,000 m²/year until 2020; 1 m²/occupant in new buildings
Spain	Minimum solar contribution to hot water supply	10 million m² and 644 ktoe savings by 2020
Morocco	Subsidies	1.7 million m² by 2020
Tunisia	Subsidies, preferential loans	2.5 million m² by 2020
South Africa	Tax reductions, rebates	4 million homes equipped by 2020
Lebanon		1.05 million m² by 2020
Israel	Mandatory solar water heating system on new buildings	
United States	Tax credit	
Brazil	Subsidies	15 million m² by 2015

125 In China, some towns like Kunming (Yunnan) and Dezhou (Shandong) have set targets to accelerate the development of solar water heating (50% of buildings with solar hot water by 2010), while Shenzhen mandated solar water heating in all new residential buildings. India is planning to offer preferential loans and to make solar water heaters mandatory on new buildings.

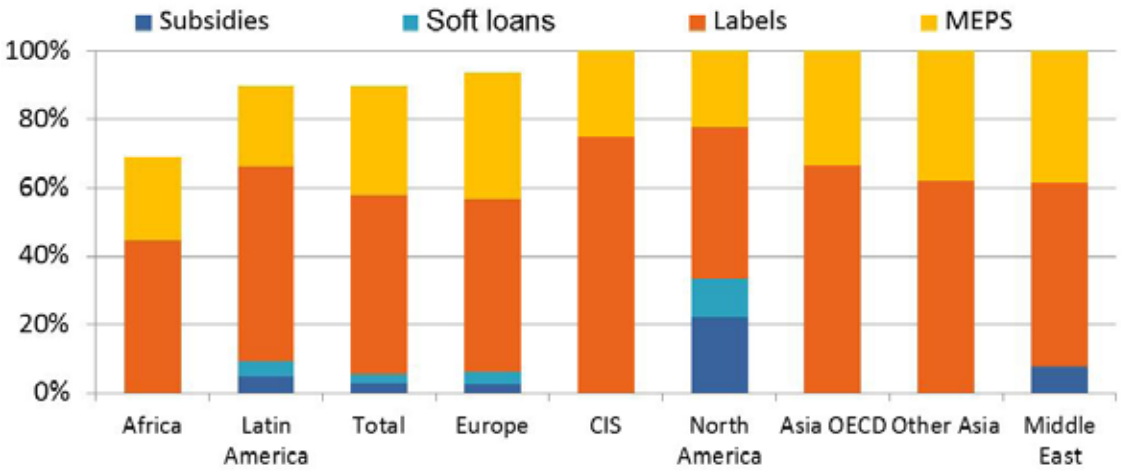
Country	Type of measures	Target
Mexico		1.8 million m^2 by 2012
India	Subsidies, investment grant	15 million m^2 by 2017 20 million m^2 by 2022
China	Subsidies	300 million m^2 by 2020
Taiwan	Subsidies	6 million m^2 by 2020
South Korea	Subsidies	342 ktoe by 2020 1,882 ktoe by 2030
Australia	Renewable energy certificates, tax credits, rebates, subsidies	12% of homes equipped with solar water heating by 2020

Air conditioning[126]

Air conditioning (AC) is an important use of electricity in both emerging and industrialised countries, particularly in the service sector.[127]

Traditional measures targeting AC include regulations (i.e. labels and MEPS) and financial incentives (subsidies and soft loans). Regulations to foster the adoption of efficient AC and to remove the least-efficient products from the market, or obligation of maintenance (e.g. all EU countries), have been promoted in many countries: labelling represents 45% of measures in the surveyed countries and MEPS 40%. Financial or fiscal incentives exist only in some countries (Figure 63).

Figure 63
Measures targeting air conditioning by type
Répartition des mesures pour les climatiseurs
Source: WEC ADEME survey 2012–2013



126 This section is adapted from a report prepared for ADEME and WEC by Prof. Luiz A Horta Nogueira (see: www.wec-policies.enerdata.eu/case-studies.php). Country case studies: Brazil, China, Ghana, India, Mexico, Thailand, Tunisia and the US.

127 In India for instance, the potential energy demand for air conditioning in Mumbai alone is about 24% of the entire US demand for the same end use (Sivak, 2009).

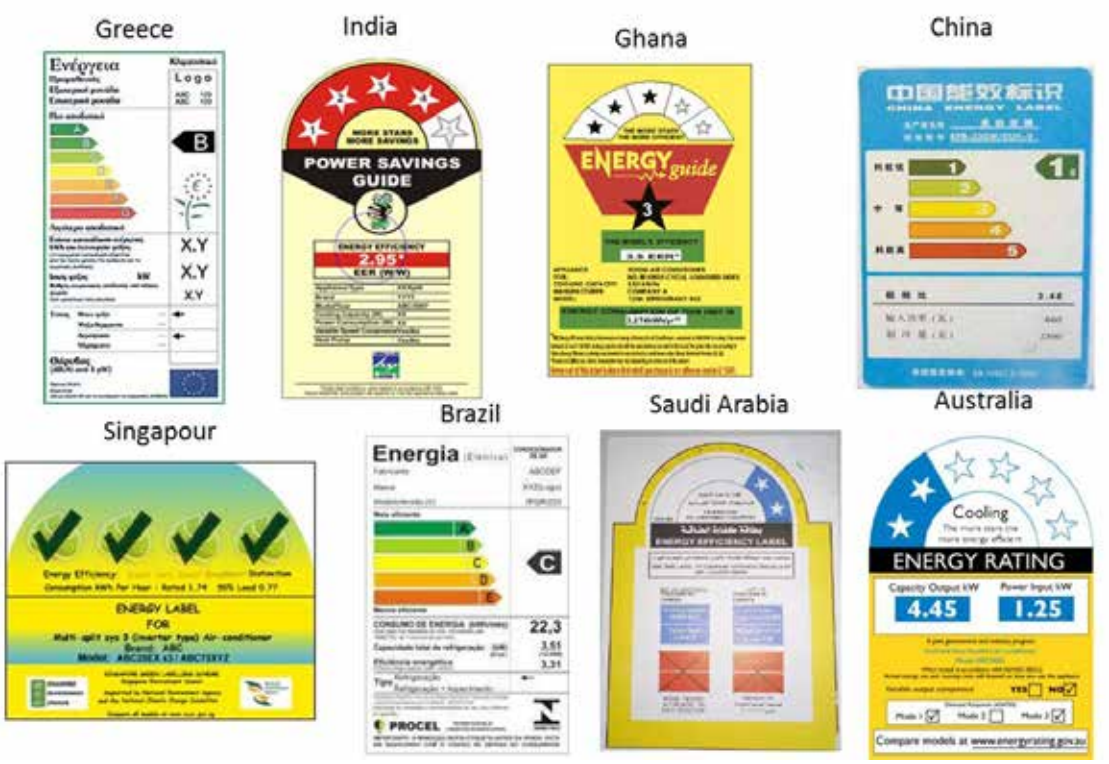
Labels are more oriented to customers, and represent key elements of the diffusion of energy-efficient equipment, while MEPS are more oriented to manufacturers. Labels for AC in the residential sector are mandatory in two-thirds of surveyed countries, and planned in 10 countries (see Figure 64). A relevant aspect of labelling programmes is how to promote adjustments in the certification criteria.[128]

Labelling has a greater impact when accompanied by a clear communication campaign. In India, a large marketing and information campaign on efficiency labelling was implemented and evaluated: the Bureau of Energy Efficiency (BEE) has set up an educational programme to educate salesmen on the AC star labelling concept and equip them with necessary sales tools to promote higher star-labelled appliances.

Figure 64
Labels for air conditioning in residential sector
Labels sur les climatiseurs dans le secteur résidentiel
Source: WEC ADEME survey 2012–2013

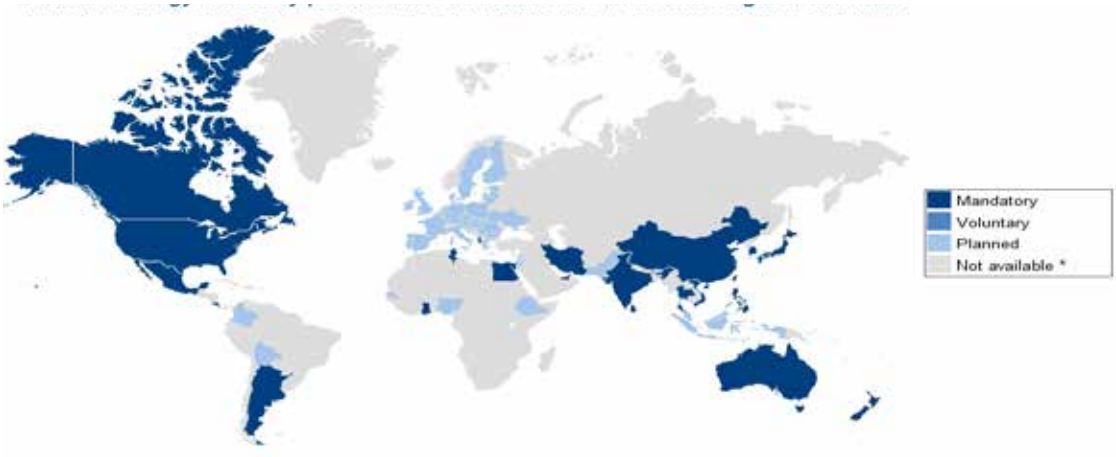
128 The approach adopted in Thailand was made available where they define different criteria for MEPs and the Energy Efficiency Label and MEPs Endorsement Label (Asawutmangkul, 2011).

Figure 65
Examples of labels for air conditioning
Exemples de labels sur les climatiseurs
Source: WEC ADEME survey 2012–2013



MEPS for AC in residential are mandatory in 25 countries (i.e. 30% of surveyed countries) and planned in 38 countries. MEPS are often linked to label classification (Figure 66).

Figure 66
MEPS for air conditioners in residential sector
Normes sur les climatiseurs
Source: WEC ADEME survey 2012–2013



More and more standards on AC are integrated in building codes and building certificates. MEPS and energy labelling for new buildings (and extensions to existing buildings) have a direct impact on AC loads.

General regulations applying to large buildings, such as mandatory audits or mandatory energy managers, also has an impact on electricity use for AC.

Financial or fiscal incentives can also be used to promote energy-efficient AC systems, such as direct subsidies in the US, or to scrap old AC systems, such as in Mexico and Greece. In the US, the Federal Tax Credits for Consumer Energy Efficiency were oriented to finance energy efficiency, including the installation of efficient AC.[129] In Mexico, incentives for scrapping old AC units were promoted, based on labelling and MEPS programmes. In total, more than 341,000 AC units were replaced.

energy-savings in AC systems can be implemented before the AC system is installed and during the installation by energy-efficient architecture and proper selection of equipment and controls like MEPS or technology procurements.

It can also be achieved after the systems have been installed, during operation and maintenance. Measures such as information campaigns can target behavioural change and help achieve energy efficiency. Demand response approach can also limit the use of air conditioners at peak time. Other measures consist of indoor temperature limitation, as in Tunisia, with a regulation in public buildings, or in Japan where further electricity restrictions are limited (including AC use in public buildings).

The main recommendations stemming from the eight case studies[130] on AC are:

- Reinforce the information and database on AC systems (number of units, operation conditions, consumer behaviour.
- Develop regular evaluation of energy efficiency and the impact of energy-efficiency programmes (allowing benchmarking).
- Promote the improvement and harmonisation of AC energy-efficiency certification and standards (e.g. introduction of the seasonal energy efficiency ratio).
- Promote the integrated approach of AC systems and building energy-efficiency programmes.
- Implement education and consumer information programmes oriented for rational use of AC systems.

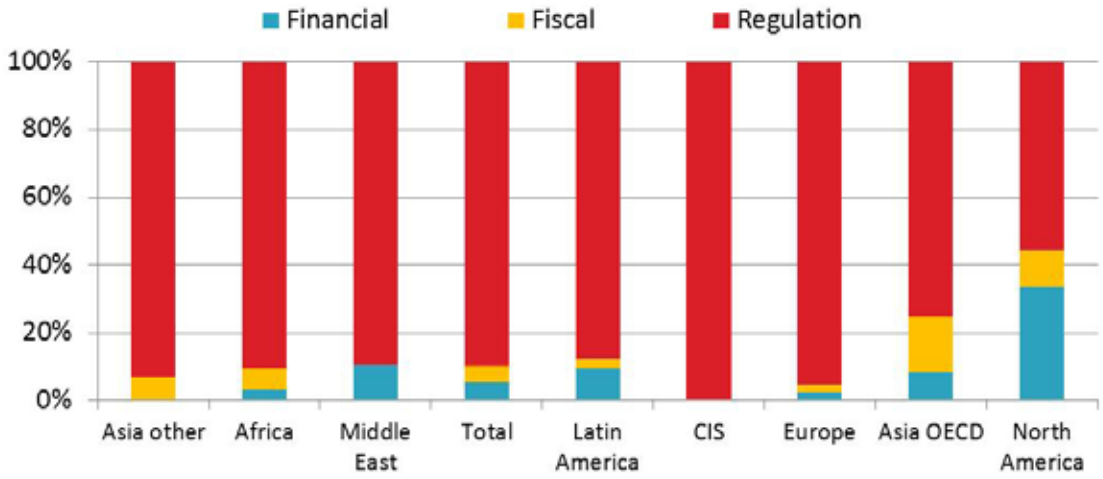
Appliances and lighting

Regulations on electrical appliances are dominant in most countries. Indeed, to slow down or even reverse the trend in the electricity consumption of households, many countries have introduced **labelling programmes** and **MEPS** for a selection of electrical appliances.

129 In line with the federal tax credits, the Tax Incentives Assistance Project, sponsored by a coalition of public interest, non-profit groups, government agencies and private organisations, was created in 2005, aiming to give consumers and businesses information to access federal tax incentives for energy-efficient technologies.
130 See report on http://www.wec-policies.enerdata.eu/case-studies.php

Financial or fiscal incentives (i.e. subsidies or tax reduction) for efficient appliances are less common (Figure 67).

Figure 67
Measures on electrical appliances*
Mesures sur les équipements électriques
Source: WEC ADEME survey 2012–2013
Note: *Includes lighting



Labelling programmes are designed to provide consumers with information, which enables them to compare the energy efficiency of different appliances. Labels aim at modify consumers' selection criteria 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.

Most countries started by focusing on refrigerators. But now labels cover a greater number of equipment: lamps and lamp ballasts, washing machines, dryers, dishwashers. Some countries have labels for a large number of appliances: e.g. there are nine appliances with labels in EU country, more than 10 appliances in Canada, China, Brazil, South Korea, Costa Rica or Chile, and up to 19 in the US.

Mandatory labelling of electrical appliances exists in 54 countries globally. Five countries also have voluntary labels[131] and 12 countries are planning their introduction.[132] Mandatory labels have proven to be more effective than voluntary labels since they require manufacturers to put labels on all appliances and not just on the most energy-efficient ones. More and more 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[133] (Figure 68).

131 Voluntary labels exist in Peru, Lebanon, Nigeria, Pakistan and Yemen, depending on appliances and sectors.
132 Labels are planned in countries such as Ukraine, Bolivia, Sri Lanka, Jordan and Ethiopia.
133 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.

In most developing countries, secondhand appliances take a large market share of the appliances sold, which reduces the impact of labelling that is restricted to new appliances.

Figure 68
Examples of energy labels
Exemples d'étiquette énergie

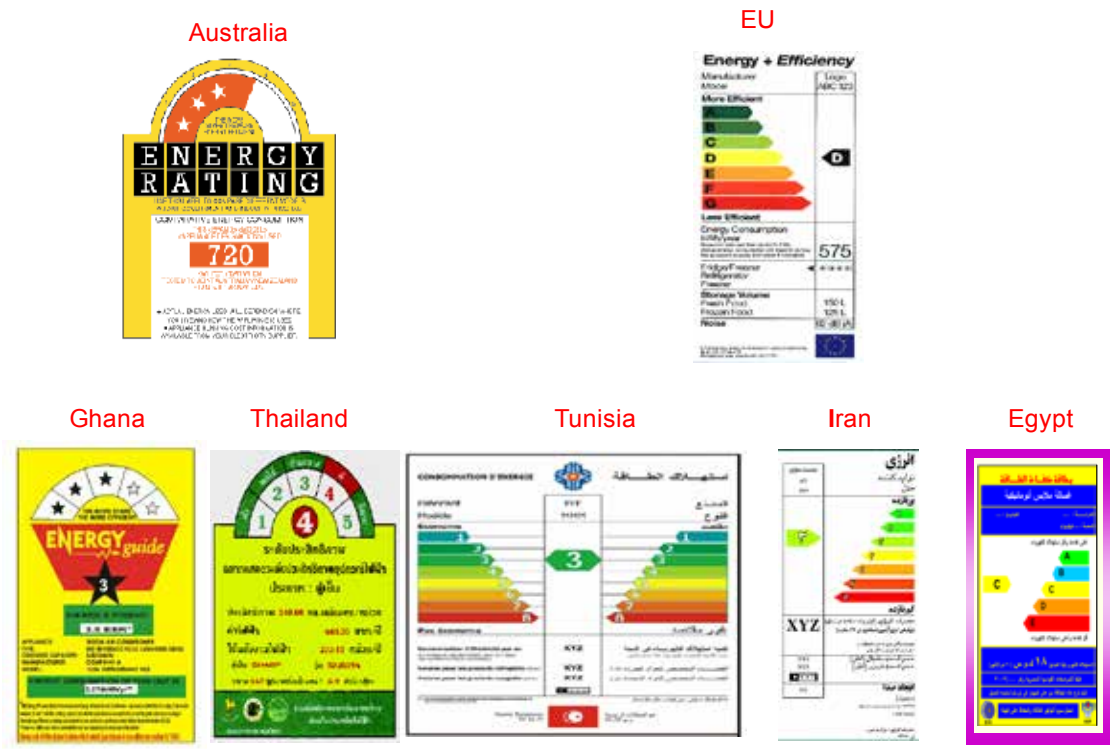
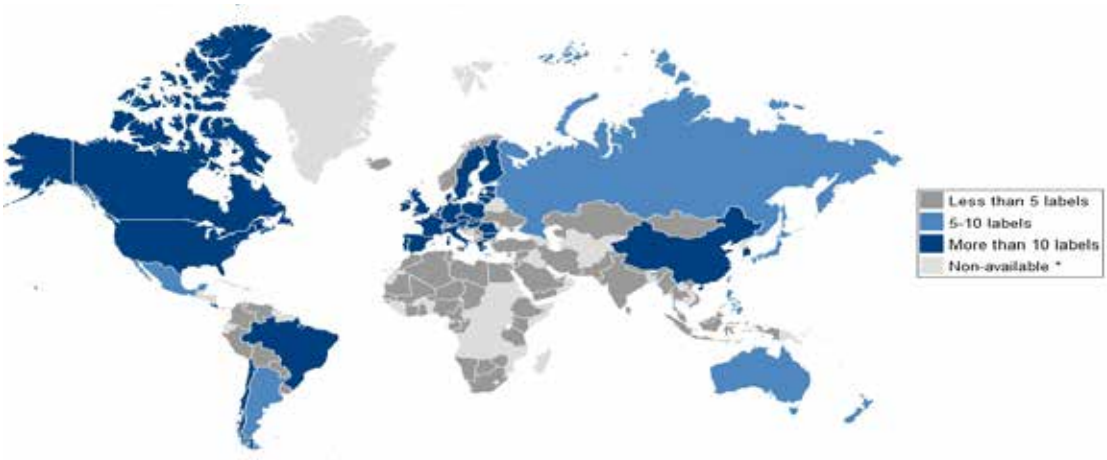


Figure 69
Number of mandatory labels in residential sector
Nombre de labels obligatoires dans le secteur résidentiel
Source: WEC ADEME survey 2012–2013



Labelling programmes alone cannot transform the market and are usually complemented by **MEPS** 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, or by requiring sales-weighted average energy-efficiency improvements ('target values' – for example, the Top Runner Programme in Japan). Target values are more flexible as they allow the sale of less-efficient equipment, provided that other models with a higher efficiency rating are also offered for sale.

Around 70% of surveyed countries have implemented a phase-out of incandescent lighting (Figure 70), and CFLs have gained wider consumer acceptance in recent years.

Many economies are also beginning to implement standards for light-emitting diode (LED) performance, quality, and safety. While LEDs may offer significant additional savings as their market share increases, current costs and efficiencies do not make them cost effective for most lighting applications. These developments change the lighting market as a whole, but often include a leadership role for the public sector through the use of efficient lighting in public facilities, spaces and infrastructures.

Figure 70
Incandescent lamp phase-out
Pays interdisant les lampes incandescentes
Source: WEC ADEME survey 2012–2013

As an alternative to the regulatory process, there are also **agreements with appliance manufacturers** (voluntary or negotiated), which aim to improve the energy efficiency of appliances.[134] Some countries have 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 corresponding to genuine additional efforts from industry.

134 This was the case in EU countries for washing machines (voluntary agreement with CECED).

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 consumers' selection criteria totally excludes energy efficiency (television sets, for example). 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.

Labelling programmes and performance standards are effective instruments, which enable authorities to obtain energy savings at a low cost for the public budget, allow consumers to spend less on electricity, and encourage 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 consumers, as producers were able to adapt and to benefit from the increased sales ('learning effect') and there is no correlation between the price of appliances and their energy ratings.

To be effective, labelling programmes and MEPS must be regularly revised and upgraded as a way of stimulating technical progress and ensuring a steady improvement in energy efficiency. However, in practice, the process can be too long and delayed.[135] The Top Runner programme has been designed to integrate the dynamic aspect of regulations and make it easier to define 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.

Subsidies or tax incentives, even if they are marginal, promote energy-efficient households appliances in some countries such as: in Hungary the replacement programme of electrical household appliances (2009 sub-programme of the Green Investment Scheme), the Maltese scheme whereby a number of CFLs would be made available free-of-charge to every household (2010); in Bulgaria, measures providing credits for purchasing energy-efficient electrical appliances (2012), with a budget of €276 million until 2020; energy premiums (bonus/malus) in the Netherlands and Czech Republic for white goods; or labels combined with eco-point systems in Belgium, South Korea and Japan.

For CFLs, a large number of developing countries have implemented diffusion programmes of free CFLs to household consumers, often with the support of international investors.

Though standby power consumes less energy than other end-uses (such as lighting, laundry, or refrigeration), there is a large coverage gap for standby power.[136] Though many economies have standards and labels in place on a product-by-product basis, there are very few with 'horizontal policy' for standby power across all products: there is a label in Argentina and MEPS in the EU, Canada, and Australia. By making these provisions horizontal across products it avoids regulatory gaps caused by delays in the regulation process or when the standby power consumption of the many small electrical appliances does not justify a dedicated regulation.

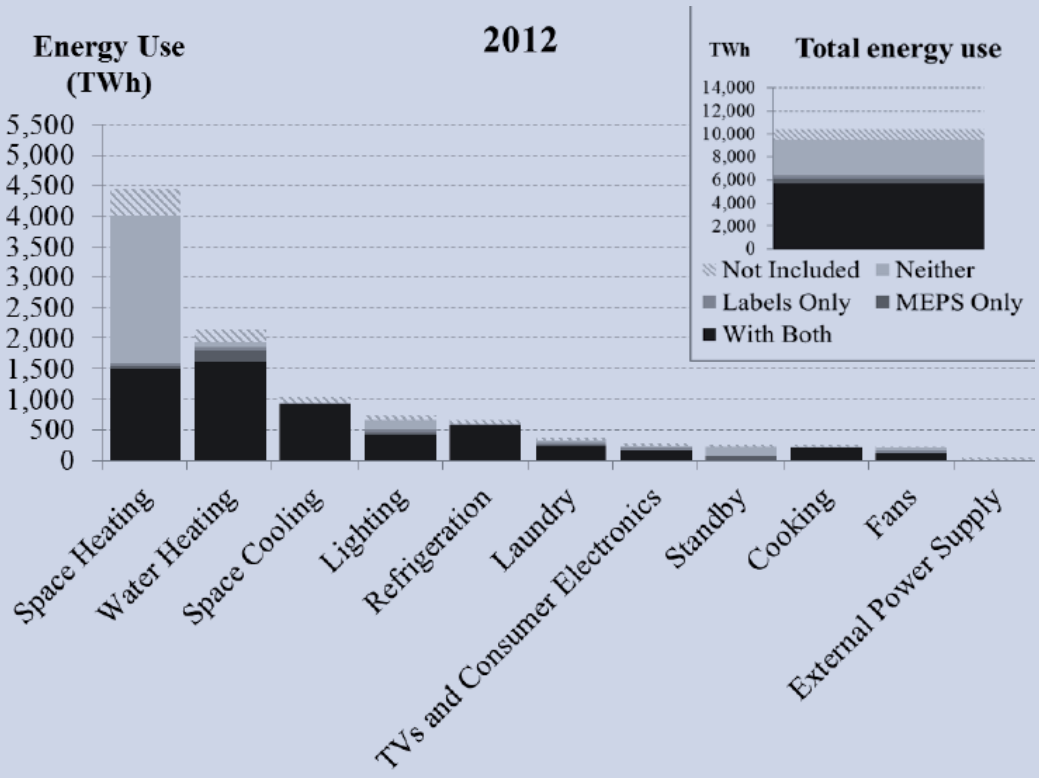
135 For instance, the duration of the ecodesign and energy labelling measures process in EU is long and has increased from 34 months for the first measure published in 2008 to an average of 76 months for the three measures published in 2012.

136 Section adapted from Clasp report, see Box 5.

Box 5: Global assessment of energy-efficiency standards and labels – CLASP

In the residential sector, for the 43 economies covered by the CLASP standards and labels database, over two-thirds of appliance energy use is covered by either MEPS or a label. Out of nearly 9,500 TWh of energy use from all product categories in 2012, 5,800 TWh is covered by both MEPS and labels, and an additional 700 TWh by only one or the other.

Figure 71
Energy use of CLASP residential products in 2012 according to standards and labels distribution
Source: CLASP



Innovative smart billing[137]

Most residential consumers in Europe receive estimated bills which are adjusted once a year on real household consumption. Typically, they are sent three to four times a year. The difference between the estimated average consumption and the actual usage is made up at the end of the billing period or when a resident changes electricity supplier. They therefore do not accurately reflect the actual usage for a given month and leave consumers little room to track the impact of change in their behaviour.

137 This section is adapted from a report prepared for ADEME and WEC by J Stromback and C Dromacque from VaasaETT, Case Study on Innovative Smart Billing for Household Consumers (www.wec-policies.enerdata.eu/case-studies.php). Country case studies: US (California); Ireland; Sweden, Australia (Victoria); United Arab Emirates (Abu Dhabi); Chile; South Africa and Hong Kong.

Smart bills on the other hand will invoice for the actual consumption and provide additional information that can help to initiate more sustainable and efficient consumer behaviour. Informative bills can be sent as frequently as once a month: they have an advantage over other feedback channels because of the fact that every customer will at least glance at their bill. Also, although this is changing, for the vast majority of customers, their only contact with their utility is through their bill. Energy bills therefore seem like a sensible channel to promote energy efficiency to every household.

As an example of a smart billing programme, the Sacramento Municipal Utility District in California offered an information programme to help customers manage their electricity consumption by providing reports comparing their electricity use to that of other similar households. In Ireland, the Commission for Energy Regulation (CER), established the Smart Metering Customer Behaviour Trials as part of the much larger smart metering technology trial which is one of the largest and most comprehensive in Europe.

The Energy Efficiency Directive implemented in Europe includes requirements in relation to smart billing (article 9-11) as well as provisions which relate to the roll-out of smart meters in member states.

The main impacts of smart billing programmes are:

- Improvement in awareness of energy consumption.
- Reduction in energy consumption and in energy bills.
- Cost effectiveness.
- Improvement in customer relationship with their utility: in competitive markets, utilities that offer households solution to manage consumption and reduce energy expenditure should be better placed to stop consumers from switching to another retailer and to attract new ones. In non-competitive markets, the industry's image may improve.

The main findings stemming from the eight case studies[138] are:

- Smart bills can be a cost-efficient and effective way to promote energy-efficient behaviour to an entire customer base and hence reduce energy consumption.
- Smart metering will not necessarily result in smart billing or any other feedback programmes unless supported by adequate regulation.
- A few simple elements can greatly improve traditional bills and provide useful actionable insights to household consumers.
- Although quality and insights are greatly improved by the data granularity enabled by modern metering systems, effective smart bills can also be implemented with traditional metering.
- The most advanced and best cases of smart bills are to be found in countries with both enhancing technology and supporting regulation.

138 US (California), Republic of Ireland, Sweden, Australia (Victoria), United Arab Emirates (Abu Dhabi), Chile, South Africa and Hong Kong.

Some building blocks of smart billing have proven effective and should be made mandatory. These elements include:

1. Normative energy use comparison.
2. Tips and advice on how to reduce energy use.
3. Tips and advice as to how benefit from time-of-use (TOU) tariffs or other types of dynamic tariffs.
4. Historical consumption data in order to track progress.
5. Where energy is subsidised, the real cost should be mentioned.
6. Indicate the different elements of the bill and who is responsible (retailer, distribution system operator, state)
7. Show pollutant emission associated with billed energy consumption.

Numerous countries are upgrading or contemplate upgrading their metering system at massive costs which, one way or another, will fall on end-users. Many countries facing increasingly difficult-to-manage spikes in electricity consumption rightfully see dynamic prices as one solution and are trying to promote them to residential consumers. Nevertheless, smart meters alone do not bring about consumption reductions and mandatory TOU tariffs can have a disproportionate negative impact on people who have no choice but to remain at home all day. End consumers need to be informed about the meaning and advantages of dynamic tariffs and how to benefit from them. This does not come naturally. Supporting regulation should ensure that feedback and education requirements (i.e. through smart billing) are an integral part of any smart meter or residential dynamic pricing policy package to ensure that all consumers are able to benefit financially and otherwise.

Good practices in the public sector

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

Benefits of improved energy efficiency in the public sector include lower energy bills and the public sector's exemplary role compared to other sectors. For example, in Europe, such a leadership role for the public sector is mandated by various directives.[139] A similar role for the public 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 market demand.

Public sector activities and operations cover multiple end-use sectors – from buildings to transport and housing, infrastructure and service provision. Such a variety of activities offers multiple opportunities for energy savings, varying with different activities, but which can

139 The Energy Efficiency Directive (2012/27/EU) and a recent recast of the Energy Performance in Buildings Directive (2010/31/EU).

reach up to 20–30%. Available measures include both simple, low-cost measures, such as lighting, and more complex actions linked to building retrofits.

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 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).

A major part of public sector energy use is in public buildings (offices, healthcare and educational facilities, public housing) for lighting, heating, cooling and ventilation as well as equipment (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 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 policies targeting the public sector have been drawn up for years, this sector is often not analysed as a separate entity. 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– 5% of total final energy consumption,[140] 2–10% of the energy consumption of buildings and 10–20% of the consumption of the service sector consumption.

Public sector buildings provide multiple opportunities to demonstrate and disseminate information about energy-efficiency measures. They can serve as flagships of public sector leadership in promoting energy efficiency.

Some countries have national energy-efficiency programmes with quantitative targets for the public sector. This is the case, for instance, in some EU countries (e.g. France, Slovenia, and Spain) and several emerging countries (e.g. Philippines). The Energy Directives in the EU have specific provisions on the public sector with specific targets for public buildings: 3 % per year of floor area owned or occupied by central governments should be renovated with minimum energy requirements according to the directive on energy efficiency adopted in September 2012; in addition, all new buildings occupied and owned by public authorities should be nZEB from 2019 according to the building directive.

Public purchasing and 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. Billions of dollars are used in the public sector to purchase energy-using products and services every year. Having energy-efficiency requirements for office equipment, lighting systems and white goods purchased through public procurement can achieve notable savings and greatly facilitate

140 In Germany, local authorities (municipalities) account for 60% of public sector energy consumption, whereas the central (Federal) and regional (Lander) governments have a similar importance with 18% each (Ringel, quoted in ECS, 2008).

the market expansion for energy-efficient appliances.[141] 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 the lower-lifecycle costs of energy-efficient equipment.

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 regulatory framework was 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 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.

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.[142]

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. In this respect, the US experience with the Leadership in Energy and Environmental Design (LEED) rating system is an example. 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.

In addition to building lighting retrofits, efficiency gains are available in the area of public lighting, including both street lighting and traffic lights. New technologies such as LED can deliver significant savings with 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. 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. Consequently, lighting programmes are often successful in less-developed countries which might lack the institutional and financial capacity to implement wider-scale programmes. For example, Uruguay banned the purchase of incandescent bulbs in the public sector in 2008, and this is expected to spread to other sectors once public leadership has established sufficient experience.

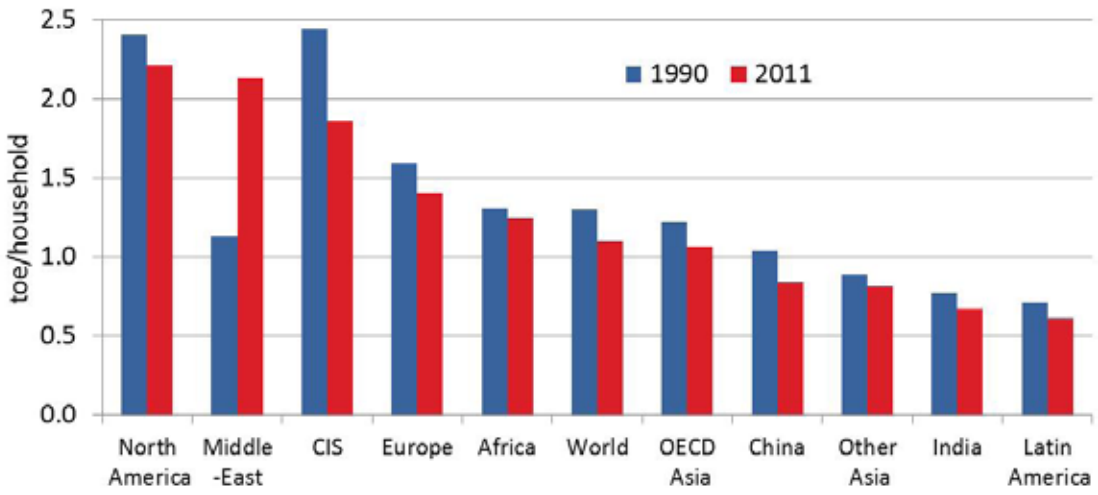
141 For example in the US, early action by the federal government to procure only Energy Star labelled computer equipment and printers resulted in a rapid market shift to more energy-efficient appliances, as manufacturers were keen to maintain their share of the $10bn annually spent on energy-using products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

142 Leased office spaces above 2,000 m^2 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.

Energy-efficiency trends in buildings

In the residential sector, there is a decreasing trend in the average amount of energy consumed per household (-0.8% per year at world level), except in the Middle East where AC is driving energy use (Figure 72). In OECD countries, the main driver is energy-efficiency improvement for space heating and appliances obtained, thanks to the implementation of tightening building codes and MEPS for appliances. In emerging countries it is mainly due to the substitution of biomass with modern fuels.

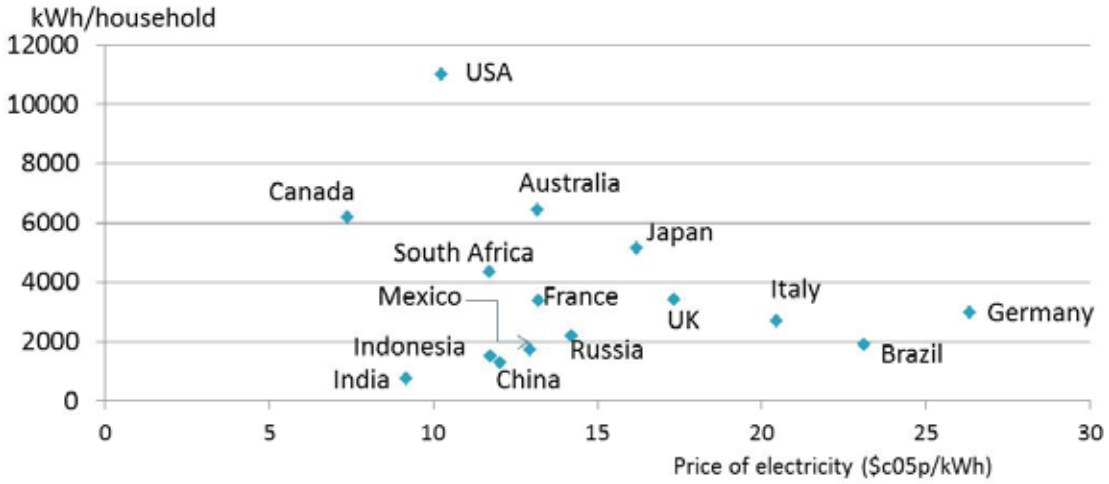
Figure 72
Energy consumption per household
Consommation d'énergie par ménage
Source: Enerdata



A comparison of electricity consumption per 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.

The average consumption of electricity per household is very diverse depending on the level of ownership of electrical appliances. For OECD countries, where equipment rates are quite homogeneous, the higher the price, the lower the electricity consumption per household. However, there is still a large range of values for similar price levels, from a value of around 3,000 kWh/household for European countries to around 6000 kWh in OECD Asia and Pacific, and around 10,000 kWh in North America (Figure 73).

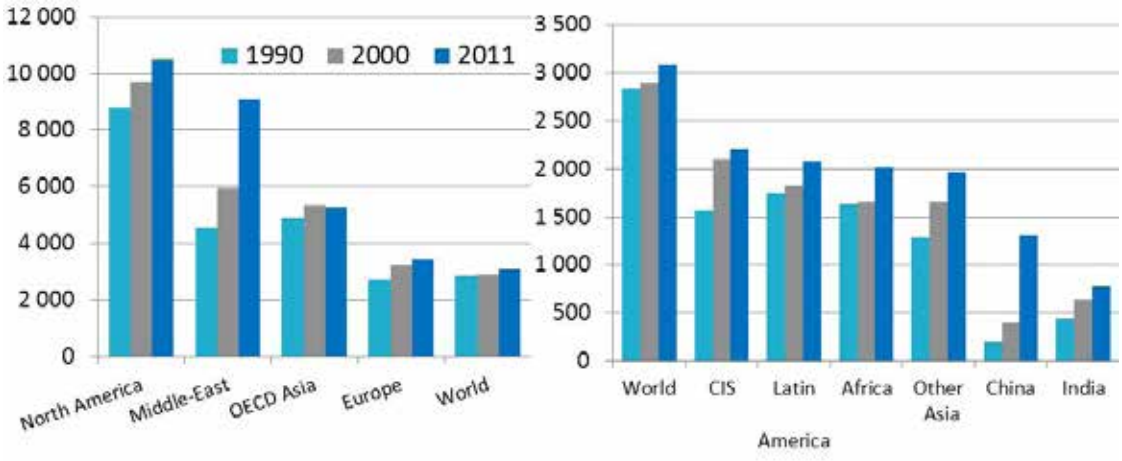
Figure 73
Household electricity consumption per electrified household* and price
Consommation d'électricité par ménage électrifié et prix d'électricité
Source: Enerdata
Note: *Excluding space heating



In emerging countries, the much lower values of specific consumption are explained by the low ownership of large appliances (e.g. refrigerators, washing machines). This specific consumption per electrified household is less than 1,000 kWh for India and around 1,300 kWh in China.

There is an increasing trend in almost all regions due to new equipment penetration (AC, office equipment), implying more and larger equipment per household (Figure 74). However, there is a lower growth since 2000 in Europe and Asia OECD thanks to policies implemented.

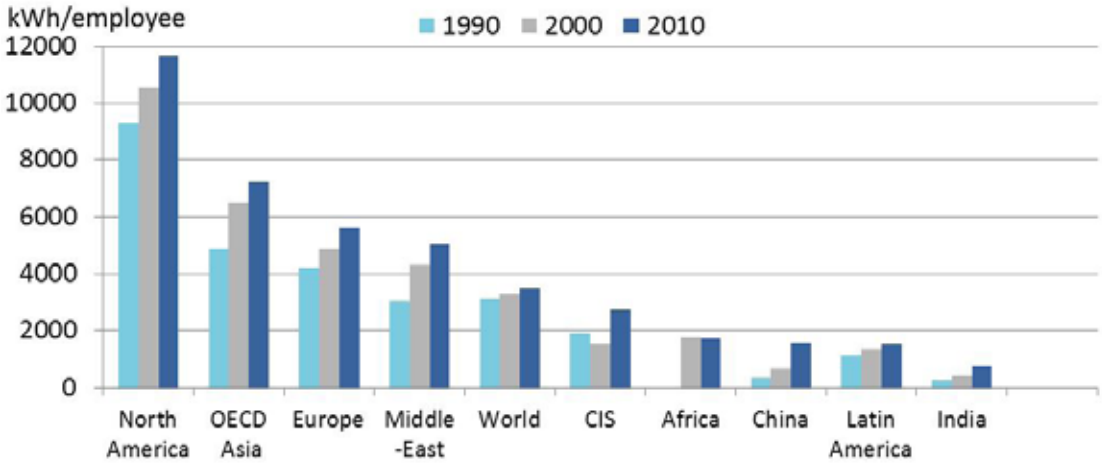
Figure 74
Consumption for electrical appliances* per electrified household (kWh/household)
Consommation des appareils électriques par ménage électrifié (en kWh/ménage)
Source: Enerdata
Note: *Excluding space heating



In the services sector (public administration, commerce and other service activities), the main source of energy used in developing countries is electricity. Therefore, the focus here will be on electricity.

The quantity of electricity required to generate one unit of value added (the electricity intensity) is increasing in most regions. This trend is mainly linked to the development of ICT and air conditioning. And there is no sign of slowdown in OECD countries. There is still a large discrepancy among countries: from around 12,000 kWh/employee in North America to 800 kWh/employee in India (Figure 75).

Figure 75
Electricity consumption per employee in services
Consommation d'électricité par employé dans le tertiaire
Source: Enerdata

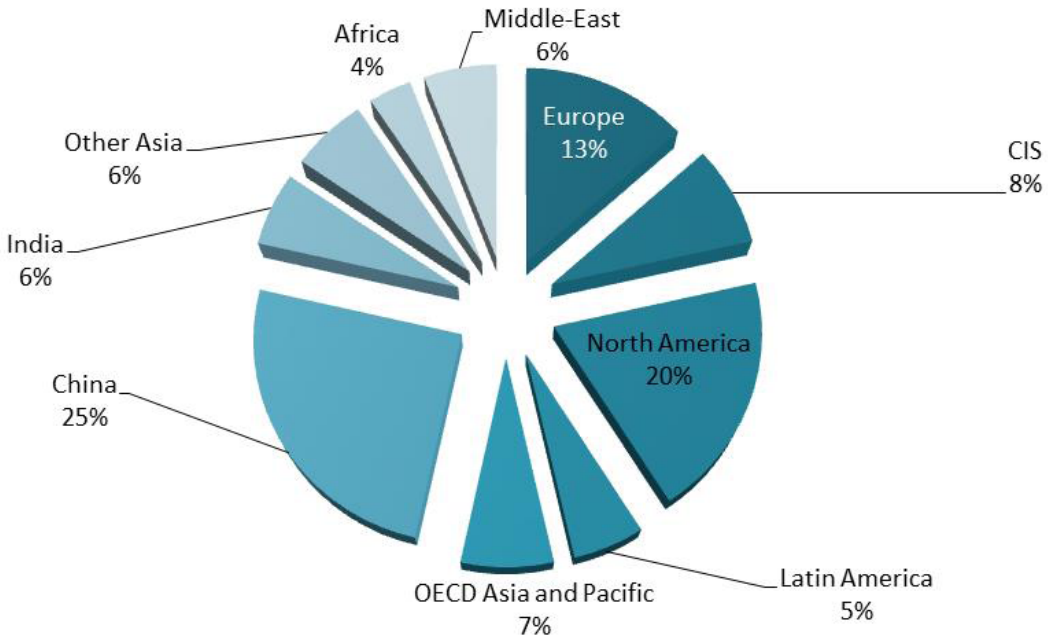


8

CO_2 emissions from energy combustion

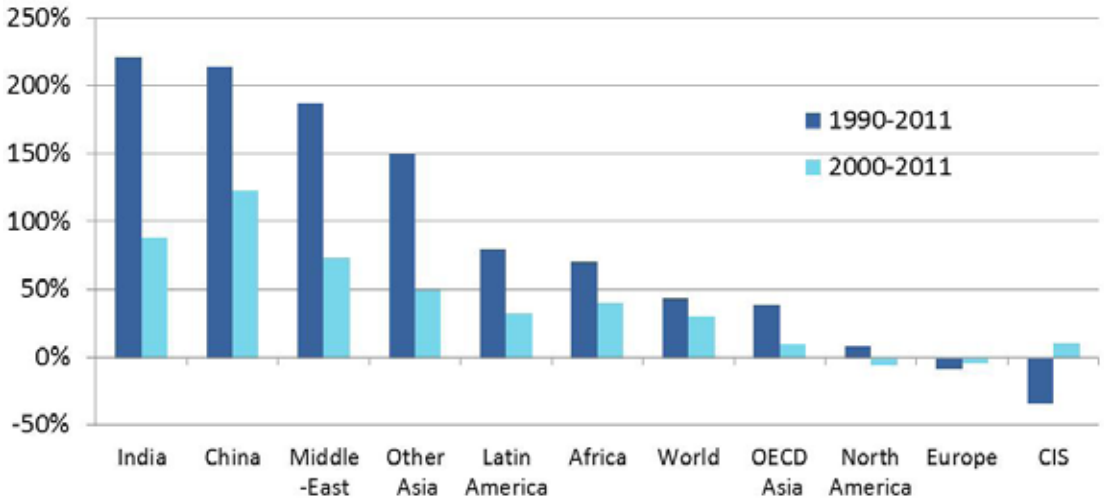
North America, Europe, CIS, Asia and Pacific OECD together still account for slightly less than half of total world CO_2 emissions from energy combustion in 2011, whereas they only represent one-fifth of the population. However, their role is decreasing rapidly, from almost 75%of total emissions in 1990 to 65% in 2000 and 48% in 2011. Since 2008, China has become the largest emitter ahead of the US with 25% of total emissions, up from 11% in 1990. The top five emitters of energy-related CO_2 emissions, China, US, India, Russia and Japan, represented 58% of world emissions in 2011 (Figure 76). The top 10 emitters, including Germany, South Korea, Iran, Canada and Saudi Arabia made up slightly more than two-thirds of world emissions that year.

Figure 76
Distribution of world CO_2 emissions from energy use (2011)
Répartition des émissions de CO_2 mondiales liées à l'énergie
Source: Enerdata



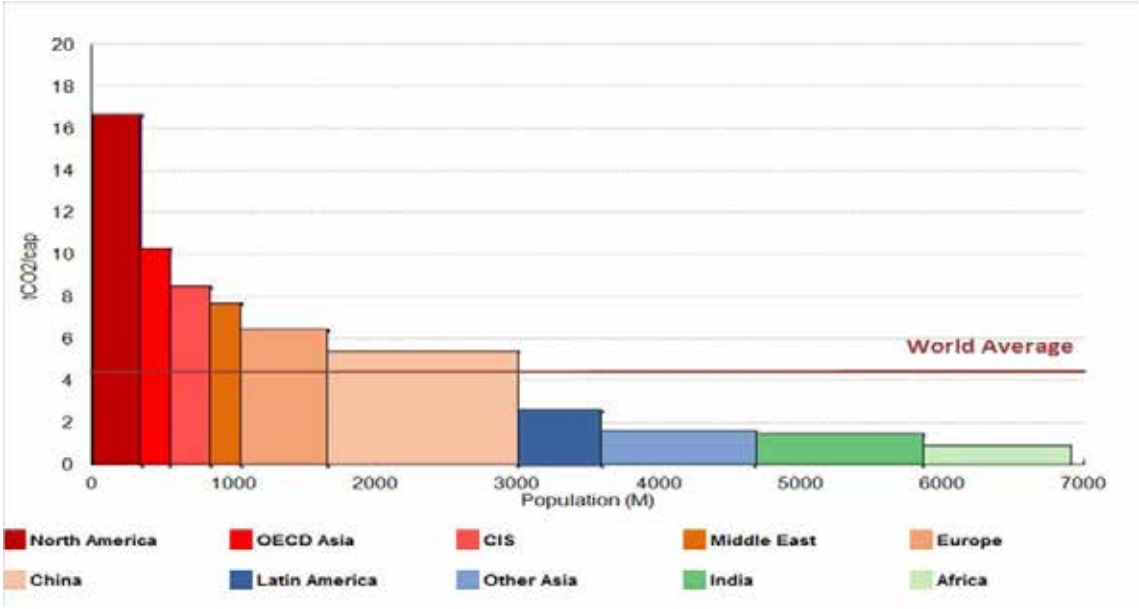
CO_2 emissions from energy use have increased by 40% at world level since 1990 (Figure 77). Trends in CO_2 emissions vary significantly between countries: the Middle East, China and India have registered a very rapid increase because of their high economic growth, with a tripling in China and India. There is a reverse trend in Europe, where the level of these emissions in 2011 was 8% below their 1990 level, i.e. in line with the Kyoto target for GHG, thanks to strong climate-change policies, and also because of the slowdown of economic growth. There is a low increase in North America with an 8% reduction since 2007 due to the effect of shale gas. In China and at world level, there has been a more rapid increase since 2000.

Figure 77
Variation of CO_2 emissions from energy use
Variation des émissions de CO_2-énergie
Source: Enerdata



There are very diverse levels of energy-related CO_2 emissions per capita: a factor of 20 between North America and the less-developed regions (Figure 78). More precisely, CO_2 emissions per capita are around 1tCO_2/cap in the less-developed regions such as Africa, less than 2t in other Asia and India, around 5.5t in China, 6t for Europe, 8t for the Middle East and the CIS, 10t in Asia and Pacific OECD and nearly 17t in North America.

Figure 78
CO_2 emissions per capita from energy combustion[143]
Emissions de CO_2-énergie par habitant
Source: Enerdata

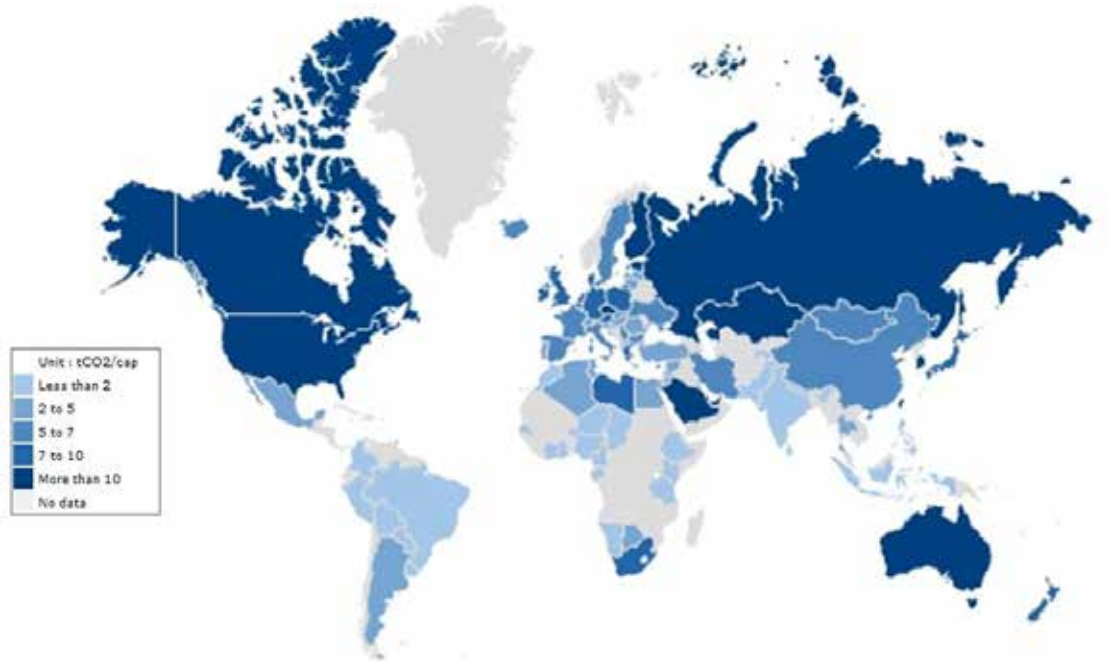


143 The size of coloured area represents the total emissions of countries or regions.

About 50 countries in the world have a level of emissions per capita above the world average, i.e. 4.2tCO_2/cap (Figure 79). About 20 countries have low emissions, below 1.2t, of which 10 are sub-Saharan African countries. Slightly less than 40 countries are above 7t, i.e. the European average. In total, 27 countries have high emissions, above 8.5t (the CIS average), of which 14 have very high emissions, above 15tCO_2/cap, including mostly countries with abundant energy resources, such as Saudi Arabia, Canada, the US and Australia.

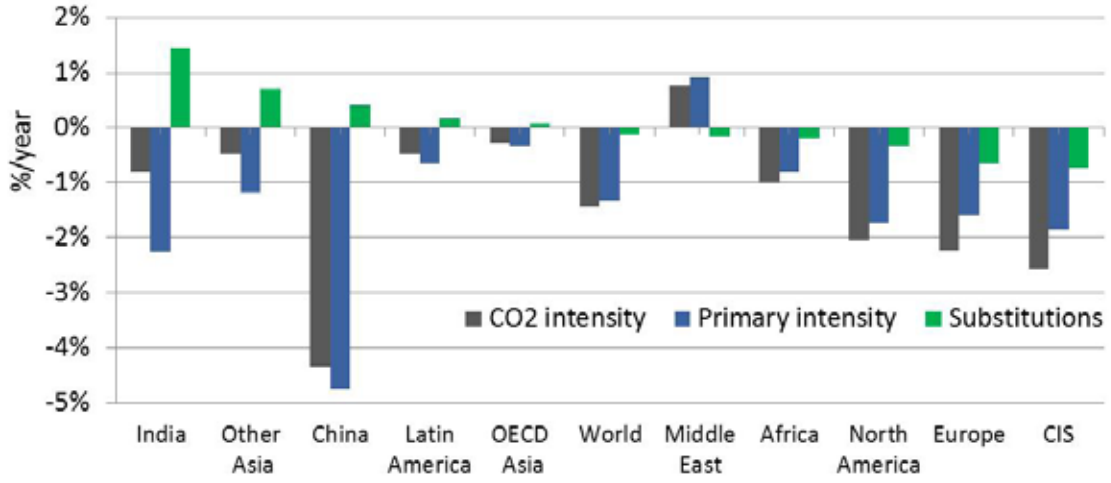
At world level, CO_2 emissions per capita increased only moderately (+10% since 1990). There was even a slight decrease between 1990 and 2000, followed by a progression by 14% between 2000 and 2011, even if the economic crisis had a significant impact in 2009 (-3%). This is the result of two opposite trends: a rise of CO_2 emissions per capita in most regions, and a decrease in Europe, CIS (until 1998) and North America (since 2000). The largest progression took place in China and India (multiplied by a factor of 3 and 2.5 respectively) and the Middle East (+75%), due to the high economic growth in these countries.

Figure 79
CO_2 emissions per capita from energy combustion (2011)
Emissions de CO_2-énergie par habitant
Source: Enerdata



There is a reduction in CO_2 intensity all over the world except in the Middle East. And most of this reduction was driven by energy-intensity decrease: up to 80% in Africa, North America and at world level; and 70% in Europe (Figure 80). Fuel substitutions contributed to the rest of the variation. In Asia and Latin America, substitutions to fuels with higher CO_2 content (e.g. coal) have offset part of the energy-intensity reduction.

Figure 80
Variation in CO_2 intensity (1990–2011): impact of energy efficiency and fuel substitutions
Variation de l'intensité en CO_2 (1990–2011): impact de l'efficacité énergétique et de la substitution d'énergie
Source: Enerdata



9

Conclusion and recommendations

Overview

Energy efficiency is the win-win strategy to meet a variety of policy objectives, in terms of security of supply, climate change, competitiveness, balance of trade, reduced investment to meet growing energy needs in emerging countries, and to address local pollution. In addition, by lowering the energy bills of consumers it lowers their vulnerability to price increase or supply disruptions and also improves economic competitiveness in industry by reducing manufacturing costs. For some groups, especially vulnerable populations, it can reduce poverty or improve living conditions. Finally, an energy-efficient asset, whether a factory or building, has a higher asset value and improved working and living conditions. Although beneficial to all of society, energy-efficiency improvements are often held back by market, financial and institutional barriers.

There is an increasing number of countries that adopt national energy-efficiency programmes with quantitative targets. The adoption of energy-efficiency laws or energy laws with a strong component related to energy efficiency is a growing approach to reinforce the institutional setting for energy efficiency. Energy-efficiency agencies are increasingly recognised as necessary instruments to foster the implementation of energy-efficiency policies.

Regulations are widely used, in part because they have been proven effective in lowering energy consumption of specific appliances and equipment and to speed up the diffusion of energy-efficient equipment, energy savings investments and practices.

Economic incentives aim at encouraging investments in energy-efficient equipment, buildings and processes by reducing the investment cost, either directly (financial incentives) or indirectly (fiscal incentives). Because of constraints on public budgets, there is an increasing involvement of the private sector in supporting investments in energy efficiency, through energy service companies (ESCOs) and energy utilities. Energy-savings obligations are an innovative measure in which energy companies have a legal obligation to undertake energy-efficiency activities with their customers.

As a result, thanks to the implementation of all these initiatives, the primary energy intensity has been decreasing in all regions, except the Middle East. In this region, energy consumption has always been increasing faster than GDP, mainly because of a rapid development of energy-intensive industries and use of air conditioning.

Energy-efficiency policies and trends by sector

The general trend in **industry** is towards a decrease in the energy required per unit of value added (industrial intensity), except in the Middle East. However, since 2000, because of the global crisis, there is a net slowdown in the intensity reduction in most regions and at world level. Trends in these energy intensities are influenced by energy-efficiency improvement at the level of each individual branch (e.g. steel, chemicals, non-metallic minerals) as well as by changes in the structure of the industrial value added. Indeed, industry sectors span a wide variety of sub-sectors with different energy intensities. Policies to improve energy efficiency in industry are designed to allow flexibility across a number of differing industry needs. The implementation of energy-efficiency measures has to take into account the worldwide competitiveness dimension, especially during economic global crisis. Industrial energy-efficiency policies are also focusing more on flexible instruments, such as voluntary agreements, rather than on regulations.

Transport is widely recognised as one of the most difficult sectors for improving energy efficiency and slowing energy demand growth. Transport energy intensity is decreasing over time in most regions and at world level, which means that the energy consumption of transport is growing much slower than the GDP. In OECD countries, the reduction in the energy intensity of transport is due to the combination of two main drivers: lower growth of car ownership and traffic, due to saturation, and rapid improvement in the energy efficiency of new cars linked to the policy measures implemented.

In China and India, the strong decoupling of transport consumption and GDP is due to the dominant role of rail transport and the lower diffusion of cars. Even if the average fuel efficiency of passenger vehicles is expected to decrease in emerging countries during the next decades, these gains will be offset by the increasing stock of cars. In addition to labels and mandatory fuel efficiency and CO_2 standards, countries should put in place policies to improve the performance of non-engine components that affect vehicle fuel efficiency (e.g. tyres for which labels have been recently implemented in Europe, air conditioning and lighting).

Governments should continue to enforce measures such as labelling, incentives and taxes to encourage the sale of more efficient vehicles and trucks. Energy use in road-freight transport has dramatically increased in both OECD and non-OECD countries and forecasts are not expecting to reverse this trend, thus current measures targeting transport companies are insufficiently addressed by policies. Few countries have implemented regulations for transport companies such as mandatory audits, energy managers, energy consumption reporting, energy savings plans or eco-driving.

There is a general trend of modal shift to more road transport, due to a strong preference for individual mobility and greater flexibility: therefore, tapping the full potential for energy demand reduction is beyond the usual energy-efficiency policy measures, and should focus on modal shift and infrastructures development.

Residential and non-residential buildings represent the largest end-use sector and the key target for energy efficiency. Final energy consumption of buildings has increased at world level by around 1% per year since 2005 and by 3% per year for electricity. There is however a decreasing trend in energy consumption per household (-0.8% per year at world level).

In OECD countries, the main driver is energy-efficiency improvement for space heating and appliances, thanks to the implementation of tightening building codes and minimum energy performance standards (MEPS) for appliances. In emerging countries it is due to the substitution of biomass with modern fuels. Building codes are becoming more widespread (new building). In OECD countries, there are multiple financial incentives, mostly offering loans at low interest rates, often combined with grants, to retrofit existing buildings.

Electrical appliances are largely targeted by policies: the most common measures is labelling, with an increasing number of appliances labelled, and MEPS. Standard and labelling represent a cost-effective way to overcome market failures in the sale of energy-efficient appliances and equipment. Air conditioning is becoming a priority as it is a fast growing end-use in most emerging countries. Despite all these efforts, there remains a large energy-saving potential, especially in the existing building sector. Governments should implement or focus on packages of policies to improve the energy efficiency of existing buildings, and should take care of the compliance of the measures implemented. To be effective, labelling programmes and performance standards must be fully enforced.

Energy-efficiency policies and trends by world region

OECD countries have significantly reduced their total energy use per unit of GDP over the last three decades. The decline in energy intensity has been driven largely by improved energy efficiency in key end-uses such as vehicles, appliances, space heating and industrial processes. Governments have implemented a wide range of policies and programmes such as energy-efficiency standards, educational efforts, obligations on market actors and financial incentives to accelerate the development and adoption of energy-efficiency measures. These policies and programmes have contributed to the improvement in energy efficiency experienced in OECD countries, together with autonomous technological progress, response to rising energy prices and in industry to competition forces pressuring businesses to cut energy costs.

In EU countries, there are many laws to enhance energy efficiency (the Energy Performance of Buildings Directive, , Eco-design, Eco-labelling, the Energy Efficiency Directive, and others, such as the CO_2 emissions standard for vehicles). Each member state has strong commitment to energy efficiency: indicative national targets for 2020, long-term strategies for building renovation, public sector to lead example, and tri-annual reports of National Energy Efficiency Action Plans. Besides all these initiatives, the EU is also developing innovative measures with the new Energy Efficiency Directive, which includes provisions for energy-efficiency obligation schemes (or alternative policies) to achieve 1.5% annual new and cumulative end-use savings over the 2014–2020 period, the creation of a national energy service providers register, the implementation of accurate and frequent individual metering and billing, of mandatory and regular audits for large companies and incentives for small and medium enterprises.

In non-OECD countries, because of fuel subsidies and institutional barriers, a significant proportion of the energy-efficiency improvement potential is not being realised. Emerging economies, and more precisely the BRICS countries (Brazil, Russia, India, China, and South Africa) are already drivers of global energy demand growth and are also becoming major players in energy efficiency. Virtually all (90%) of the one-third growth in primary energy consumption between 2010 and 2035 will take place outside OECD countries. In keeping with their role in global economic growth, China and India lead the way in energy demand growth as well – representing over half. China alone represents almost one-third of the growth, but even with this, its per-capita energy consumption in 2035 will be less than half the US or Australian levels.

Recommendations

These recommendations aim to give energy-efficiency policies their greatest impact. They rely on the experience of policy implementation in various countries and global organisations – for example, the WEC, International Energy Agency , International Partnership for Energy Efficiency Cooperation, Cepal/Eclac (the Economic Commission for Latin America), Medener (the EU's Mediterranean and Middle East policy unit), the European Energy Network(EnR club), EU Commission – and on policy case studies carried out in the framework of the project.

The following main recommendations are proposed:

- Energy prices should reflect real costs and give more incentives to consumers.
- Consumers should be better informed.

- Innovative financing tools should be implemented to support consumers' investments.
- The quality of energy-efficient equipment and services should be controlled.
- Regulations should be enforced and regularly strengthened.
- Behaviours should be addressed as much as technologies. ICT could help.
- Monitoring achievements and the impacts of measures is necessary to check the real impact of energy-efficiency policies.
- International and regional cooperation should be enhanced.

1. Energy prices should reflect real costs and give more incentives to consumers

In countries with subsidised energy prices, efforts should be made to adjust the domestic energy price to the real cost to send the right signals to the consumers. Although most countries are convinced of such a need, very few have succeeded to deregulate energy price.

Energy price reform can be realised in a progressive way instead of by rapid changes. The government should adopt 'smoothing' energy price mechanism to gradually adjust domestic energy prices to actual costs. They should also take a wider strategy to enforce the price reform such as creating an autonomous body (e.g. regulatory commission) for pricing, explicitly linking the realised revenue with specific public expenditures and introducing 'safety nets' to protect the economically disadvantaged part of the population.

In countries where energy prices are already high and taxed, the issue is to provide incentive price signals for energy-efficiency investments, through progressive pricing and dynamic pricing through Time of Use tariffs (especially for large consumers); long-term signals for consumers and investors (ESCOs) should be given to avoid price fluctuations.

2. Consumers should be better informed

The **simplification and unification of information channels are necessary**. Governments should develop local information centres as accessible as possible for consumers. Governments should also improve advice provided to households by clearly appointing contact/entry points, harmonising their messages on possible interventions, and facilitating consumers' action by providing updated lists of service and equipment providers.

The promotion of **targeted information and guidance** on possible actions through appropriate channels is alsoimportant, such as energy audits.

Smart billing, smart meter and in house display combined with smart phone applications represent a non-negligible potential of energy savings and should be supported by governments, as it improves consumers' ability to monitor and control their electricity use, ultimately leading to lower usage.

Sectoral benchmarking and voluntary agreements where companies agreed on individual energy-savings targets should be promoted. This type of measure has already demonstrated its effectiveness in terms of energy-efficiency promotion in commercial buildings, offices, hotels, and so on (for instance, in Switzerland with AenEC or Germany with the Learning Energy Efficiency Networks (programme).

3. Innovative financing tools should be implemented to support consumers' investments

Given the increasing number of financial programmes, and the different implementation timeframes, governments should simplify and unify processes, and centralise information on existing support schemes.

Furthermore, financial measures 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 should be linked to energy or environment funds that are supplied from diversified sources rather than coming from the public budget alone: funding from dedicated taxes, from the banking system, or from international financing institutions.

Governments should facilitate private investments in energy efficiency and support the development of intermediate third parties (such as ESCOs, utilities and installersplaying a role of aggregator and filling the gap between projects and finance (possibly by defining an Energy Efficiency Public Service). Governments should also support Energy Performance Contracts because they provide a framework to encourage private funding to support energy-efficiency investments with a minimum role for governments. Energy-efficiency obligations are another important tool for financing energy-saving measures by including energy companies as investors.

Very low-interest loans with a lending period long enough to enable acceptable monthly loan reimbursements should be encouraged as it is a condition for large-scale building retrofitting and for a large diffusion of costly equipment such as solar heaters.

In less-developed countries, micro finance can be promoted to subsidise energy-efficient equipment in rural areas (e.g. cooking stoves).

4. The quality of energy-efficient equipment and services should be controlled

Governments should ensure a quality control of locally produced and imported products, in particular compact fluorescent lamps, as well as of installations, through the certification and standardisation of equipment, installers, and auditors. Moreover, harmonisation of testing procedures at regional level should be promoted. Public incentives conditioned to quality labels for equipment and services should be encouraged.

5. Regulations should be enforced and regularly strengthened

Regulations represent a powerful instrument to promote energy efficiency but their impact depends on good implementation and effective compliance. Policy and programme effectiveness should be evaluated during and after implementation. Indeed, non-compliance alters significantly the actual energy savings. For instance, thermal requirements for buildings become more demanding (nearly Zero Energy Buildings) leading to increasing evidence of a performance gap between design intent (i.e. theoretical performance) and the actual energy performance in use. Associated penalties should be clear and serve as constructive disincentives to non-compliance.

To be effective, labelling programmes and performance standards should be regularly revised and upgraded, as a way of stimulating technical progress and ensuring a steady improvement in energy efficiency. However in practice, the process can be too long and delayed. MEPS revisions should be embedded in regulations to guarantee their regular updating (e.g. new buildings in EU countries).

6. Behaviours should be addressed as much as technologies. ICT could help.

It is important to test behaviour thanks to experiment in order to promote the diffusion of technologies and services that favour efficient behaviours (e.g. information on specific fuel consumption, tyre pressure in vehicles).

In addition, governments should promote the diffusion of technologies that limit the impact of inefficient behaviours (e.g. sensor device for lighting, speed limiters, programme automatically set to saving modes).

7. Monitoring achievements and the impacts of measures is necessary to check the real impact of energy-efficiency policies

Monitoring achievements and the impacts of measures is necessary to check the real impact of energy-efficiency policies. They should include:

- Development of end-use data collection.
- Development of energy-efficiency indicators to monitor progress achieved on a yearly basis.
- Evaluation of measures that work and do not work, through various criteria (e.g. cost effectiveness, economic impacts, rebound effects, free rider effects), so as to better tune them.
- Promotion and use of standardised procedures for measuring energy savings (e.g. draft ISO 257).
- Enhancing monitoring reporting and verification (MRV) for international funding.

8. Enhanced international and regional cooperation

The development of international standards could help to enhance international and regional cooperation in addition to regional testing and harmonisation facilities and certifications. Countries should continue to exchange their experiment in order to benchmark policies and identify best practices.

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For sustainable energy.
ISBN: 978 0 946121 27 4