WORLD
ENERGY
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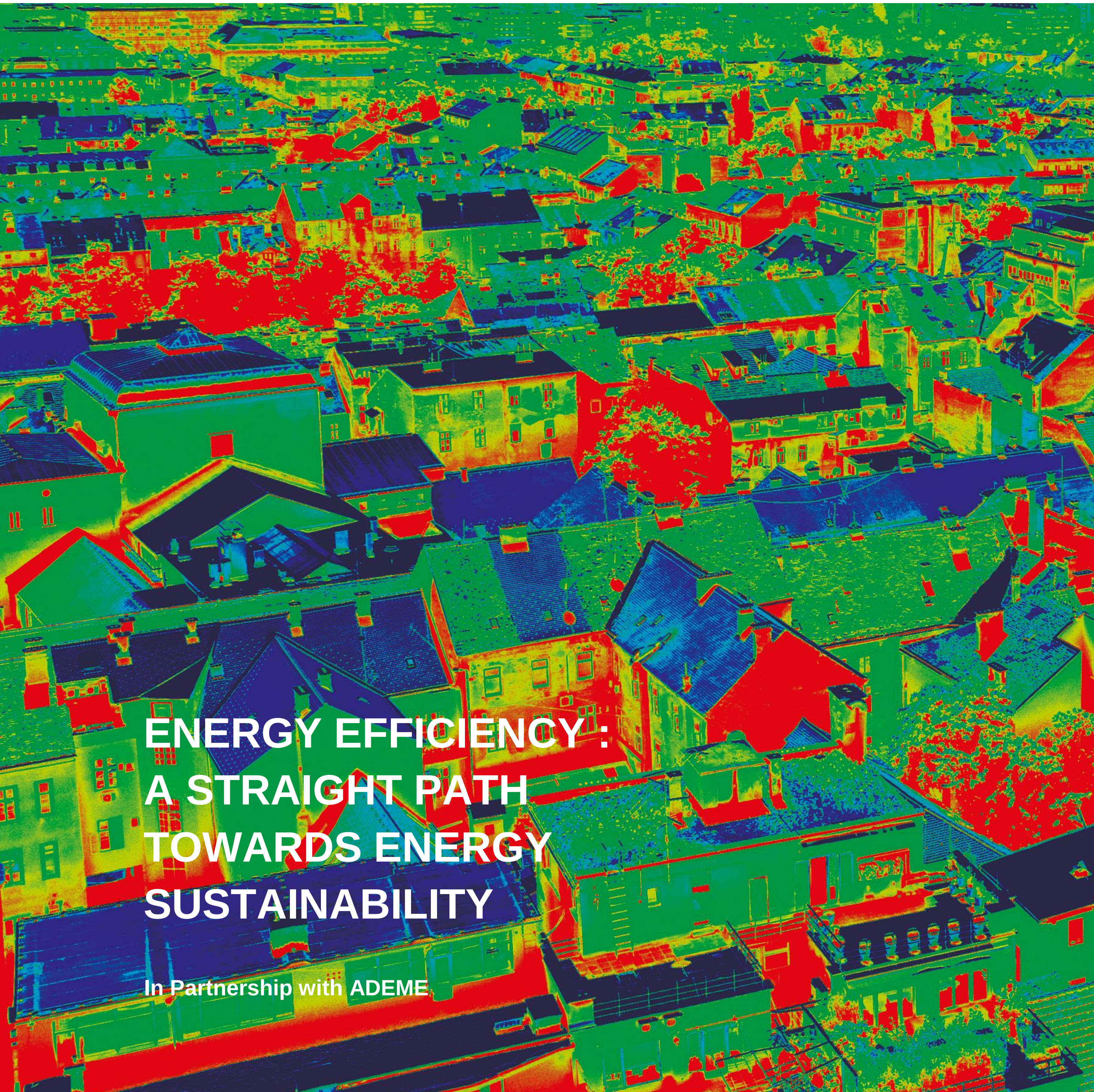
World Energy Perspectives

Energy efficiency policies | 2016



ABOUT THE WORLD ENERGY COUNCIL

The World Energy Council is the principal impartial network of energy leaders and practitioners promoting an affordable, stable and environmentally sensitive energy system for the greatest benefit of all.

Formed in 1923, the Council is the UN-accredited global energy body, representing the entire energy spectrum, with over 3,000 member organisations in over 90 countries, drawn from governments, private and state corporations, academia, NGOs and energy stakeholders. We inform global, regional and national energy strategies by hosting high-level events including the World Energy Congress and publishing authoritative studies, and work through our extensive member network to facilitate the world's energy policy dialogue.

Further details at www.worldenergy.org and @WECouncil

ABOUT THE WORLD ENERGY PERSPECTIVES

Energy Efficiency a Straight Path Towards Energy Sustainability. François Moisan, Chair of the World Energy Council Knowledge Network on Energy Efficiency Policies & Indicators and Director of Strategy and Research, ADEME (France) says: "The introduction of energy efficiency policies and measures has been growing fast around the world. The increasing number of countries with an energy efficiency law, ten more compared to the 2013 report, signifies a strengthening and consolidation of the institutional commitment to energy efficiency."

This is the 8th report in the series of triennial reports produced by the Council together with ADEME and it is the most comprehensive global publication in the area of energy efficiency policies. Drawing on the experiences and lessons from the research conducted in more than 95 countries around the world, the report presents and evaluates different approaches to energy efficiency policies adopted in these countries and helps identify policies which work well and those which do not.

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EXECUTIVE SUMMARY

The research conducted by the World Energy Council together with ADEME since 1992 concludes that energy efficiency continues to improve all over the world but despite the significant advances, much more can and should be done to improve the efficiency of energy production and use. Energy Efficiency policies play a fundamental role in supporting the transition towards sustainable energy.

KEY FINDINGS

1. ENERGY PRODUCTIVITY IS IMPROVING IN MOST COUNTRIES AND REGIONS. Energy consumption per unit GDP (primary energy intensity) is decreasing in 80% of the surveyed countries and most regions, mainly due to the combination of a number of factors, including high energy prices until 2014 and other economic factors, successful energy efficiency programmes, expanding GHG emissions abatement regulations and the transformation of economic activities with a growing share of services in the GDP in countries around the world.

2. LARGE DIFFERENCES BETWEEN COUNTRIES. There are large disparities between regions and countries, both in terms of industrial and household energy use. Europe has the lowest primary energy intensity per unit GDP at Purchasing Power Parity (PPP), followed closely by Latin America and OECD Asia, while China uses twice the amount of energy per unit GDP compared to Europe. Oil producing countries, on the other hand, have in general low energy prices which attract energy intensive industries and hold back the deployment of efficient equipment and best practices. In the household sector, the average consumption of electricity varies significantly between countries depending on different factors, mainly the number of electrical appliances in the household, and ranges from 1,000 kWh/household in India to 8,000 kWh in North America, 2,000 kWh in Italy and 4,000 kWh in Japan.

3. GLOBAL CO_2 EMISSIONS HAVE INCREASED BY 51% SINCE 1990 but the main sources have changed. In Europe, CO_2 emissions have dropped by 22% between 1990 and 2014, while strong economic growth in China and India resulted in tripling of their CO_2 emissions. However, per capita emissions are still significantly higher in the developed countries with nearly 16 tonnes CO_2 per year in North America compared to 2 tonnes CO_2 in India and 6 tonnes CO_2 in China.

4. SIGNIFICANT ACHIEVEMENTS DESPITE GLOBAL ECONOMIC CRISIS. In most regions, annual improvement rate of energy efficiency has slowed down from 1.6% between 2000 and 2008 to 1.3% in the following years. Despite this, the energy efficiency improvements over the last 15 years saved the world 3.1 Gtoe of energy and 7 Gt of CO_2, which corresponds to 23% of global energy consumption and 21% of global CO_2 emissions in 2015.

5. PRICE SIGNALS ARE KEY BUT ALONE ARE NOT ENOUGH TO IMPROVE EFFICIENCY. Analysis of the country specific policies and measures around the world indicates that clear and targeted policies are required to reinforce the role of energy prices in market economies. These policies would support a wider deployment of energy efficient equipment and services which would drive consumer choice towards the most efficient and cost effective solutions.

ENERGY EFFICIENCY POLICIES AND MEASURES

Introduction of energy efficiency policies and measures has been growing fast around the world. The increasing number of countries with an energy efficiency law signifies a strengthening and consolidation of the institutional commitment to energy efficiency. Energy efficiency policy measures (P&Ms) implemented by public stakeholders include a combination of regulations, financial and fiscal instruments and information. P&M are usually adapted for the different economic activities and end-uses. The target areas include, for instance, phasing out and replacement programmes for old and inefficient stocks.

The Minimum Energy Performance Standards (MEPS) set the minimum performance criteria to be achieved by new appliances or buildings and efficiency labels guide consumers towards more energy efficient appliances and buildings and motivate manufacturers to supply energy efficient products. However, labels alone are not sufficient to transform the market, they are just the first step and need to be complemented with MEPS to remove inefficient equipment or introduce best practices. The improvement effect of labels and MEPS is linked to the quantity of equipment which is replaced or the amount of investment in new equipment.

MULTIPLE BENEFITS OF ENERGY EFFICIENCY

The main strategic benefits of improving energy efficiency are to enhance security of supply and reduce CO_2 emissions. In addition, there are associated benefits, including job creation, productivity improvement and energy access.

CASE STUDY: INTERNATIONAL LABELLING OF ELECTRIC MOTORS

Industrial electric motors and electric motor-driven systems (EMDS) consume almost half of the total electricity and account for 70% of the total electricity consumption in the industry. The cost-effective potential to improve energy efficiency of motor systems is roughly 20% to 30%, and such improvement would reduce the total global electricity demand by about 10–15% per year. There are many policies and measures to increase the efficiency of new motors, in particular through their better labelling. The IEC (International Electrotechnical Commission) has put in place four energy efficiency classes for electric motors (with IE4 corresponding to the highest efficiency).

THE WAY FORWARD – RECOMMENDATIONS FOR FUTURE

The role of energy efficiency is well-understood and appreciated by the global community. The potential for energy efficiency improvement is huge and moreover, it can be realised quickly. On the path to energy sustainability, efficiency must come first, as it is the cheapest and readily available "fuel source".

The report suggests that the following considerations will help advance energy efficiency improvements:

- **Energy prices** should closely reflect the real cost of supply. The countries should set deadlines for a gradual energy pricing reform.
- Consumers need to be **better informed**. It is necessary to simplify messages on energy efficiency to reach the majority of consumers.
- **New technologies**, including smart meters and billing offer attractive benefits and their wide introduction should be supported by policies.
- **Innovative financing tools** need to be widely introduced to reduce the public spending on financial and fiscal incentives.
- **Control over implementation** and evaluation of policies and measures are fundamental to the policies success.
- **Regulations** must be regularly reviewed and strengthened if necessary, and labelling and MEPS should be regularly revised and upgraded.
- The development of **international** or **multi-national standards** can help enhance international and regional cooperation, in addition to regional testing and harmonisation of equipment testing standards and facilities. International energy fora should be used to exchange experiences to benchmark policies and identify best practices.

Overall energy efficiency trends through macro indicators, energy efficiency key achievements in the power sector and indicators by end-use sectors (industry, transport and buildings) as well as CO_2 emissions from energy use are analysed in the first part of this report. The results of the policies and measures (P&M) survey are presented in the second part in different graphs showing the degree of implementation of the measures in four world regions: Europe, Asia, America, Africa & Middle East.

Chapter 1
Introduction

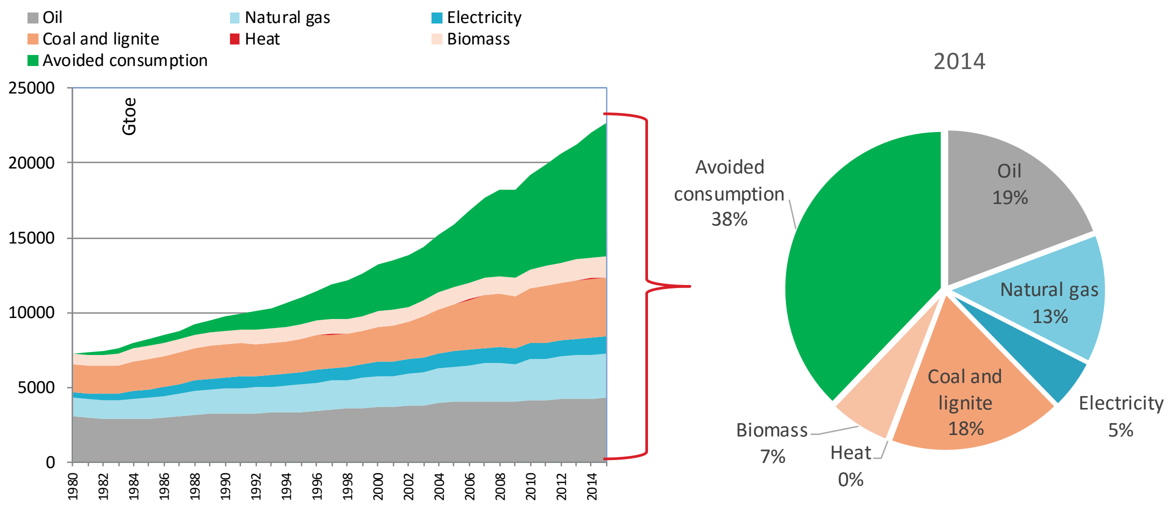
1.1 ENERGY EFFICIENCY MATTERS

Energy efficiency is among the "first fuels" at world level

Energy efficiency can be considered an energy resource, and not a hidden energy resource but the "first fuel" in the largest economies. At world level, the World Energy Council indicators database shows that the share of energy efficiency in total primary energy consumption (with avoided energy consumption taken into account) in 2014 was 38%, ahead of oil at 19% and coal/lignite at 18% (Figure 1).

FIGURE 1: PRIMARY ENERGY CONSUMPTION, INCLUDING AVOIDED CONSUMPTION (PERCENT AT WORLD LEVEL)

PART DES ÉNERGIES DANS LA CONSOMMATION PRIMAIRE PRENANT EN COMPTE LES CONSOMMATIONS ÉVITÉES



* Avoided consumption is calculated as the difference between current consumption at 1980 energy intensity levels and the actual energy consumption.

Source: Enerdata

All over the world, energy efficiency is becoming a top priority in energy policies as it is competitive, cost effective to implement and widely available.

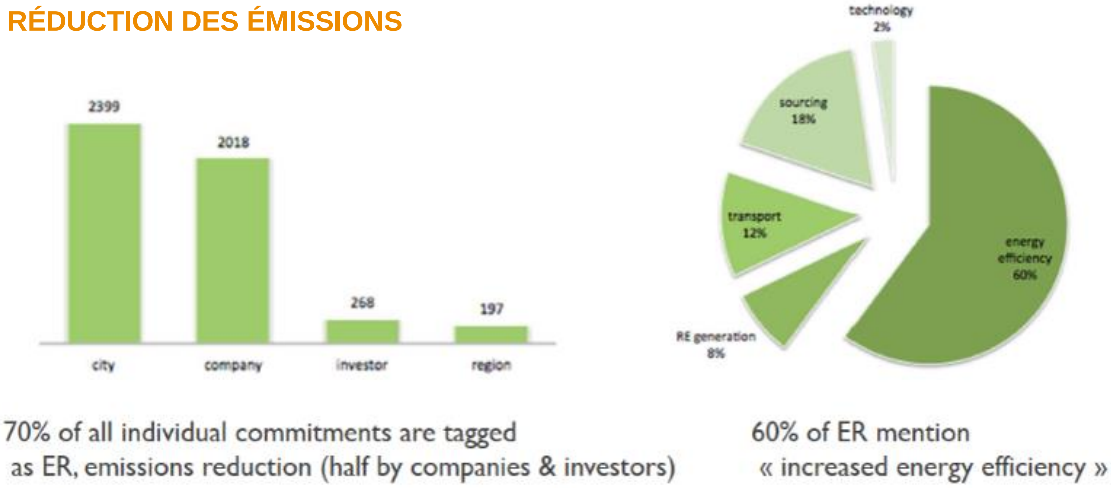
The World Energy Council energy efficiency indicators show that there is no antinomy between economic development and energy efficiency. Quite the opposite: the best improvements over time in energy intensity took place in China, where GDP growth was high during the last decade.

The Sustainable Energy for All (SE4ALL) initiative launched by the UN Secretary-General in 2011 has three interlinked objectives to be achieved by 2030, where the second objective is to “double the global rate of improvement in energy efficiency”[1]. This objective was included as one of the 17 Sustainable Development Goals (SDGs) in the Agenda for Sustainable Development adopted by world leaders in September 2015 at the UN Sustainable Development Summit.

In addition to government or state commitments on energy policy, other stakeholders make commitments to emissions reductions. The Non-State Actor Zone for Climate Action (**NAZCA**), global platform launched by the COP20 president in Lima provides visibility to the commitments by cities, regions, companies and investors. During COP21 in Paris, Parties encouraged the registration of the scaled-up actions by non-Party stakeholders on NAZCA. A study by Yale University (USA) for ADEME shows that 70% of all individual commitments (non-party stakeholders listed in NAZCA) are tagged as emission reductions. **60% of these emissions reductions mentioned an improvement in energy efficiency (**Figure 2).

FIGURE 2: EMISSIONS REDUCTIONS (ER) COMMITMENTS IN NAZCA

ENGAGEMENTS DES ACTEURS NON-ÉTATIQUE NAZCA SUR LA RÉDUCTION DES ÉMISSIONS



Source: Yale University Study for ADEME and French Ministry of Energy and Environment, April 2016

Towards harmonised policy instruments

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

[1] The other two are to “Ensure universal access to modern energy services” and to “double the share of renewable energy in the global energy mix.

The major reasons for failure in market mechanisms are often pinpointed to justify the introduction of policy measures:

- The information is either missing or partial;
- The availability of efficient appliances and production devices in the domestic market is limited;
- The lack of technical, commercial and financial services;
- Investment decision-makers are not always the final users who have to pay the heating or cooling bills ("split incentives");
- Financial constraints faced by individual consumers are often more severe than what is actually revealed by national discount rates or long-term interest rates. This often leads consumers to over-emphasise the purchase cost of equipment and devices[2].

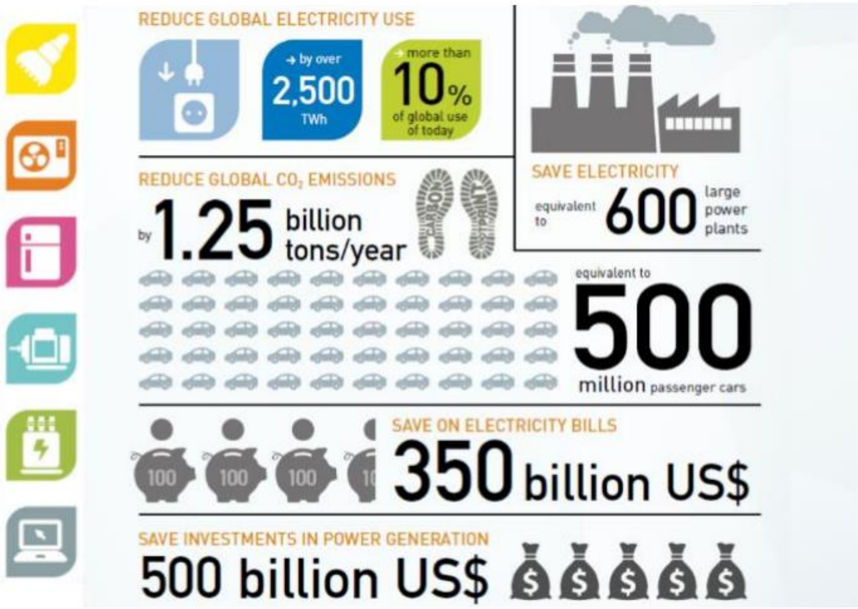
Energy efficiency policies are necessary to address these multiple barriers. The World Energy Council energy efficiency Policies & Measures survey shows that there is a growing interest in policy implementation worldwide, as the number of implemented measures is increasing. Regulations are most often implemented measures, both to raise consumer awareness using the energy efficiency labels, and to remove from the market the inefficient equipment and buildings with MEPS (Minimum Energy Performance Standards). The report shows that regulations tend to be harmonized across countries.

One survey shows that some recommendations set out in previous Council reports are becoming a reality. For instance, the Council survey demonstrates a convergence in policy implementation: e.g. MEPS for the largest appliances are implemented worldwide; building codes are spreading in emerging economies. There is an increasing interest in harmonised tests of minimum requirements (e.g. testing laboratory of MEPS for some electrical appliances). Regulations alone have often a low rate of compliance and need incentives to push the market toward "greener" practices. The financial constraints are increasingly addressed in emerging economies by energy efficiency funds set up with the support of regional and international banks (e.g. World Bank, ADB, etc.) as well as by development banks in OECD countries (e.g. kfW for Germany, AFD for France); these funds aim at providing resources to support economic incentives to finance energy efficiency programmes.

[2] Implicit discount rates in industry are over 20% compared to less than 10% for public discount rates, and 4-6% for long-term interest rates.

FIGURE 3: POTENTIAL OF IMPROVING ENERGY EFFICIENCY FOR TOP 6 HIGH CONSUMING PRODUCTS

POTENTIEL EN MATIÈRE D'AMÉLIORATION DE L'EFFICACITÉ ÉNERGÉTIQUE POUR 6 PRODUITS ÉNERGIVORES



Source: UNEP, 2014 (estimated annual figure for 2030)

1.2 THE WORLD ENERGY COUNCIL ENERGY EFFICIENCY PROJECT IN BRIEF

Over the last two decades, the World Energy Council together with ADEME has been conducting triennial global surveys to catalogue energy efficiency policies and measures and to identify prevailing trends. This project is part of the activities of the Knowledge Network on Energy Efficiency and it is supported by two online databases:

- Energy Efficiency Indicators by country and region
- Energy Efficiency Policies and Measures by country

Database on energy efficiency indicators

The database contains a list of 40 indicators by sector (macro, transformation, industry, transport, residential, commercial and agriculture) and has a user-friendly interface. The energy efficiency indicators are updated once a year and cover now the period up to 2014 (last update in May 2016). These indicators are available on the WORLD ENERGY COUNCIL website (https://www.worldenergy.org/data/efficiency-indicators/)

The energy efficiency indicators are calculated for 96 countries and ten world regions: Europe[3], CIS[4], North America (USA, Canada), Latin America (including Mexico), OECD Asia[5], China, India[6], Other Asia, Africa and Middle East.

Database on energy efficiency policies and measures (P&Ms)

The data base provides an overview of energy efficiency policy measures. It can be accessed on the WORLD ENERGY COUNCIL website by measure and/or country https://www.worldenergy.org/data/energy-efficiency-policies-and-measures. As for the indicator database, 96 countries are covered. To update the data base, a survey of P&Ms has been conducted during summer 2015 through the WORLD ENERGY COUNCIL National Member Committees. The survey was organised in four sections according to the nature of measures: institutions and programmes; financial and fiscal measures; regulations and others measures. In total, 56 countries participated in the survey (participation rate of 58%). For the 40 remaining countries, only information on national institutions and main regulations on labels, MEPS and building codes have been updated.

[3] Europe, Albania, Bosnia, Croatia, Iceland, Macedonia, Norway, Serbia, Switzerland, and Turkey.
[4] CIS (Commonwealth of Independent States): Azerbaijan, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan and Ukraine.
[5] Japan, Korea, Australia, New Zealand.
[6] India and China are treated as regions given their demographic weight.

The policy database includes policy case studies on selected topics. These case studies have several objectives:

- Provide a summary of the state of the art of selected implemented measures;
- Compile standardised national case studies of ex-post evaluation for up to ten countries with "good practices";
- Provide lessons and recommendations for their implementation.

Three new case studies have been added in 2016 covering the following topics:

- Electric motors;
- Energy information centres and “one-stop” shops in buildings;
- Building codes with a focus on emerging countries.

Energy efficiency trends

The evaluation of energy efficiency trends by world region in this report is based on a set of homogeneous energy efficiency indicators covering the period 2000-2014. As there has been a slowdown in the economic growth in most regions since 2008 following the financial crisis, some comments refer to the period 2008-2014.

The data used for the calculation of the energy efficiency indicators come from ENERDATA world energy database[7]. This database compiles harmonised data from international organisations, industry associations and national institutions (Box 1). It provides a consistent coverage of the world energy consumption, split by main regions, and is regularly updated to take into account the most recent trends.

BOX 1: SOURCES OF DATA USED TO CALCULATE THE ENERGY EFFICIENCY INDICATORS

Primary and final energy consumption by sector:

- 2000 to 2012/13: IEA, National sources
- 2013/2014: Enerdata from national energy ministries and utilities, EUROSTAT, IEA, Cedigaz for gas

Economic data (GDP, Value added): World Bank, IMF, Asian Development Bank

[7] The indicators are presented by country in a database developed and maintained by Enerdata: http://www.worldenergy.org/data/efficiency-indicators/

Other data:

- Population, employment: World Bank
- Households: Enerdata from national sources
- Stock of vehicles: IRF (International Road Federation) for transport, Odyssee, national sources
- Industrial production: World Steel Association for steel, UNIDO & USGS for cement, FAO for paper
- Solar water heaters: Observer, IEA and national sources

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[8].

Energy efficiency policies

The evaluation of energy efficiency policies in this report covers the spread of selected energy efficiency policy measures around the world and provides answers to the questions: What is the importance of energy efficiency measures? What are the priorities? What are the trends in policy implementation? What measures are being favoured? What are the innovative measures?

This evaluation relies mainly on a comprehensive global survey. It also draws on the three case studies on policy measures prepared by different experts. The main findings of these case studies have been included in the relevant chapters of this report. The country case studies are available in the Council's policy database[9].

Figure 4 presents the countries covered by the survey[10] of energy efficiency policy measures. As almost two thirds of countries do not belong to OECD, this sample shows a good representation of non-OECD countries, especially in Latin America and Asia. The results of the survey can be viewed by type of measure, by target (i.e. sector, type of appliance) and by country in the World Energy Council policy data base[11].

[8] Electricity is converted to toe according to 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 UNFCCC definitions.

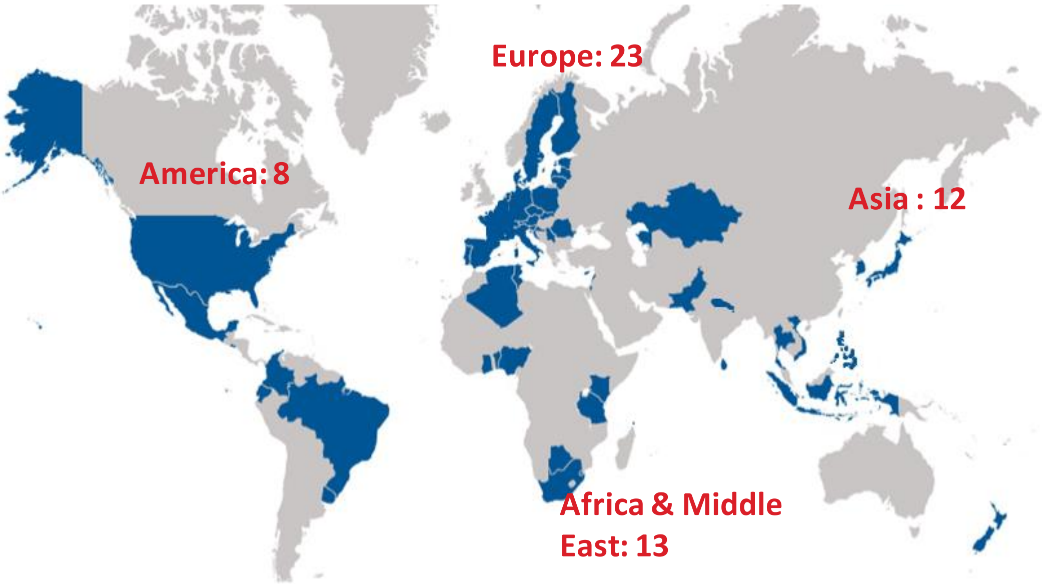
[9] http://www.wec-policies.enerdata.eu/case-studies.php; other case studies evaluated in the 2013 report are also included: good practice in the public sector, financial tools for households, measures for low income households, obligation of energy savings for energy utilities, regulation and compliance, and, finally, smart meters.

[10] The survey is based on a questionnaire designed by ADEME and Enerdata and distributed to all Council's Member Committees.

[11] http://www.worldenergy.org/data/energy-efficiency-policies-and-measures/

FIGURE 4: COUNTRIES COVERED BY THE WORLD ENERGY COUNCIL SURVEY ON ENERGY EFFICIENCY POLICIES

PAYS COUVERTS PAR L'ENQUÊTE CME SUR LES POLITIQUES D'EFFICACITÉ ÉNERGÉTIQUE



Source: World Energy Council - ADEME survey 2016

The survey covers institutional aspects, as well as existing regulations and financial measures. The measures considered in the survey are[12]:

Institutions and programmes

- Institutions: agencies (national, regional and local), Ministerial departments for energy efficiency;
- National programmes of energy efficiency with quantitative targets;
- Energy efficiency laws;

[12] 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 emerging and developing countries.

Regulations

- Labels for 5 domestic appliances (refrigerators, washing machines, Air Conditioning (AC) lamps, water heaters), cars, existing and new buildings (both in residential & public/commercial sector) and electric motors;

- Minimum efficiency standards for electrical appliances (refrigerators, washing machines, AC, lamps, water heaters, electric motors), cars and buildings (new and existing in residential or public/commercial sectors);

- Other regulations for consumers: mandatory energy audits, mandatory energy managers, mandatory energy consumption reporting, mandatory energy saving plan; energy saving quotas;

- Energy savings obligation for energy companies with their consumers;

Financial and fiscal measures

- Energy efficiency funds

- Economic incentives: subsidies for energy audits by sector (industry, commercial/public/residential buildings, transport companies); subsidies or soft loans (i.e. loans with subsidised interest rates) for energy efficiency investment and equipment by sector;

- Fiscal measures: - tax credit or deduction on certain cars, appliances and buildings;

  - accelerated depreciation for industry, tertiary or transport sectors,

  - tax reduction by type of equipment (appliances, cars, lamps, etc.);

Cross-cutting measures

- Energy Service Companies (ESCO)

- Voluntary agreements

- Mandatory training of professionals

Although energy pricing is an important component of energy efficiency policies, it was not addressed in the survey, as there is an international data base to monitor price level and trends[13]. In the same way measures related to information campaigns, training or communication were not included to avoid overloading the survey, as they are common everywhere and in addition, they often rely on regional/local initiatives, which makes them

[13] IEA provides energy prices for OECD countries; Enerdata covers a selection of non-OECD countries.

difficult to track comprehensively. Measures related to information and communication are discussed later in the report.

Content and structure of the report

Overall energy efficiency trends through macro indicators, energy efficiency key achievements in the power sector and indicators by end-use sectors (industry, transport and buildings), including CO_2 emissions from energy use are analysed in the first part of this report. The results of the policies and measures (P&M) survey are presented in the second part in graphs showing the degree of implementation of the measures in four world regions: Europe, Asia, America, Africa & Middle East. Based on these results a set of recommendations have been agreed by the Council's Energy Efficiency Knowledge Network.

Chapter 2

Energy efficiency trends

2.1 OVERALL ENERGY EFFICIENCY TRENDS

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

i. 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, etc. Intensities are used each time energy efficiency is measured at a high level of aggregation, i.e. at the level of the whole economy or of a sector. To make these energy intensities more comparable, they are all converted to purchasing power parities at 2005 prices. (Box 2).

ii. 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 (tonnes of steel, number of passenger-kilometres, etc.) or to a consumption unit (e.g. vehicle, dwelling, etc.). These techno-economic ratios are called unit or specific energy consumption.

iii. The indicators of diffusion aim at monitoring the market penetration of energy efficient technologies (e.g. share of cogeneration in industry and in total per capita power generation, share of electric steel, installed area of solar water heaters[14]) and practices (e.g. per capita mobility by rail transport).

A general indication of energy efficiency performance is given by the primary energy intensity, which relates the total energy consumption of a region or a country to its GDP. Primary energy intensity measures how much energy is required to generate one unit of GDP[15]. The energy intensity is more an indicator of "energy productivity" than a true indicator of efficiency from a technical point of view, as it reflects the effect on many factors that are not directly linked to energy efficiency. Indeed, the energy intensity level is influenced by the nature of economic and industrial activities ("economic structure", i.e. the shares of various sectors in the GDP), the primary energy mix (i.e. the share of coal, oil, gas, biomass, other renewables and nuclear), the climate, the level of development, the organisation of transport sector (in particular the importance of public transport), the diffusion of household equipment and more generally lifestyles.

[14] Solar water heaters are usually considered as energy saving devices as they save energy in consumer premises.

[15] 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 the 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.

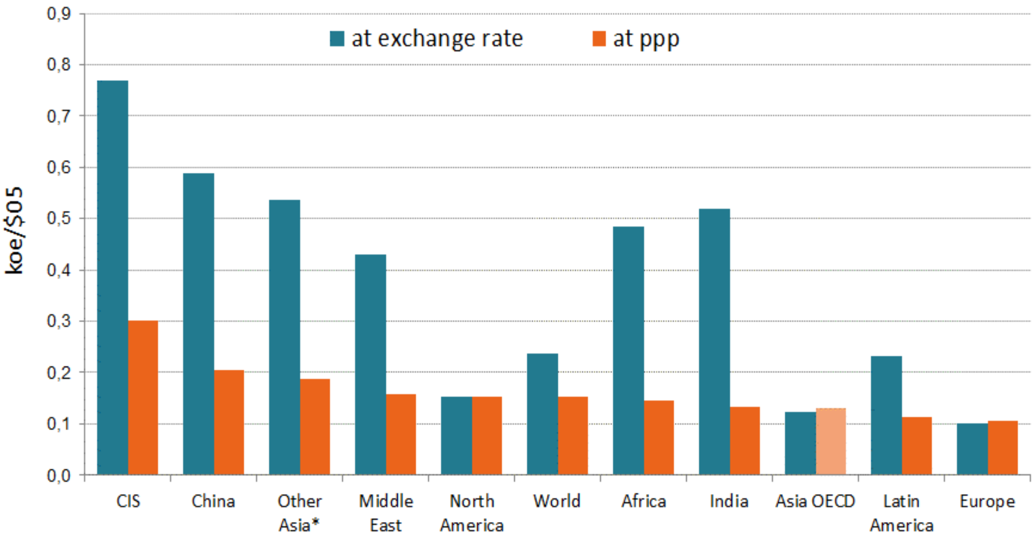
In addition to energy efficiency improvements at end-use level (equipment and buildings) and in the energy sector (power generation, other energy production or transmission activities), trends in energy intensities are influenced by changes of all these factors and energy efficiency is one among many drivers of energy intensity trends; it is however generally the major driver.

BOX 2 : 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. Using PPP 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[16] (Figure 5). Energy intensities at PPP are more relevant for comparisons as they relate the energy consumption to the real level of economic activity and life styles. The use of PPP narrows the gap of energy intensities between countries and regions with different levels of economic development, compared to what would be shown by any exchange rates. As the intensities are measured at constant prices and parities, the use of PPP changes the intensities' levels but does not affect their trends at country level[17]

FIGURE 5 : PRIMARY ENERGY INTENSITY: PURCHASING POWER PARITIES VS EXCHANGE RATES (2014)

INTENSITÉ ÉNERGÉTIQUE PRIMAIRE : PARITÉS DE POUVOIR D'ACHAT VS TAUX DE CHANGE (2014)



* Data for 2013

Source: Enerdata based on PPP values from World Bank

[16] On average, for non-OECD countries the GDP at 2005 purchasing power parties is 2.3 times higher than if it is expressed at 2005 exchange rates (factor 3 for India and 2.4 for China).

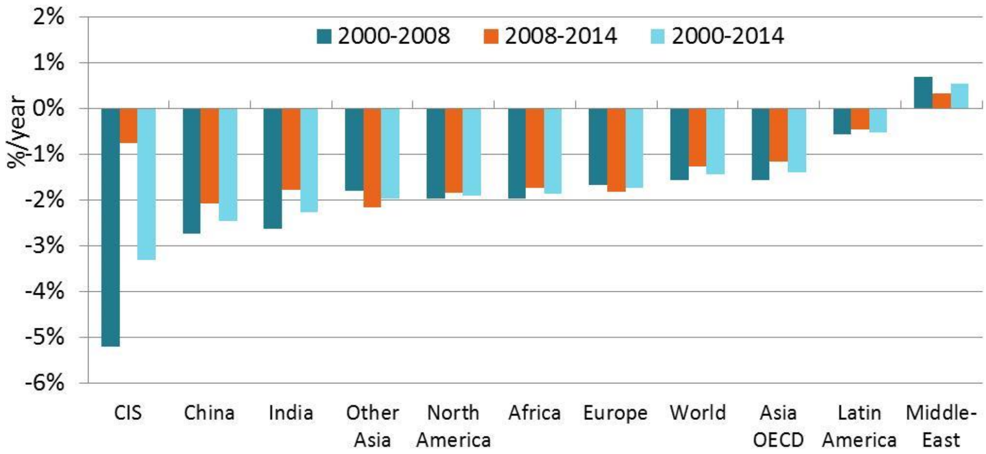
[17] The trend at world or region level may be however affected by differences in the GDP growth of countries with different intensities.

The world economic crisis lowered the energy productivity improvement in most regions

The primary energy intensity has been decreasing at world level in all regions, except the Middle East. Since 2008, the world economic crisis had a strong impact on the overall energy productivity improvement in most regions, except Other Asia and Europe: at world level, the energy intensity has decreased less rapidly since 2008 (1.3% per annum versus 1.6% per annum between 2000 and 2008) (Figure 6). This is mainly due to the fact that part of the energy consumption is not linked to the level of economic activity. In the Middle East, energy consumption has always been increasing faster than GDP, mainly because of a rapid development of energy intensive industries and air conditioning[18].

FIGURE 6: VARIATION OF PRIMARY ENERGY INTENSITY BY WORLD REGION

VARIATION DE L'INTENSITÉ ÉNERGÉTIQUE PRIMAIRE PAR RÉGION DU MONDE



Source: Enerdata

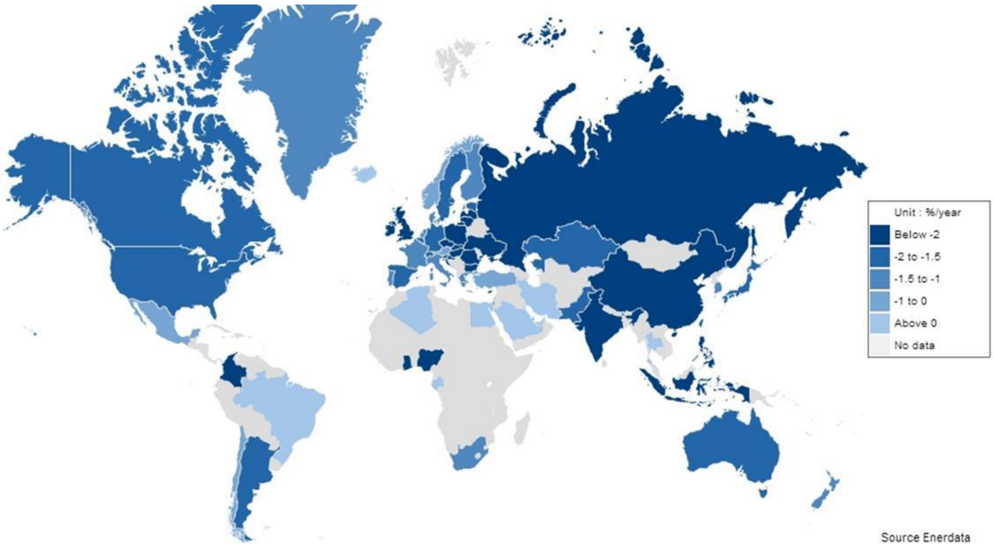
CIS region and China experienced the strongest improvement in energy productivity, 3.3% and 2.5% per annum on average since 2000. The improvement is the result of various factors: more efficient use of coal, switch from coal to oil and gas, industry restructuring (rapid growth of equipment manufacturing industries), closure of old facilities and higher energy prices (until 2014). More than 80% of the countries in the world[19] have increased their energy productivity (i.e. decreased their energy intensity) (Figure 7). Since 2000 this primary energy intensity decreased by more than 3% per annum in 11 countries (e.g. 17% of surveyed countries).

[18] This rapid growth of air conditioning is driving electricity use that leads to increased losses in thermal power plants.
[19] Based on a sample of 96 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 account for a significant share of the total consumption (e.g. Europe, North America, CIS). For that reason, it is preferable to work with intensities in normal climate (Box 3). As the data on temperature degree days are available for all countries only since 2005 it was not possible to account for the impact of climate variations on the indicators.

FIGURE 7: TRENDS IN PRIMARY ENERGY INTENSITY (2000-2014) (PERCENT PER ANNUM)

TENDANCES D'INTENSITÉ ÉNERGÉTIQUE PRIMAIRE (2000-2014)



Source: Enerdata

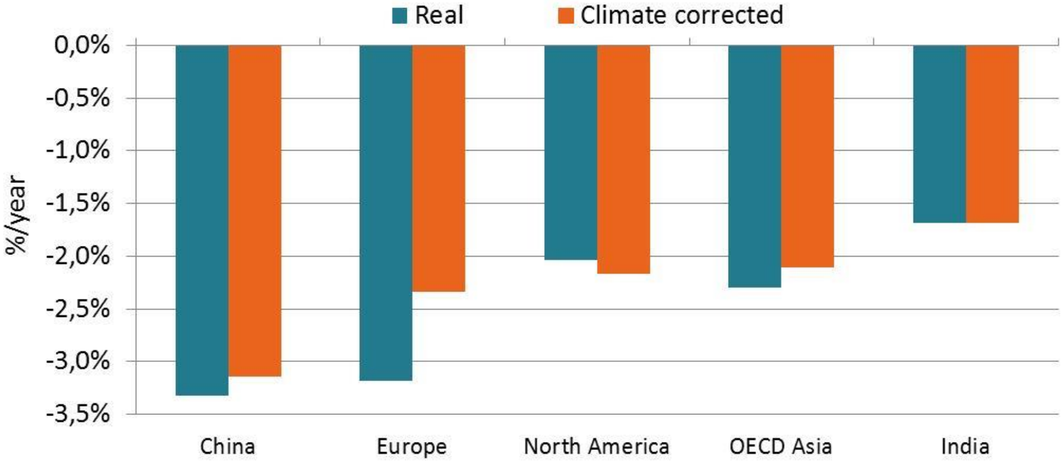
BOX 3 : INFLUENCE OF CLIMATIC CORRECTIONS

In countries with heating requirement, years with cold winters will have a higher consumption than years with mild winters. This is the same for warm years for air conditioning. Correcting energy consumption trends for the fluctuations due to climate is achieved by adjusting the part of consumption used for space heating and air conditioning. Such corrections are based on degree-days which measure for each day of the heating or cooling period, the difference between the outdoor temperature and a reference room temperature[20]. Over the period 2010-2014, the impact of climate was mainly significant for Europe: the intensity at normal climate decreases 25% less than the actual value (2.4% per annum compared to 3.4% per annum); indeed 2014 was much warmer than 2010 (Figure 8).

[20] For instance, for heating the usual reference temperature is 18 °C and the number of heating degree days is defined as the sum of the difference 18 – T for each heating day, where T is the average temperature of the day.

FIGURE 8 : INFLUENCE OF CLIMATIC CORRECTIONS ON THE PRIMARY ENERGY INTENSITY (2010-2014)

INFLUENCE DES CORRECTIONS CLIMATIQUES SUR L'INTENSITÉ ÉNERGÉTIQUE PRIMAIRE

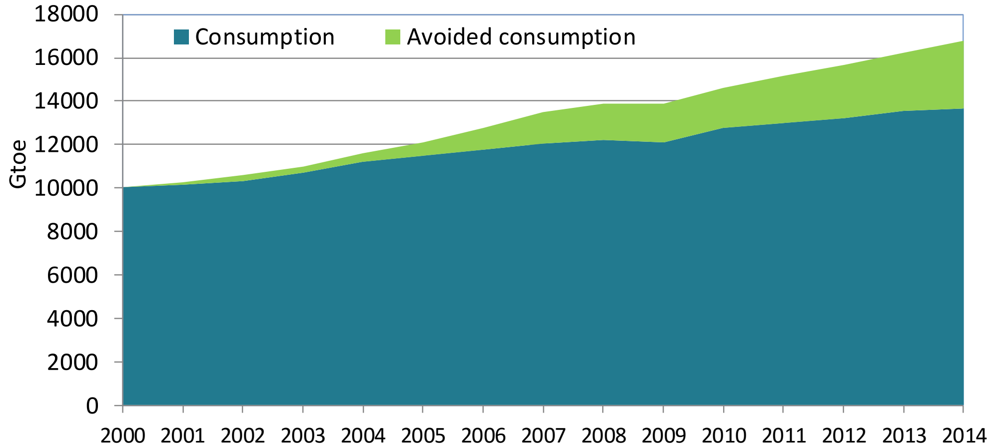


Source: Enerdata

Energy productivity improvements avoided 7 Gt CO_2 in 2014 at the world level

Energy productivity improvements since 2000 avoided an energy consumption of 3.1 Gtoe in 2014[21] at world level, with China accounting for 40% (Figure 1). These improvements also reduced CO_2 emissions by 7 Gt CO_2 in 2014.

FIGURE 9: AVOIDED ENERGY CONSUMPTION FROM ENERGY INTENSITY DECREASE AT WORLD LEVEL



* Avoided consumption is calculated as the difference between a fictive consumption at 2000 (or 1990) energy intensity and the actual energy consumption.
Source: Enerdata

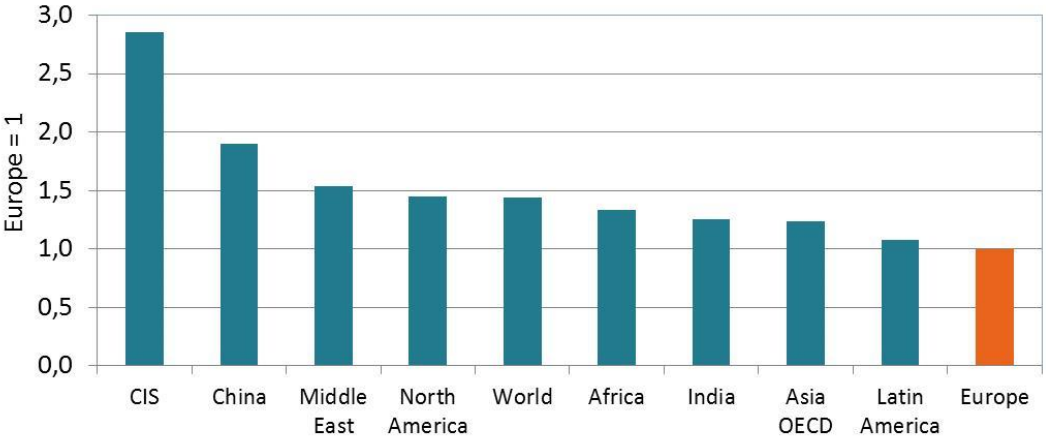
[21] At 2000 energy intensity by main region (i.e. at technologies and economic structure of 2000), world energy consumption would have been 3.1 Gtoe higher in 2014

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

Europe[22] is the region with the lowest primary energy intensity at purchasing power parities, followed closely by Latin America and OECD Asia (Figure 10 and Figure 11). The CIS uses almost 3 times more energy per unit of GDP than Europe, while in China the energy intensity is almost twice higher than the average in Europe. Highest energy intensities can be attributed to various factors, including the dominant role of energy intensive industries (China and the Middle East), the fuel mix (especially for power generation) and energy efficiency. Oil producing countries have generally low energy prices which attract energy intensive industries and inefficient equipment and practices.

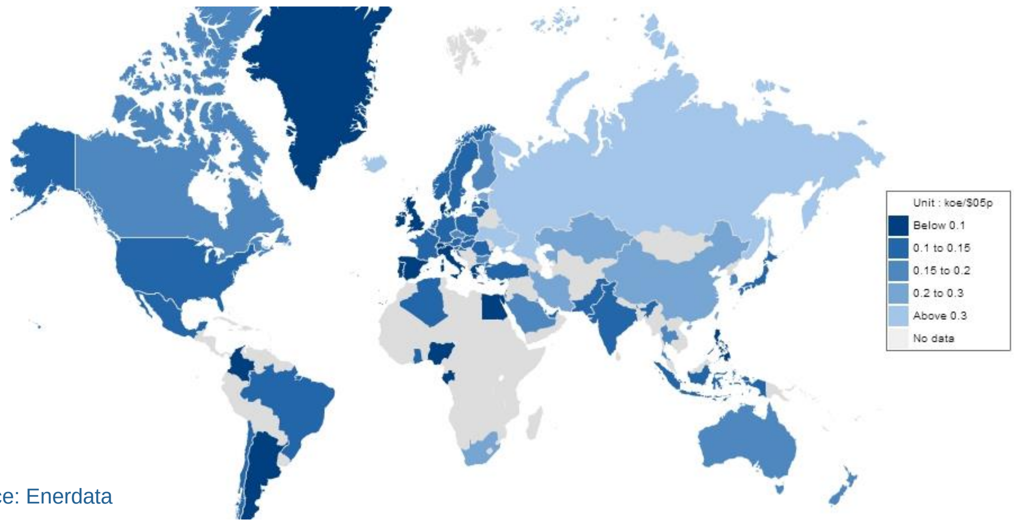
FIGURE 10: PRIMARY ENERGY INTENSITY LEVELS BY WORLD REGION (2014)

INTENSITÉ ÉNERGÉTIQUE PRIMAIRE PAR RÉGION DU MONDE



Source: Enerdata

FIGURE 11: PRIMARY ENERGY INTENSITY LEVELS BY COUNTRY (2014)
INTENSITÉ ÉNERGÉTIQUE PRIMAIRE PAR PAYS



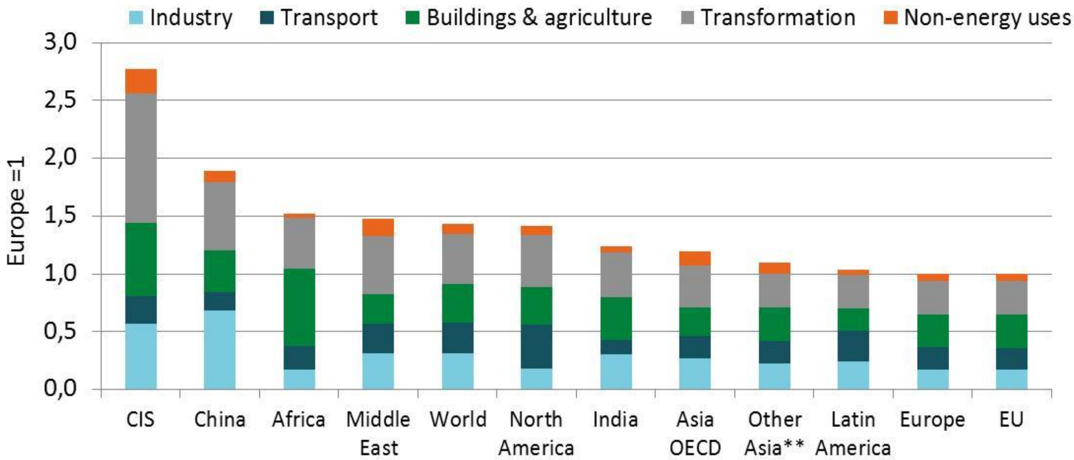
Source: Enerdata

[22] Including in total 34 countries.

Figure 12 shows how much each economic activity sector contributes to the primary energy intensity. The high contribution of energy transformation and industry explains part of the higher energy intensity of CIS, China and Middle-East (transformation: 40% in CIS, 35% in Middle-East and China; industry around 33% in China). In Africa, the dominant use of low efficiency biomass in the residential sector explains the dominance of the building sector and its high energy intensity. Surprisingly, transport has a lower influence on energy intensity levels (except in The Middle-East and North America).

FIGURE 12 : CONTRIBUTION OF SECTORS TO PRIMARY ENERGY INTENSITY (2014)*

CONTRIBUTION DES SECTEURS À L'INTENSITÉ ÉNERGÉTIQUE PRIMAIRE



* Energy consumption per sector related to GDP measured at purchasing power parities
** Data for 2013
Source: Enerdata

About 15% of energy productivity improvements at the final consumer level offset by higher conversion losses

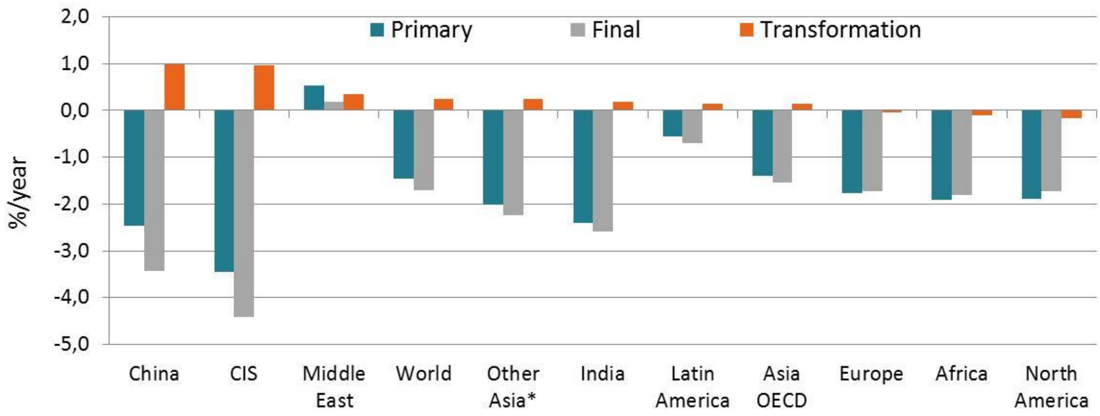
The final energy intensity corresponds to the energy consumed per unit of GDP by final consumer uses. Compared to the primary intensity, it excludes consumption and losses in energy conversion, mainly in power generation, and non-energy uses.

The final energy intensity at world level decreased more rapidly than the primary energy intensity - 1.7% vs 1.5% per annum between 2000 and 2014 (Figure 13). In other words, energy productivity improved 15% more rapidly at the level of final consumer than at the overall level. This means that 15% of the energy productivity was offset by increasing losses in energy conversion, mainly power generation. 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 consumption, as electricity is predominantly produced by thermal power plants, with 60-70% of losses. The share of electricity in final energy consumption rose from 15% in 2000 to 18% in 2014 at world level; in China and other Asia, the electricity penetration was even more rapid (from 10 to 20% in China or 10% to 15% in other Asia).

In Europe and North America, trends in primary and final intensities were very similar due to the fact that energy conversion losses were stabilised by the increasing share of more combined-cycle plants and cogeneration.

FIGURE 13 : VARIATION OF PRIMARY AND FINAL ENERGY INTENSITY[23] (2000-2014)

VARIATION DE L'INTENSITÉ PRIMAIRE ET FINALE (2000-2014)



Source: Enerdata

With the exception of CIS, the higher the Human Development Index[24], the lower the energy intensity (Figure 14).

Changes in the economic structure influence final energy intensities

Changes in the economic structure influence variations in final energy intensities. For example, all things being equal, the increasing share of services in the GDP will decrease final energy intensities, as the energy intensity of services is six times lower than in industry at world level[25]. In other words, it requires six times less energy to produce one unit of GDP activity in services than in industry. The effect of structural changes is especially important in countries with rapid economic growth. These structural changes are generally not the result of energy efficiency policies and need to be excluded from the analysis to evaluate the effect of energy efficiency policies more accurately.

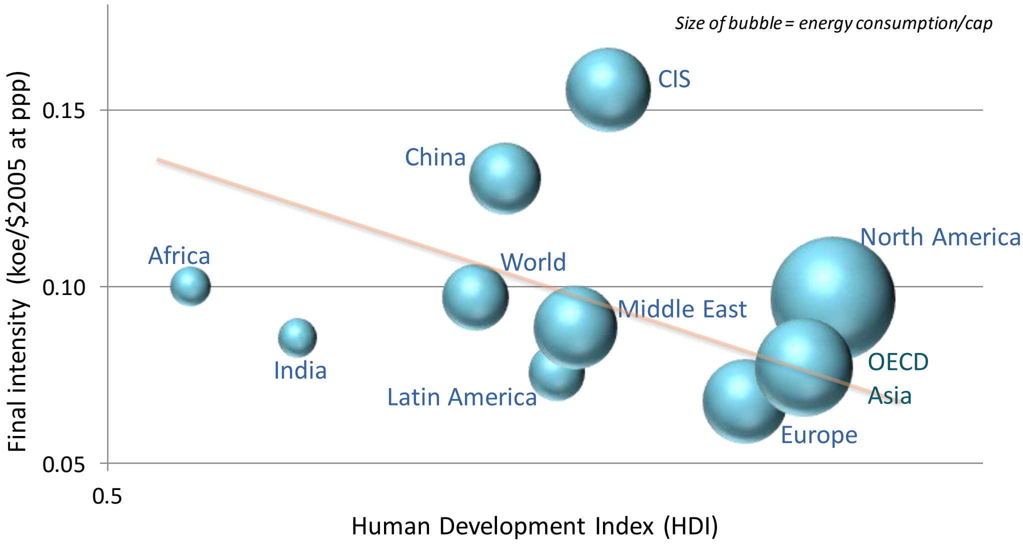
[23] Non energy uses are excluded from the final energy intensity.

[24] The Human Development Index (HDI) from UNDP is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and having a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions.

[25] 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.

FIGURE 14 : FINAL ENERGY INTENSITY, HDI, ENERGY CONSUMPTION/CAPITA (2014)

INTENSITÉ ÉNERGÉTIQUE FINALE, IDH ET CONSOMMATION FINALE PAR HABITANT



Source: Enerdata; HDI averages by world region weighted by population calculated by Enerdata from UNDP

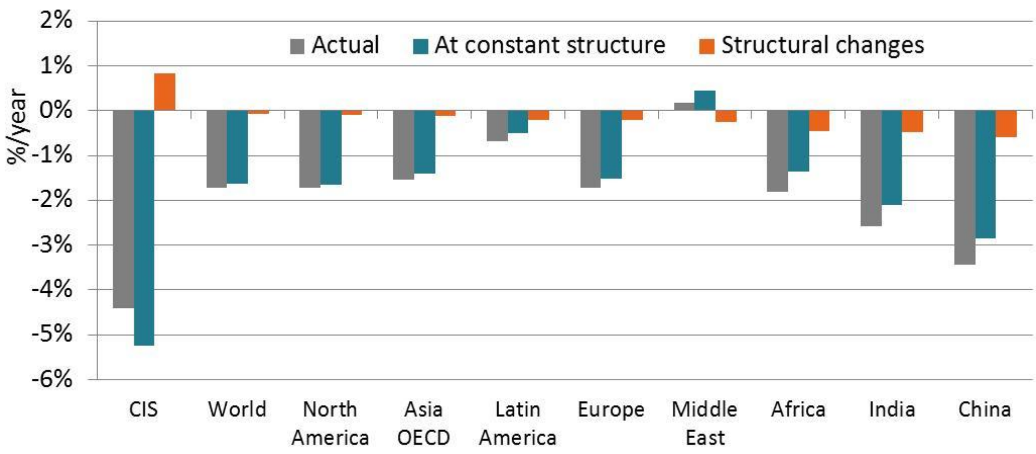
Correcting energy intensity trends for the influence of structural changes is done by calculating final energy intensity at constant GDP structure[26]: the difference in the variations of this actual final energy intensity and a theoretical intensity at constant GDP structure shows the influence of structural changes in the economy.

In Africa, India and China, the final intensity decreased faster than the intensity at constant structure (Figure 15). This means that part of the energy productivity improvement was due to an increasing share of less energy intensive sectors in the economy. Thus, changes in the GDP structure explain around 1/4 of the final energy intensity decrease in Africa and around 20% in India and China, due to an increasing importance of services in the GDP (up by 4% in Africa, 12% in India and 5% in China). At world level, the effect of structural changes was marginal. In CIS, However, structural changes were in the opposite direction and contributed to increase the final energy intensity.

[26] 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.

FIGURE 15 : ROLE OF STRUCTURAL CHANGES IN THE GDP (2000-2014)

RÔLE DES CHANGEMENTS STRUCTURELS DANS LE PIB



Source: Enerdata

Comparisons of primary energy intensities are more relevant after adjustments

In the same way, differences in primary intensity levels can be explained by differences in GDP structure. The share of industry in the GDP varies from 20% to 22% in North America and Europe, to approximately 30% in other regions, and over 40% in China (2014). The share of services varies from 39% in China, to around 50% in CIS, India and Africa, 65% in Europe and 72% in North America.

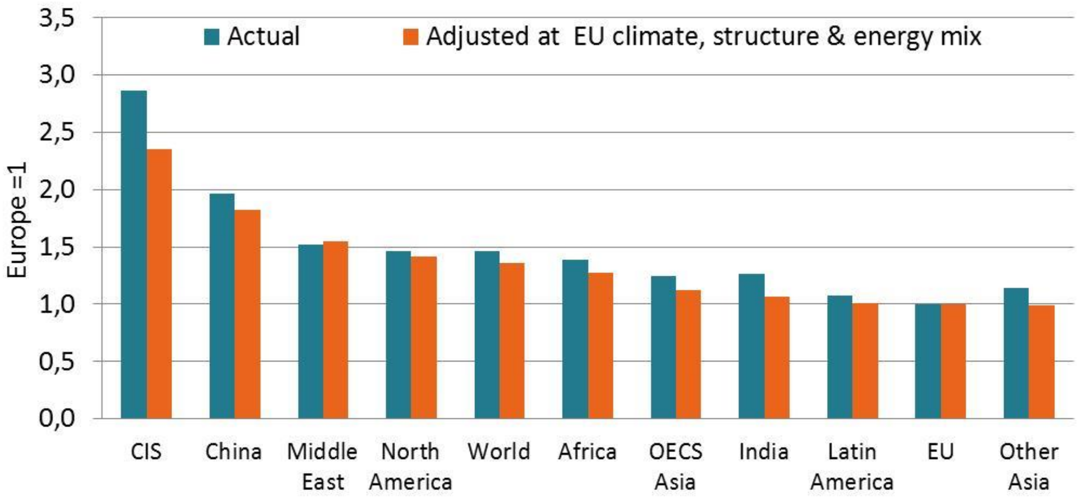
Differences in the fuel mix can also contribute to the intensity level: the fuel mix varies significantly with the share of coal and nuclear - the least efficient power generation technologies[27] - between 74% in China (whereof 71% from coal) or 64% in India to 5% in Latin America, where hydropower plays a leading role.

Comparison of energy intensities can be easily improved by several adjustments that are easy to quantify. After adjustment to the same GDP structure, same climate and same fuel mix, the ranking of regions slightly changes: Other Asia becomes the region with the lowest intensity followed by Europe and Latin America (Figure 16). The difference between regions gets narrower (range of 2.3 between the highest and lowest values compared to a factor of 2.8 without adjustment). The remaining gaps are due to differences in industry structure, lifestyles and, above all, energy efficiency.

[27] The efficiency of nuclear power is 33% and coal around 35%.

FIGURE 16 : PRIMARY ENERGY INTENSITY ADJUSTED TO EU FUEL MIX (2014)

INTENSITÉ PRIMAIRE AJUSTÉE AU MÊME MIX ÉLECTRIQUE QUE L'EUROPE



Source: Enerdata

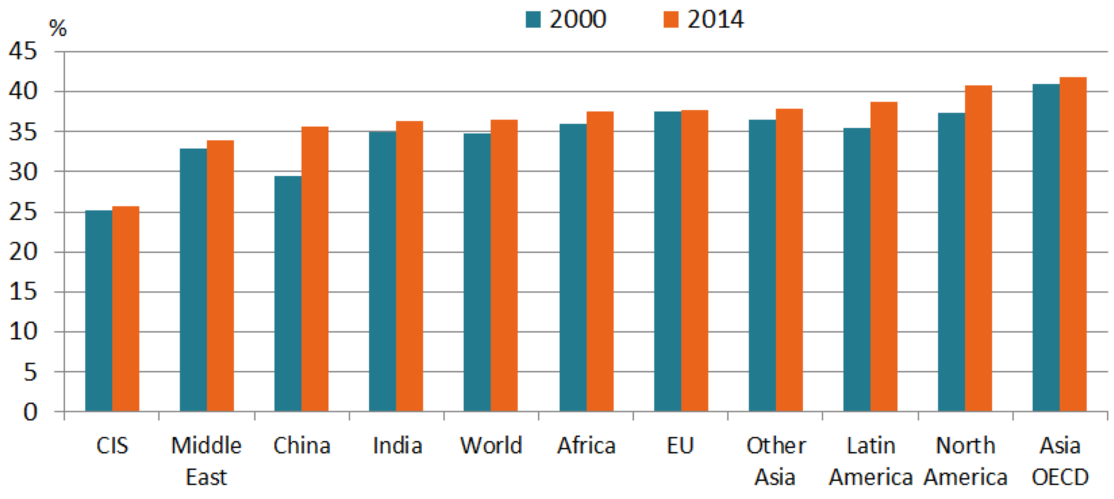
2.2 ENERGY EFFICIENCY ACHIEVEMENTS IN THE POWER SECTOR

Slow improvement of the average efficiency of thermal power generation

Energy efficiency of thermal power generation improved by 0.9% since 2000 at world level reaching an average value of 36.5% in 2014. This is far below the OECD Asia or North America average (both above 40%) or world best practice: Spain with 45% due to a high penetration of CCGT, combined cycle gas turbines (Figure 17). The greatest improvements can be seen in China with the commissioning of new efficient coal plants, as well as in North and Latin America with the spread of CCGT. At world level, CCGT represent 19% of the installed thermal power generation capacity, a rise of 10% since 2000 (reaching 34% in Europe and over 30% in Latin America).

FIGURE 17 : TRENDS IN THE AVERAGE EFFICIENCY OF THERMAL POWER

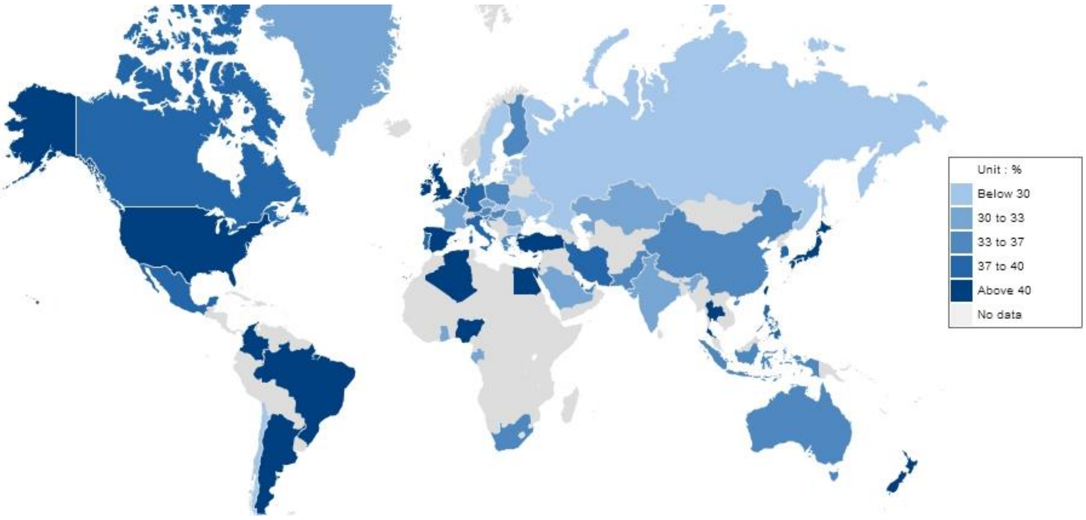
EVOLUTION DU RENDEMENT MOYEN DES CENTRALES THERMIQUES



Source: Enerdata

FIGURE 18 : AVERAGE EFFICIENCY OF THERMAL POWER PRODUCTION BY COUNTRY (PERCENT IN 2014)

RENDEMENT MOYEN DES CENTRALES THERMIQUES PAR PAYS

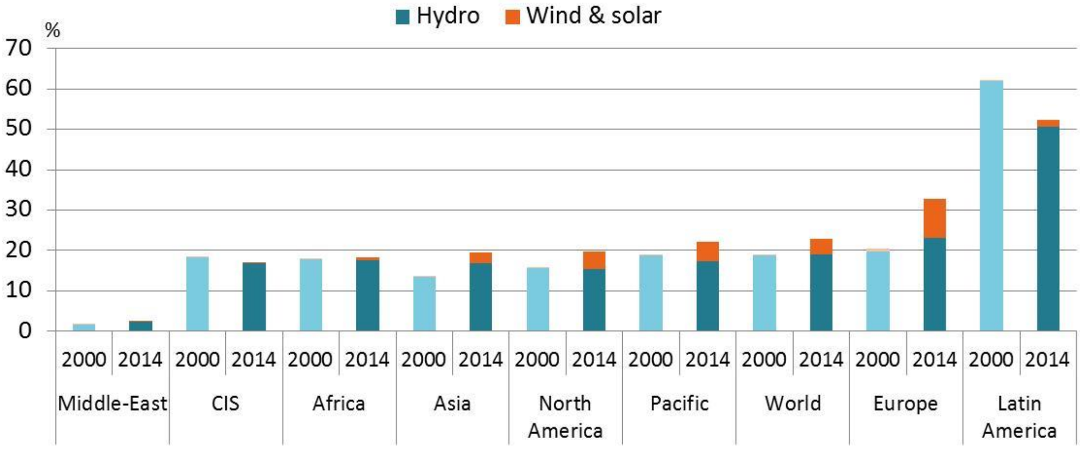


Source: Enerdata

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 is increasing at world level thanks to wind and solar (Figure 19). Europe experienced the highest penetration of wind and solar, which together reached almost 10% of power generation capacity in 2014 (4% at world level).

FIGURE 19: SHARE OF RENEWABLE IN ELECTRICITY PRODUCTION

PART DES RENOUVELABLES DANS LA PRODUCTION D'ÉLECTRICITÉ

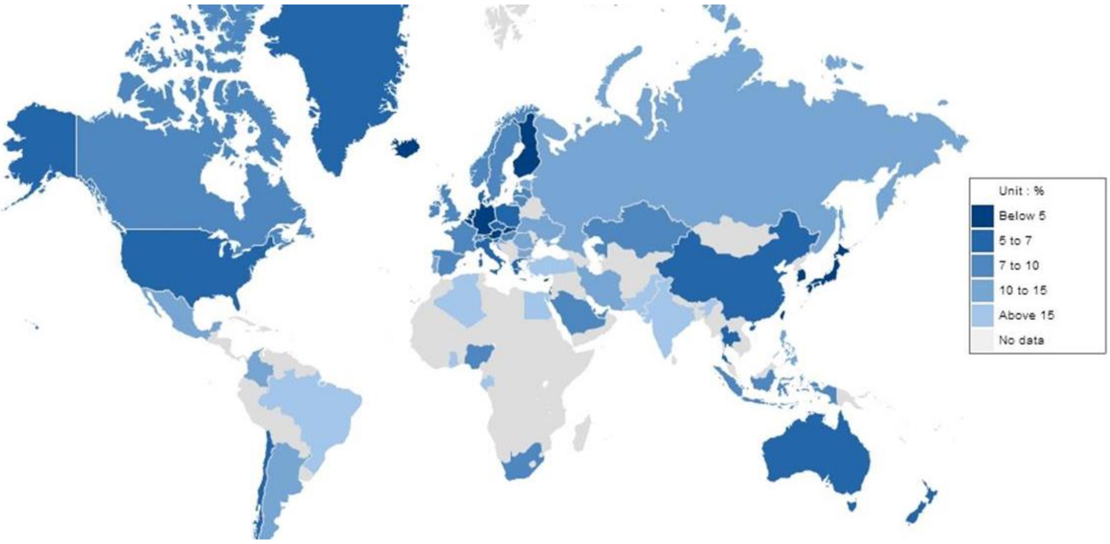


Source: Enerdata

At world level, the rate of power transmission and distribution losses remained stable since 2000 (8.6% in 2014), with differences amongst the regions. Latin America and Africa showed greater losses (over 15% on average and up to 20% in India), mainly due to poor infrastructure reliability, irregular power supplies and non-technical losses, including theft and unpaid bills (Figure 20).

FIGURE 20 : ELECTRICITY TRANSMISSION AND DISTRIBUTION LOSSES (PERCENT IN 2014)

TAUX DE PERTES DE TRANSPORT ET DISTRIBUTION DE L'ÉLECTRICITÉ



Source: Enerdata

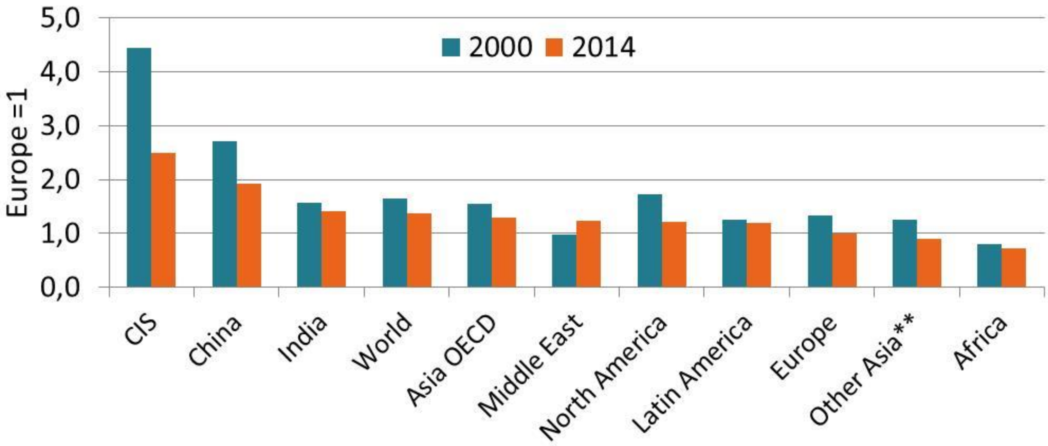
2.3 ENERGY EFFICIENCY ACHIEVEMENTS IN INDUSTRY

Towards a decrease in industrial intensity

Since 2000, the general trend in industry is towards a decrease in the energy required per unit of value added (Figure 21). It is explained by a combined effect of energy efficiency gains and structural changes towards less energy intensive industries, except in the Middle East, where the increasing trend is mainly linked to an opposite structural change with a greater role of energy intensive industries. Since 2008, there is a net slowdown in the intensity reduction in most regions and at world level, because of the global crisis, from 1.6% per annum between 2000 and 2007 to about 1% per annum since 2007. In regions the most hit by the economic slowdown, the energy consumption did not follow the contraction of production, as industrial plants were not operating at full capacity and as part of this consumption is independent of the level of production.

FIGURE 21: ENERGY CONSUMPTION OF INDUSTRY PER UNIT OF VALUE ADDED

INTENSITÉ ÉNERGÉTIQUE DE L'INDUSTRIE PAR UNITÉ DE VALEUR AJOUTÉE



** year 2013 for Other Asia
Source: Enerdata (index based on intensities at purchasing power parities in koe/$2005)

Trends in the energy intensities are first of all influenced by energy efficiency improvements at the level of each individual branch e.g. steel, chemicals, non-metallic minerals.

They are also affected by structural changes in the industrial activity (i.e. changes in the share of the different branches in the industrial value added). In countries or regions with a growing importance of energy intensive industries (e.g. The Middle East[28]), such a trend will, all things being equal, contributes to increase the energy intensity of the industry. On the contrary, a greater specialisation of industrial activities on less intensive branches, such as the production of electrical equipment or textiles, will lower the energy intensity. This was the case for instance for the EU where around 20% of the intensity decrease in manufacturing industry since 2000 was due to structural changes[29].

Even if these intensities are converging because of the globalisation of industrial activities, there are still large differences between regions due to differences in energy efficiency and industry specialisation: for instance, intensities are around 2 to 2.5 times higher in CIS or China compared to Europe, even though these two regions experienced a strong reduction of their industrial intensity.

Most of the energy consumption in industry is concentrated on a few energy intensive branches, such as steel, cement, paper and chemicals (typically 60-70%). Benchmarking of energy efficiency performance for these branches is usually done on the basis of their specific energy consumption. To be closer to energy efficiency, such comparison should be done at similar process/product mix.

For instance, 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 with the electric furnace process will have, all things being equal, a much lower specific energy consumption than countries with a large proportion of steel produced with the energy intensive oxygen process.

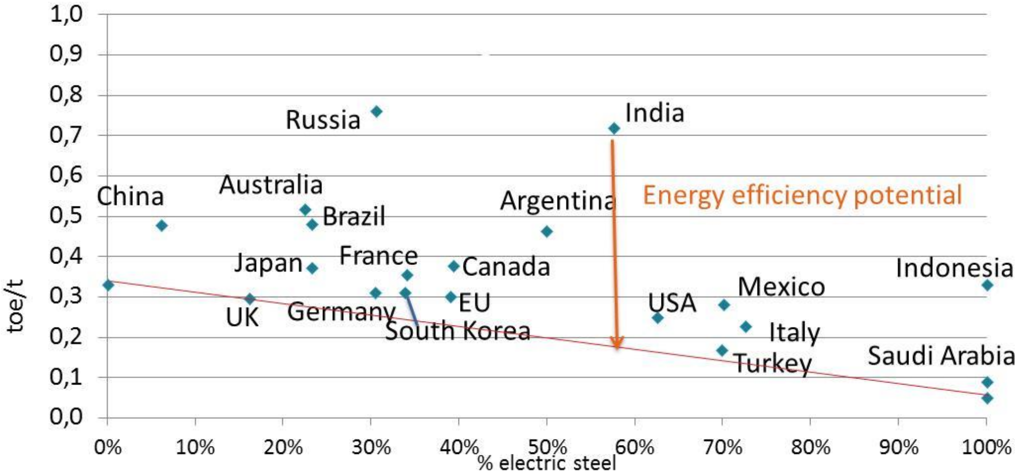
Figure 22 indicates the average consumption per tonne of steel in relation to the share of the electric process for selected countries. Only groups of countries with a similar process mix can be compared. There are large gaps between countries with similar process mix: Russia, Brazil, Japan, Australia and UK can be compared, with UK having the lowest specific consumption. Best practices are not always in OECD countries because of globalisation, as new more efficient plants are more often built in emerging countries. The distance of each country to the world's best practice (red line) gives an estimate of the potential of 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.

[28] This was also the case in Brazil and Uruguay as calculated in the BIEE project of UN ECLAC http://www.cepal.org/drni/biee.

[29] Source: ODYSSEE data base.

FIGURE 22: AVERAGE ENERGY CONSUMPTION PER TONNE OF STEEL (2014)

CONSOMMATION UNITAIRE PAR TONNE D'ACIER (2014)



Source: Enerdata

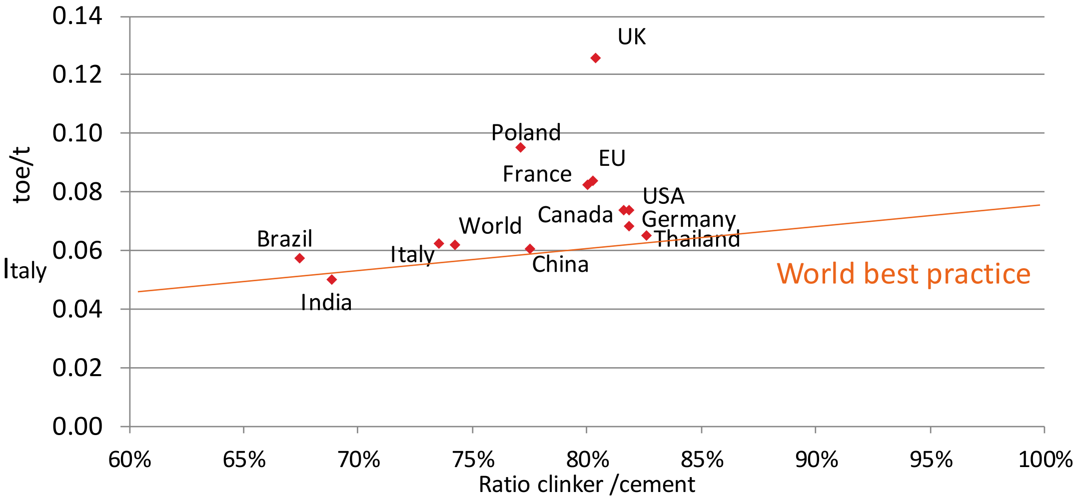
For cement, most of the energy consumption (more than 80%) goes to the fabrication of clinker. As cement is produced by mixing clinker and additives (e.g. ashes), the energy performance of cement production depends on the efficiency of clinker production, but also on the composition of cement (share of additives) and the share of clinker produced in the country. Thus the lower the ratio clinker/cement production, the lower the specific consumption[30]. Comparisons should be made at similar ratios.

Figure 23 displays the specific energy consumption of cement as a function of the ratio clinker/cement. Distance to the red line (world best practice) indicates the potential for energy savings. Again, only countries with a similar ratio of clinker/cement can be compared: for instance, among the countries with a ratio around 80%/85% which include China, Poland, France, UK and EU, China demonstrates the best performance.

[30] Case of countries with a high proportion of additives and/or importing part of the clinker.

FIGURE 23 : ENERGY CONSUMPTION PER TONNE OF CEMENT (2013)

CONSOMMATION UNITAIRE PAR TONNE DE CIMENT



Source: Enerdata based on data from WBCSD, Global Cement Database on CO_2 and Energy Information "Getting the Numbers Right" (GNR), http://www.wbcsdcement.org/GNR-2013/index.html

2.4 ENERGY EFFICIENCY ACHIEVEMENTS IN TRANSPORT

The decrease in transport sector in OECD driven by lower car ownership combined with improvement in specific consumption of cars

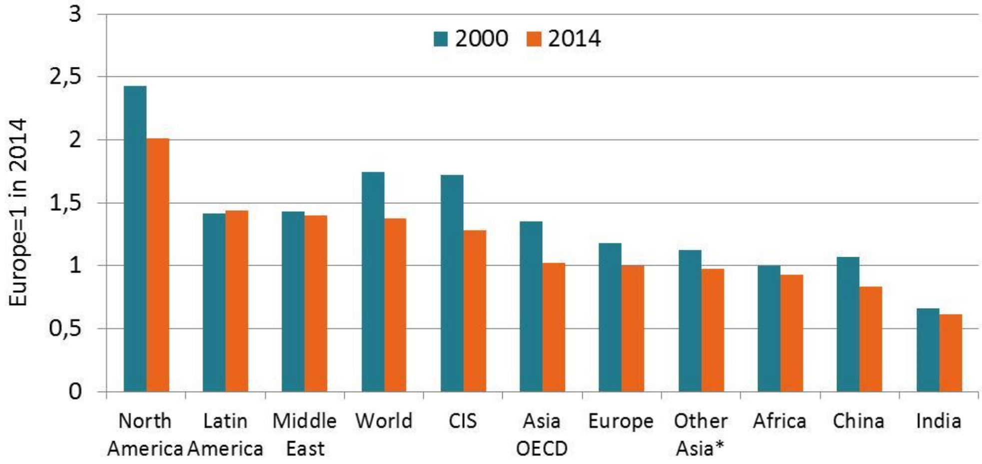
There is no good indicator to reflect the overall energy efficiency trend in the transport sector, mainly because of the variety of transport modes. The most common indicator is the energy intensity, i.e. the energy consumed in transport per unit of GDP, as transport activities take place in all sectors. North America is the region with the highest intensity in transport[31]: 80% over the world average and 2.5 times higher than in Europe, OECD Asia, other Asia and Africa (Figure 24). The US situation results from a combination of factors, such as the dominant role of cars for passenger transport with larger and less efficient cars, the highly developed air transport linked to the size of the country etc. Latin America, the Middle East and CIS are also above the world average: in these regions low motor fuel prices and a lower development of public transport (at least in Latin America and the Middle East) explain a higher intensity. In China and India, because of a lower car ownership and the dominant role of rail transport for the transport of goods, the energy intensity is low compared to the other regions.

In most regions and at world level, this energy intensity is decreasing over time, which means that the energy consumption of transport is growing much slower than the GDP. In OECD countries this trend is due to the combination of two main drivers: lower growth of car ownership and traffic, due to the saturation, and significant improvement in cars' energy efficiency linked to the policy measures implemented for new cars. In other regions, the introduction of standards on vehicles (e.g. China) and labelling schemes start to have an impact.

[31] In the ODYSSEE project for Europe, an alternative indicator is used, which combines in a single index the energy efficiency trends by mode (ODEX) (see www.odyssee.indicators.org).

FIGURE 24: ENERGY INTENSITY OF TRANSPORT

INTENSITÉ ÉNERGÉTIQUE DU TRANSPORT

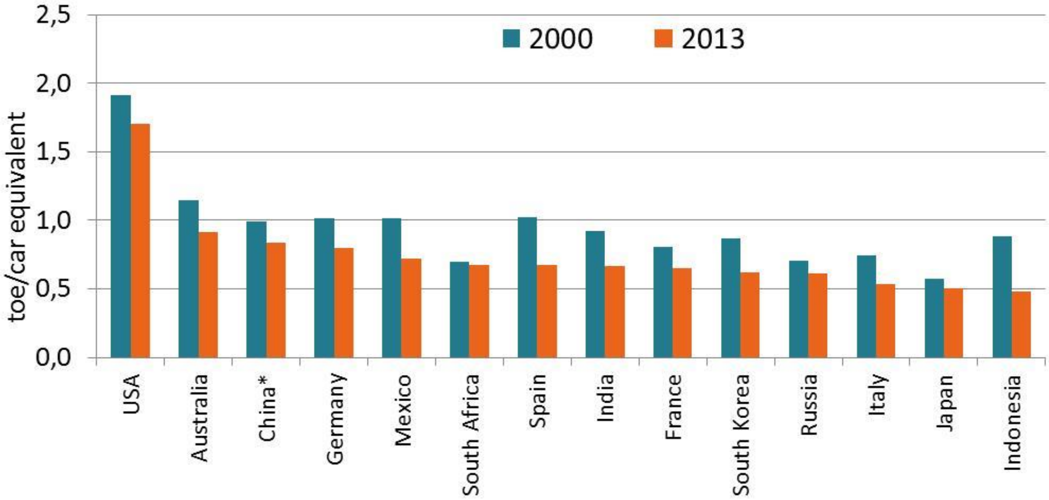


Source: Enerdata

Because of the difficulty of separating out the energy used for road transport, the dominant mode in the energy consumption (around 90%), by type of vehicles (cars, trucks etc.), the energy efficiency of road vehicles can only be measured globally for most countries on the basis of a specific indicator of unit consumption of road transport per car equivalent (Box 4). The decreasing trend of this indicator shows that the energy efficiency of road transport is improving (Figure 25).

FIGURE 25: FUEL CONSUMPTION OF ROAD TRANSPORT PER CAR EQUIVALENT

CONSOMMATION DU TRANSPORT ROUTIER PAR ÉQUIVALENT VOITURE



Source: Enerdata

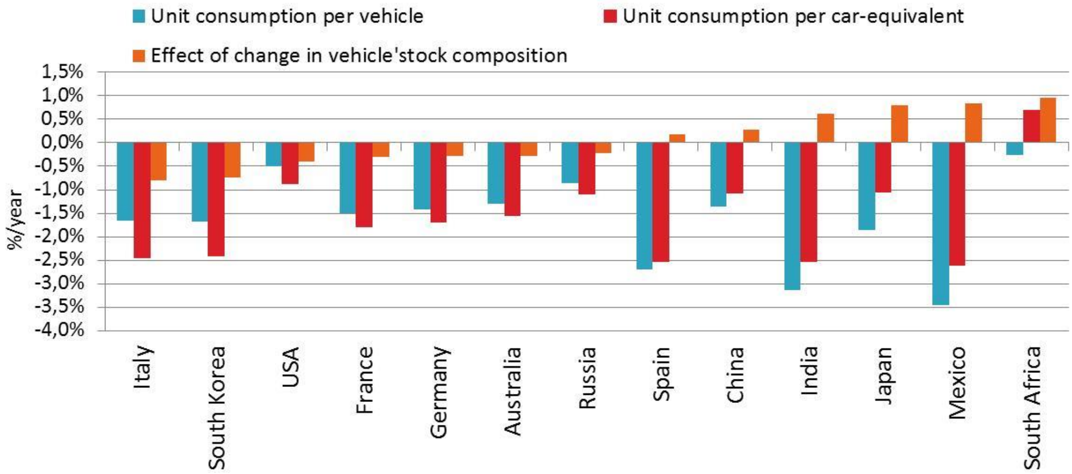
BOX 4 : CONSUMPTION OF ROAD TRANSPORT PER CAR EQUIVALENT

The consumption of road transport per car equivalent relates the total consumption of road transport to the total fleet of vehicles measured in car equivalent. With this indicator, the total fleet of vehicles is not calculated by adding all types of vehicles (i.e. cars, bus, trucks and light vehicle, and two-wheelers) but by adding their number measured in car equivalent. For instance, if a bus consumes on average 15 times more fuel per year than a car it is equivalent to 15 cars. The default values used for the calculation are: 1 bus = 15 cars; 1 truck and light vehicle = 4 cars; 1 two-wheeler = 0.15 cars.

Energy efficiency improvements can be evaluated more accurately with the variation of the unit consumption per car-equivalent, as it discounts the effect of changes in the vehicle fleet (Figure 26).

FIGURE 26: TRENDS IN ROAD TRANSPORT CONSUMPTION (2000-2013, PERCENT PER ANNUM)

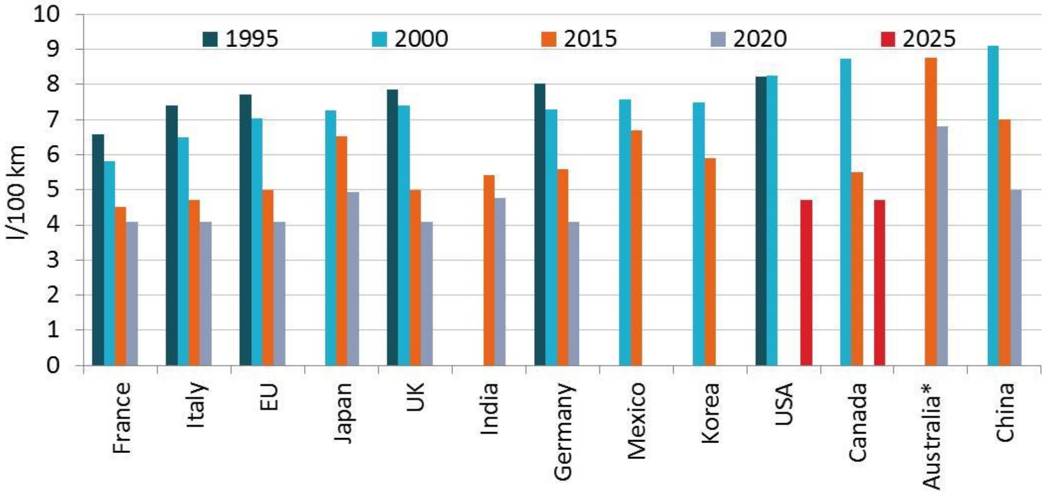
TENDANCES DE CONSOMMATION DU TRANSPORT ROUTIER PAR ÉQUIVALENT VOITURE



Source: Enerdata

There is a rapid decrease in the specific consumption of new cars in many countries thanks to the implemented measures: mandatory standards in many OECD countries and emerging countries (e.g. China, Mexico), labelling, fiscal and financial incentives and voluntary agreements (Figure 27). For instance, in EU and Japan, the specific consumption of new cars has decreased regularly since 1995 (by about 20%). This trend is expected to continue because of the ambitious targets set for 2020 and 2025.

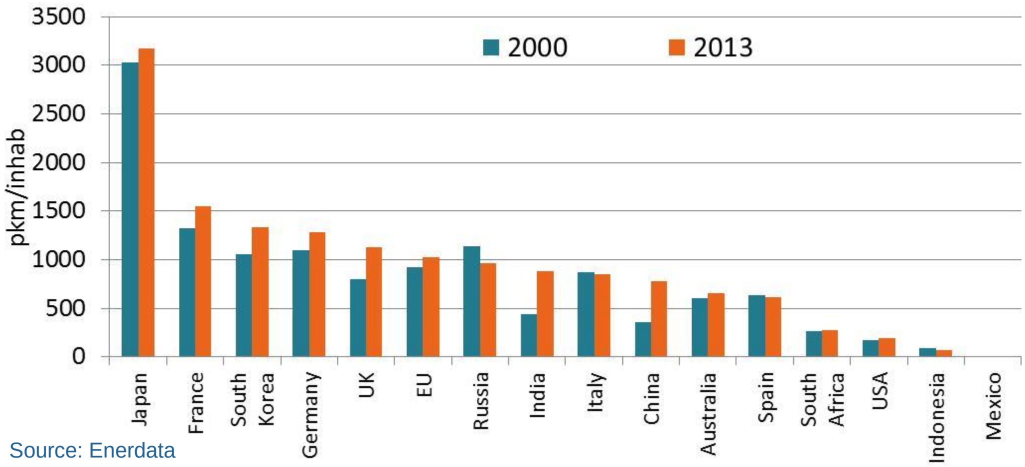
FIGURE 27: SPECIFIC CONSUMPTION OF NEW CARS (LITRES/100KM)[32] CONSOMMATION SPÉCIFIQUE DES AUTOMOBILES NEUVES



Source: Enerdata, from ODYSSEE, ICCT. Data for year 2015 correspond to national targets.

Due to their higher energy efficiency and lower carbon emissions compared to road transport, railways are an important for sustainable mobility and energy efficiency. The promotion of rail transport around the world to meet current and future challenges of mobility is becoming important. Today, there are large differences between countries in the mobility by train reflecting different priorities given to development of rail infrastructures and availability of high-speed trains. Japan is by far the country with the highest mobility by rail, with 3,000 km per annum per capita on average, followed by France, with 1,500 km per capita (Figure 28). Almost everywhere, this type of mobility is growing.

FIGURE 28: PER CAPITA RAIL MOBILITY[33] (KM PER INHABITANT) MOBILITÉ FERROVIAIRE PAR TÊTE (KM PAR HABITANT)



Source: Enerdata

[32] Test values.

[33] This indicator corresponds to the rail passengers transport in passengers-km divided by the population.

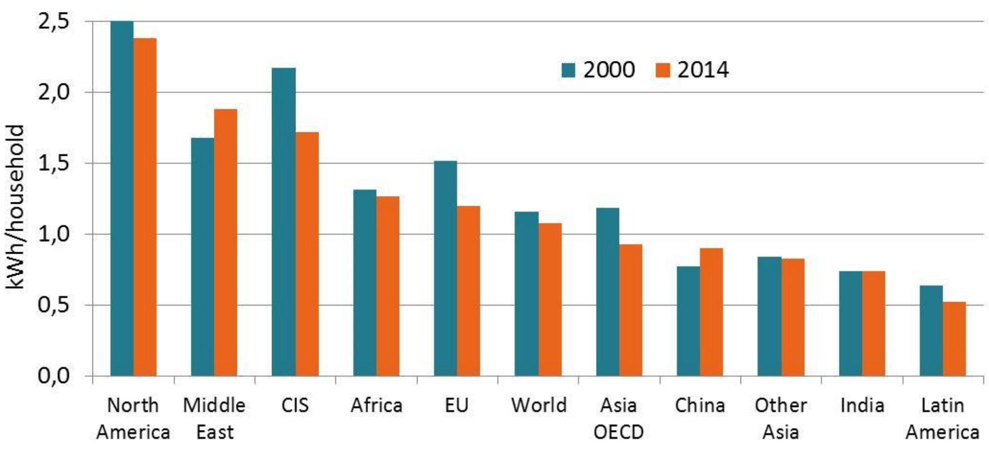
2.5 ENERGY EFFICIENCY ACHIEVEMENTS IN BUILDINGS

Improvement in specific consumption for residential buildings at global level

The average amount of energy consumed per household is decreasing almost everywhere (by approximately 0.4% per annum at world level since 2000), except in the Middle East, where air conditioning is driving energy use and in China due to fast growth in electrical appliances ownership and increased thermal comfort (Figure 29). In OECD countries, the main driver is energy efficiency improvement for space heating and electrical appliances thanks to the implementation of tightening building codes and minimum energy performance standards (MEPS) for appliances, coupled with financial incentives to promote thermal retrofitting of existing dwellings and the use of more efficient heating appliances (e.g. gas condensing boilers, heat pumps). In Latin American and African countries, the main driver of the reduction in the energy consumed per household is the substitution of biomass with modern fuels for cooking.

FIGURE 29: ENERGY CONSUMPTION PER HOUSEHOLD

CONSOMMATION D'ÉNERGIE PAR MÉNAGE



Source: Enerdata

The average consumption of electricity for appliances and lighting per electrified household is very diverse depending on the level of ownership of electrical appliances[34]: from 1,000 kWh/ household in India to 8,000 kWh in North America. For countries with a similar level of development, and thus assumed similar level of appliance ownership, there is no

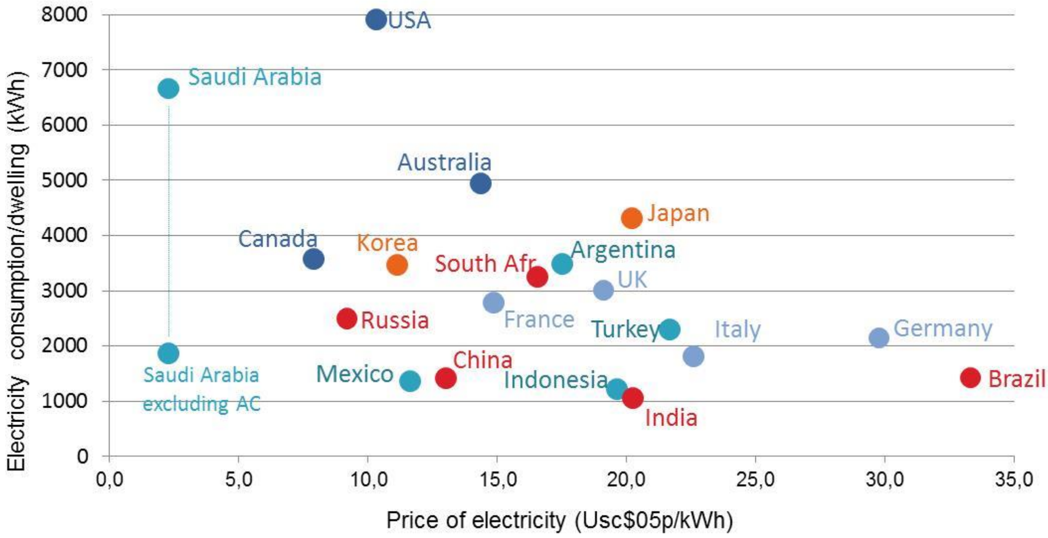
[34] The electricity consumption per household exclude thermal uses (mainly space heating): so it mainly corresponds to appliances and lighting. It is related to the number of electrified households to make the comparison more meaningful between OECD and non OECD countries.

obvious correlation between the electricity consumption per electrified dwelling and the electricity price level. For the same price level, measured at purchasing power parities (for example around 20U$c/kWh), the range is quite large, from 2,000 kWh in Italy to above 4,000 kWh in Japan (Figure 30). However, the high price of electricity in Germany explains partly its lower specific consumption compared to other OECD countries with a similar level of development.

This specific consumption is generally growing in emerging countries with the spread of appliances, whereas in OECD countries it is stable or even decreasing because of the strict policies for appliances and also because of a relative saturation in appliance ownership. For instance, the specific consumption has been decreasing by 0.8% per annum in the EU between 2010 and 2014 and by more than 2% per annum in UK and Canada[35]. Emerging countries also have implemented the same policies later, but the impact can already be seen from a slowdown in the consumption growth in recent years.

FIGURE 30: ELECTRICITY CONSUMPTION PER ELECTRIFIED HOUSEHOLD* AND PRICE OF ELECTRICITY(2014)

CONSOMMATION D'ÉLECTRICITÉ PAR MÉNAGE ÉLECTRIFIÉ ET PRIX D'ÉLECTRICITÉ



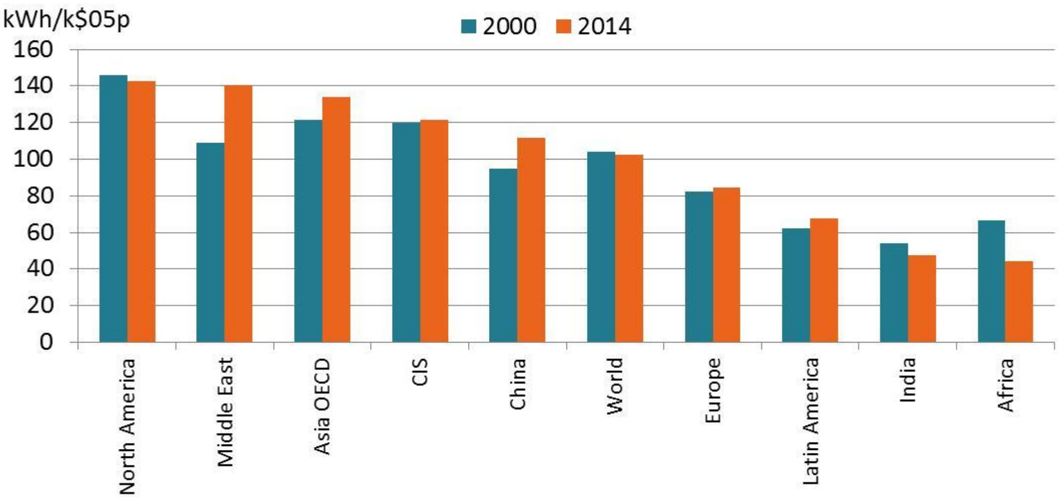
Source: Enerdata;* excluding space heating.

[35] https://www.World Energy Council-indicators.enerdata.eu/secteur.php#/specific-electricity-use.html

In the service sector (public administration, commerce and other service activities), where electricity is generally the main source of energy, the 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 information and communication technologies (ICTs) and air conditioning. There is still a large discrepancy among countries: by a factor 3.5 between North America and India or Africa (Figure 31).

FIGURE 31: ELECTRICITY INTENSITY OF SERVICE SECTOR

CONSOMMATION D'ÉLECTRICITÉ PAR EMPLOYÉ DANS LE TERTIAIRE



Source: Enerdata

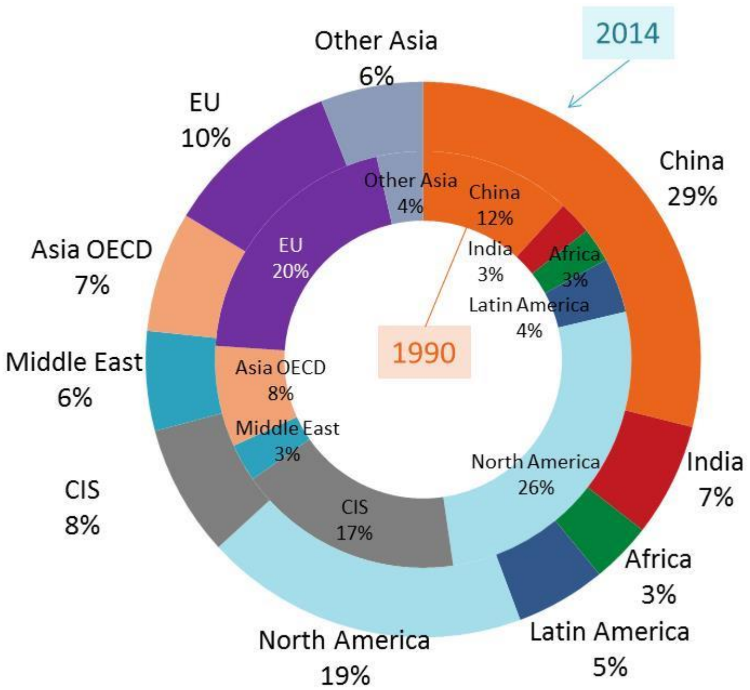
2.6 CO_2 EMISSIONS FROM ENERGY COMBUSTION

Significant and increasing share of China and India in world CO_2 emissions

With the strong economic growth in emerging countries, and thus in their CO_2 emissions, the share of OECD countries and CIS in world CO_2 emissions from energy combustion has dropped from 71% in 1990 to 44% in 2014. China's contribution to these global emissions increased by 17% (from 12% to 29%) and India's 4% (Figure 32).

FIGURE 32: DISTRIBUTION OF WORLD CO_2 EMISSIONS FROM ENERGY USE (1990 AND 2014)

RÉPARTITION DES ÉMISSIONS DE CO2 MONDIALES LIÉES À L'ÉNERGIE



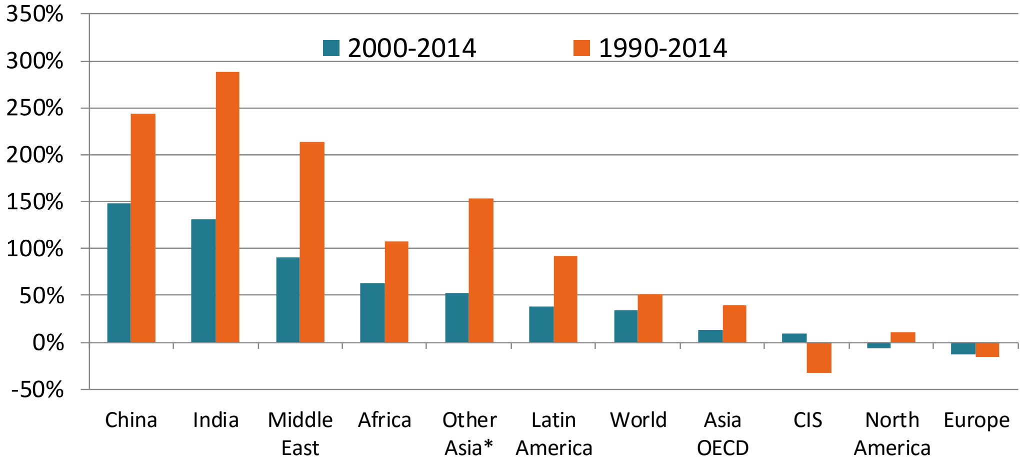
Source: Enerdata

CO_2 emissions from energy use have increased by 51% at world level since 1990 (Figure 33). Trends in CO_2 emissions vary significantly between regions: China and India have registered a very rapid increase (above 130% since 2000) because of their high economic growth with a tripling of emissions in both countries. On the other hand, there is a reverse trend in Europe where the emissions were 22% lower in 2014 than in 1990 (and 16% lower than in 2000), mainly thanks to the effective energy efficiency and renewables policies and since 2008, because of the economic recession. There is a low increase in

North America, with a 9% reduction since 2007, due to the replacement of coal by gas in power generation, as a result of the boom of shale gas. In China, India and at world level, the increase is even more rapid increase since 2000 than between 1990 and 2000.

FIGURE 33: VARIATION OF CO_2 EMISSIONS FROM ENERGY USE

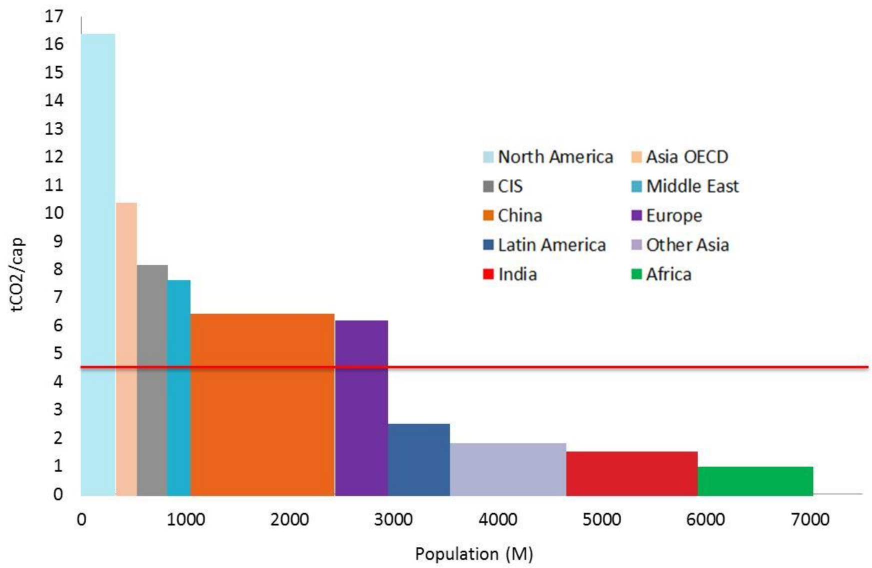
VARIATION DES ÉMISSIONS DE CO2- ÉNERGIE



Source: Enerdata

CO_2 emissions per capita (from energy combustion) vary by a factor 17 between North America and the less developed region, Africa (Figure 34), where they are below 1 tonne CO_2/cap in Africa, less than 2 tonnes in other Asia and India, 6 tonnes for Europe and China, 8 tonnes for the Middle East and the CIS, 10 tonnes in Asia & Pacific OECD and near 16 tonnes in North America.

FIGURE 34: EMISSIONS CO_2 PER CAPITA FROM ENERGY COMBUSTION[36] EMISSIONS DE CO2-ÉNERGIE PAR HABITANT



36

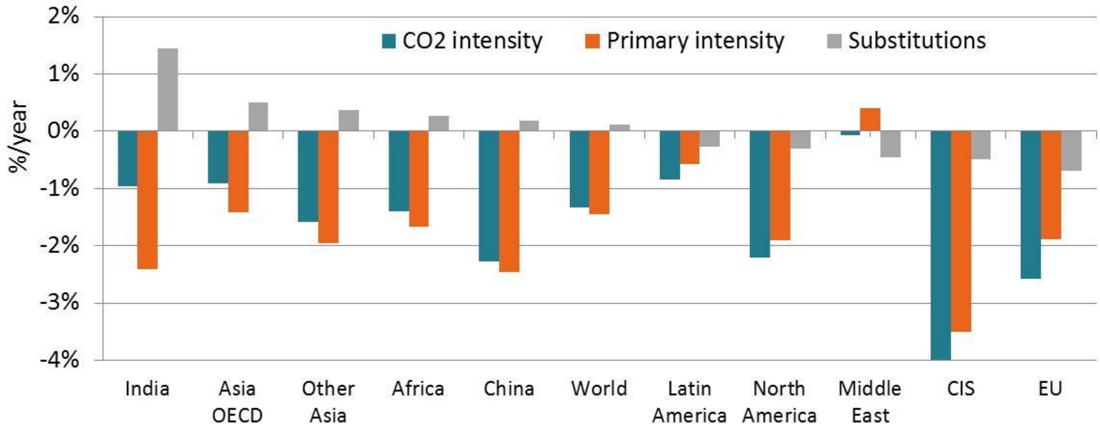
The size of colored area represents the total emissions of countries or regions.

Source: Enerdata

There is a reduction in CO_2 intensity all over the world. And most of this reduction was driven by a decrease in energy intensity and not by a change in the fuel mix, especially in Africa, at world level, in CIS and in Europe (Figure 35). In Asia, substitutions to fuels with higher CO_2 content (e.g. coal) have offset part of the effect of the energy intensity reduction.

FIGURE 35: VARIATION IN CO_2 INTENSITY (2000-2014): IMPACT OF ENERGY EFFICIENCY AND FUEL SUBSTITUTIONS

VARIATION DE L'INTENSITÉ EN CO2 (2000-2014) : IMPACT DE L'EFFICACITÉ ÉNERGÉTIQUE ET DE LA SUBSTITUTION D'ÉNERGIE



Source: Enerdata

Chapter 3
Energy efficiency policies: common, current and innovative practices

3.1 A STRONGER INSTITUTIONAL CONTEXT

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

- Firstly, what is the degree of commitment to energy efficiency? This can be monitored by quantitative targets to be achieved in the framework of the energy efficiency programme, as well as by energy efficiency laws.

- Secondly, 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 specific institutions (e.g. agencies).

3.1.1 MORE THAN 50% OF COUNTRIES HAVE IMPLEMENTED NATIONAL ENERGY EFFICIENCY LAWS

The adoption of energy efficiency laws or energy laws with a strong component related to energy efficiency is becoming a common approach worldwide to consolidate the institutional commitment to energy efficiency. A law gives a more durable status to energy efficiency policies as changing an existing law may often be a complex process. Energy efficiency laws may avoid to a certain extent the “stop and start” on energy efficiency policies linked to political changes.

Often these laws provide a legal framework for the adoption of targets or other regulations, such as labelling, MEPS (e.g. Kenya, New Zealand, Singapore, etc.), obligations for large consumers (e.g. India) or even energy savings obligation for utilities (e.g. France, China) or energy audits (e.g. Ireland). Energy efficiency law may also provide a legal framework for setting up an energy efficiency fund (e.g. Thailand, Uruguay). 50 World Energy Council’s member countries have implemented energy efficiency laws and four countries are developing the law (Figure 36); compared to the previous survey in the 2013 edition of the report there are ten additional countries.

FIGURE 36: COUNTRIES IMPLEMENTING ENERGY EFFICIENCY LAW

PAYS AYANT UNE LOI SUR L'EFFICACITÉ ÉNERGÉTIQUE

Source: World Energy Council's energy efficiency policies database 2016

3.1.2 TARGETS: 90% OF SURVEYED COUNTRIES SET QUANTITATIVE OBJECTIVES

The adoption of national energy efficiency programmes with quantitative targets is now fairly common: 90% of the countries surveyed[37] in 2015 had set at least one target, which represents 4% more compared to 2012.

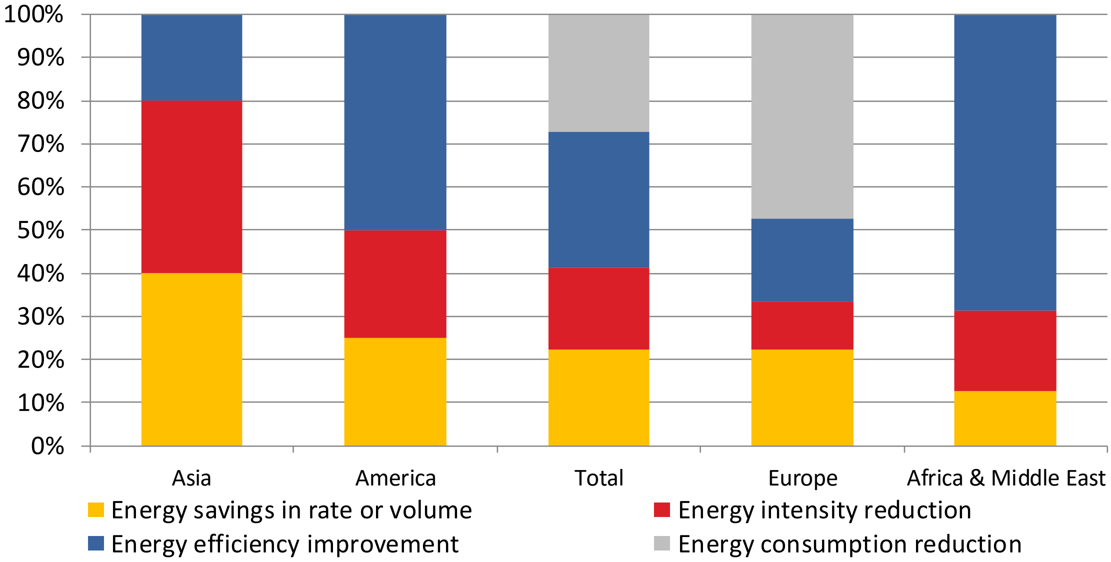
The targets are expressed in different ways and vary across regions. They can refer first of all, to a rate of energy savings or efficiency improvement, which is the most common target used in 2016 (Figure 37). This is the case in all EU countries covered by the Energy Efficiency Directive (EED)[38]. Objective of energy consumption reduction compared to a reference historical year is a much stricter target that is now also required by EED in EU countries. Targets for energy intensity reduction are more common in other regions such as Asia (e.g. China where targets are set at provincial level in the Five Year Plan 2011-2015, New Zealand, South Korea, Sri Lanka, Thailand, etc.).

[37] For the rest of the report we call the surveyed countries the 54 countries that participate to the survey (equivalent to participation rate of 56% of the 96 WORLD ENERGY COUNCIL countries).

[38] The Energy Efficiency Directive of 2012 imposes to all member countries a rate of 1.5% per year additional energy savings between 2014 and 2020 (based on historical energy sales).

FIGURE 37: MAIN QUANTITATIVE TARGETS OF ENERGY EFFICIENCY PROGRAMMES

PRINCIPAUX OBJECTIFS DES PROGRAMMES D'EFFICACITÉ ÉNERGÉTIQUE

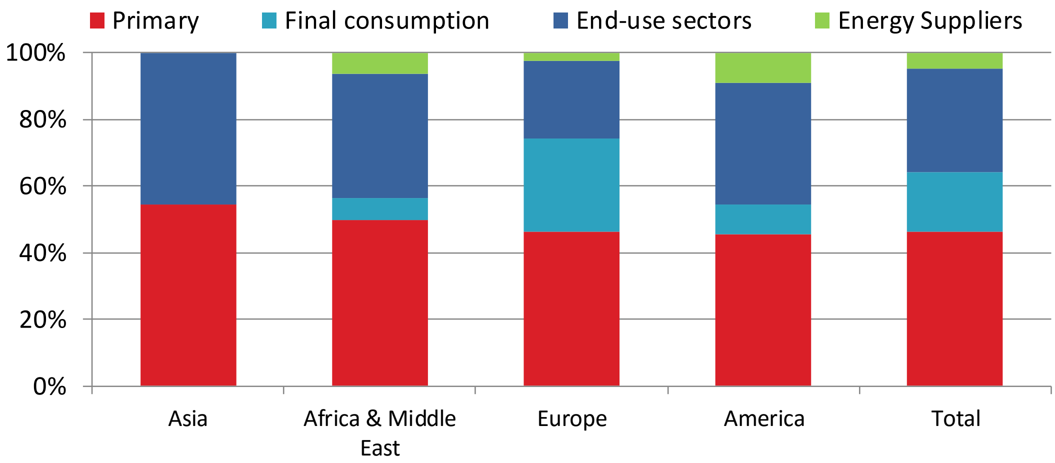


Source: WORLD ENERGY COUNCIL energy efficiency 2016 survey

At world level, about 75% of targets are related to total energy consumption (either primary or final) and half of the surveyed countries have end-use sector targets (i.e. targeting residential, industry or transport), and the remaining targets are for energy suppliers (e.g. Poland, South Korea, South Africa and USA (Figure 38). Different world regions focus on different measures. In Europe targets for the total final consumption are more important because of the EED Directive. Most surveyed countries have implemented several targets (e.g. two on average in Europe) and in total half of the targets are for primary energy and 30% for end-use sectors.

FIGURE 38: DISTRIBUTION OF POLICY TARGETS BY REGION

MODE D'EXPRESSION DES OBJECTIFS POLITIQUES

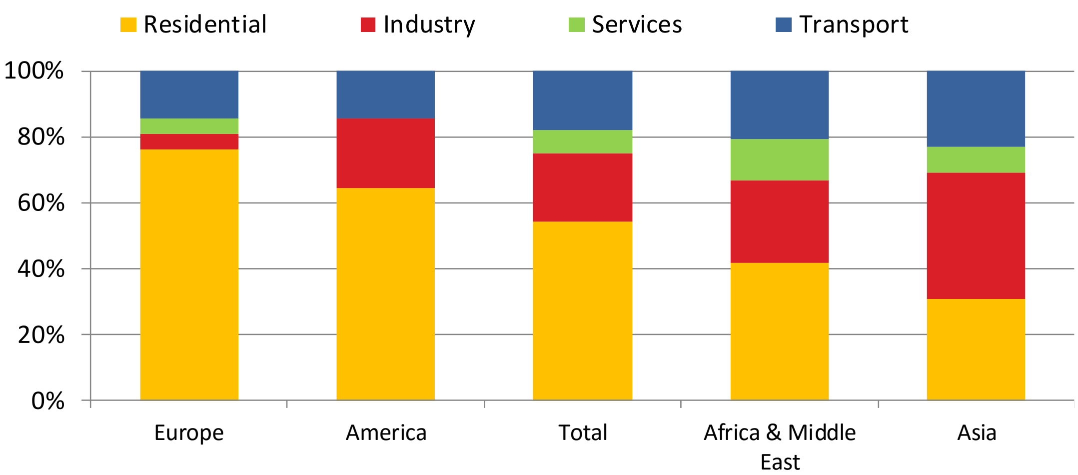


Source: World Energy Council Energy Efficiency Survey 2016

In total, 10 of the surveyed countries in Europe had sectoral targets, 6 in Africa/Middle-East, 5 in Asia and 4 in America. On average more than half of the sectoral targets concern the residential sector (thermal retrofitting, new buildings, solar water heaters, lighting, or electrical appliances) and around 21% the industrial sector (energy audits or targets on energy intensity, or energy consumption reduction). Targets in industry are particularly important in Asia (Sri Lanka, South Korea, New Zealand, Japan), while targets for the residential sector are dominant in Europe and America (Figure 39).

FIGURE 39 : TARGETS FOR ENERGY EFFICIENCY PROGRAMMES BY END-USE SECTOR

RÉPARTITION DES OBJECTIFS D'EFFICACITÉ ÉNERGÉTIQUE PAR SECTEUR



Source: World Energy Council Energy Efficiency Survey 2016

3.1.3 60% OF COUNTRIES HAVE SET UP A NATIONAL ENERGY EFFICIENCY AGENCY

Some measures, such as energy pricing or introduction of international standards may be implemented without a specific energy efficiency institution. But most of the time the implementation of energy efficiency programmes requires a dedicated technical body able to reach scattered and multiple energy consumers.

An energy efficiency agency is defined here as “a body with strong technical skills, dedicated to implementing the national energy efficiency policy”[39]. Such agencies are usually separate from ministries, but may be part of a ministry, e.g. in Denmark, Canada or the US. Energy efficiency agencies are increasingly recognised as necessary instruments to foster energy efficiency policies. As a whole, 60% of countries (i.e. 58 countries) have a national energy agency (Figure 40). Energy efficiency agencies have the mission and capabilities to design, implement and evaluate programmes and measures, contract a range of stakeholders, such as companies, local authorities, or NGOs and, finally ensure coordination with all levels of authorities (international, national, regional and local).

These agencies are usually public institutions funded by the state budget, and 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), whilst others are expected 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. In addition, many other countries have set up local or regional agencies[40]. More than three quarters of the 58 surveyed countries have local or regional agencies. It is estimated that there are now around 800 local or regional agencies at world level, 400 of which are in Europe. These regional and local agencies aim at providing more targeted information and measures, as they are closer to consumers and are better able to take into account regional circumstances (climate, energy resources, etc.). The primary objective of all these institutions is to provide technical expertise to governments and consumers, which 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 effective deployment, energy agencies can play an ongoing role in that field by certifying those which have the required quality. Government ministries do not always have the required expertise to carry out the activities of energy agencies.

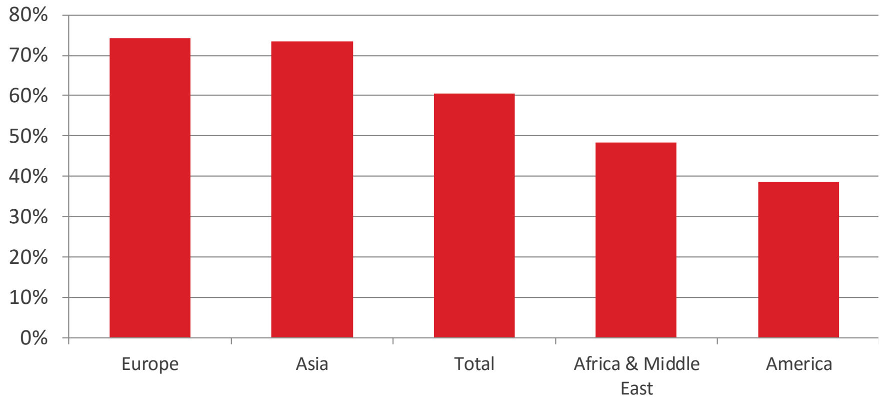
[39] In some countries they have a broader scope and cover renewables as well as environmental policy (e.g. France, the Netherlands).

[40] In some countries with a national energy agency, there exist regional offices of the national agency (e.g. ADEME in France with 28 offices).

Another important function for agencies is to act as a coordinator of all governmental initiatives in the field of energy efficiency to avoid scattered and uncoordinated actions by different ministries. In particular, such agencies have 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 in addition act as the national representative with whom donors can negotiate the implementation of financial packages for energy efficiency.

FIGURE 40: COUNTRIES WITH AN ENERGY EFFICIENCY AGENCY

PAYS DISPOSANT D'UNE AGENCE D'EFFICACITÉ ÉNERGÉTIQUE



Source: World Energy Council energy efficiency policies database 2016

3.1.4. THE POLICIES AND MEASURES IMPLEMENTATION TOOLBOX

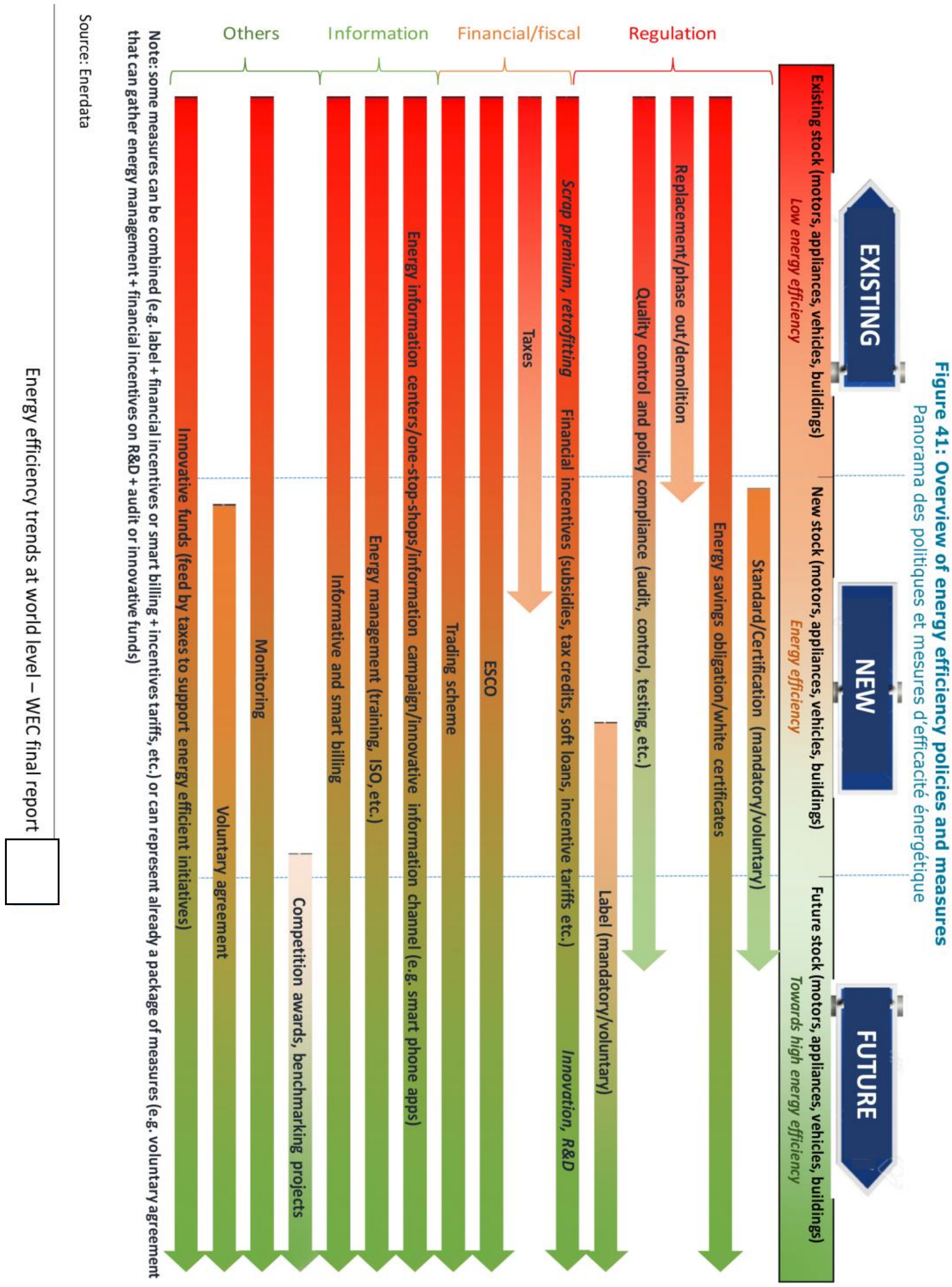
Scaling up energy efficiency needs an integrated enabling environment where regulations are necessary but finance is also part of the project. Public stakeholders use various types of policy instruments (P&Ms) to improve energy efficiency. These include most often regulations, financial and fiscal instruments and information. P&Ms target several sectors (or end-uses) and can be implemented or be relevant at the different phases of development. For instance, phasing-out programmes are necessary to remove old and inefficient stocks, while MEPS provide minimum energy performance standards for new appliances or buildings and energy efficiency labels guide consumers towards the more efficient appliances and buildings.

For example, policies and measures for electric motors must cover all phases of the motor lifecycle, ranging from product development and marketing to procurement and use. Figure 41 shows the lifecycle stages and some applicable policies and measures in each of them. The majority of policies and measures are addressing the efficiency of new motors. Minimum Energy Performance Standards (MEPS), energy labels, procurement tools as well as subsidies and tax rebates all address energy efficiency. If properly enforced, MEPSs are a strong policy tool for new motors, but the number of motors replaced or new investments in motors constitute only a fraction of the total motor stock. Moreover, MEPSs have no influence on correct sizing, installation and running time. Therefore, a balanced portfolio of supplementing policies and measures is needed. The use phase is very important as well and special situations, since they all have efficiency implications. This phase can be addressed by energy inspection management and energy services (e.g. energy audits), information measures and electricity taxation. One noteworthy fact is that motors are quite often used beyond their planned service lives. The service life of motors has generally been estimated at between 10-20 years but Swiss surveys have found a large proportion of older motors still in use, with some units up to 60 years old. If this finding is applicable to other markets, it suggests that the turnover of the stock will be slower than has often been foreseen (IEA 2015). Therefore, measures addressing only procurement do not suffice.

Figure 41 summarises the different P&M covered in the World Energy Council's survey according to their type and relevant phase of development. However, most of the time a "package of measures" is used to ensure the compliance or acceptability of measures: for instance, a regulatory framework is often linked to or accompanied by a financial incentive.

FIGURE 41: OVERVIEW OF ENERGY EFFICIENCY POLICIES AND MEASURES

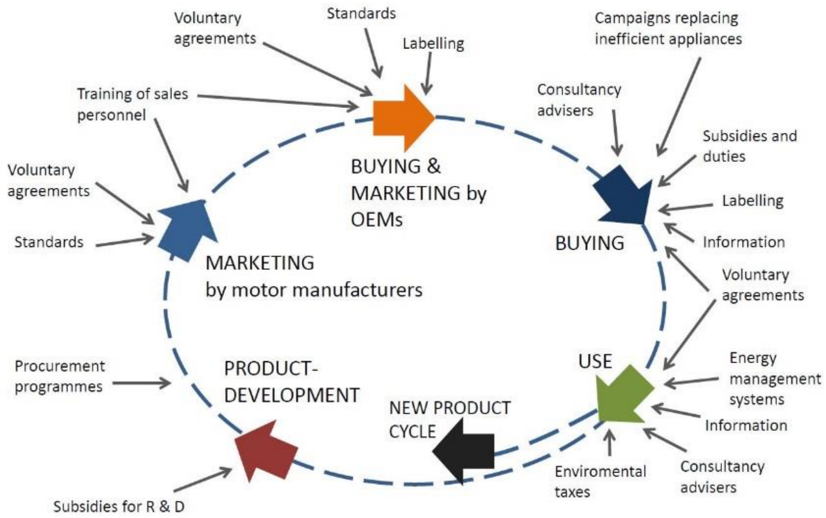
PANORAMA DES POLITIQUES ET MESURES D'EFFICACITÉ ÉNERGÉTIQUE



Source: Enerdata

FIGURE 42: POLICIES BY PRODUCT CYCLE PHASE – CASE OF ELECTRIC MOTORS

POLITIQUES PAR PHASE DU CYCLE DE VIE -CAS DES MOTEURS ÉLECTRIQUES



OEM = Original Equipment Manufacturer[41]
Source: based on IEA 2011, modified by Motiva for the World Energy Council's case study on electric motors

Results of the 2016 World Energy Council survey show that regulations are still widely used and accounted for more than 50% of all measures in 2015 (Figure 43)[42] because they have been proven effective in reducing energy consumption of specific appliances and equipment and speeding up the deployment of energy efficient equipment, energy savings investments and practices.

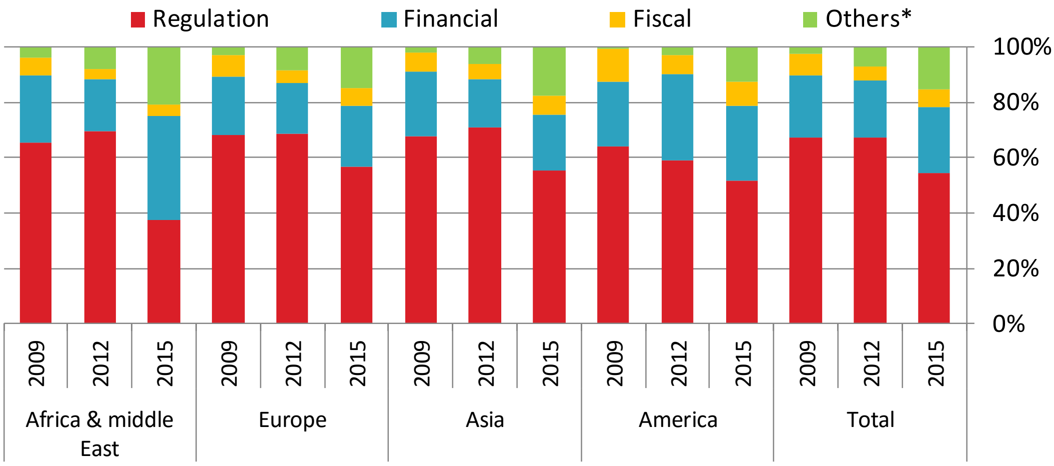
Regulations are more powerful than traditional incentives to transform the market as they are mandatory for the consumers. The effect of incentives is often weak as it depends on the changes of behaviour of millions of consumers most of whom lack information and resources. However, the impact of regulations depends on their enforcement or on the accompanying measures making enforcement more acceptable. In most regions the share of regulations in the policy toolbox is decreasing (e.g. Africa and the Middle East), leading other measures such as financial/fiscal measures or Energy Service Company (ESCO), particularly in Asia.

[41] OEM is a company that makes a part that is marketed by another company typically as a component of the second company's product. In the case of motors, it means a manufacturer of equipment that uses a motor.

[42] As explained above, measures on information are not included here.

FIGURE 43: DISTRIBUTION OF MEASURES BY TYPE

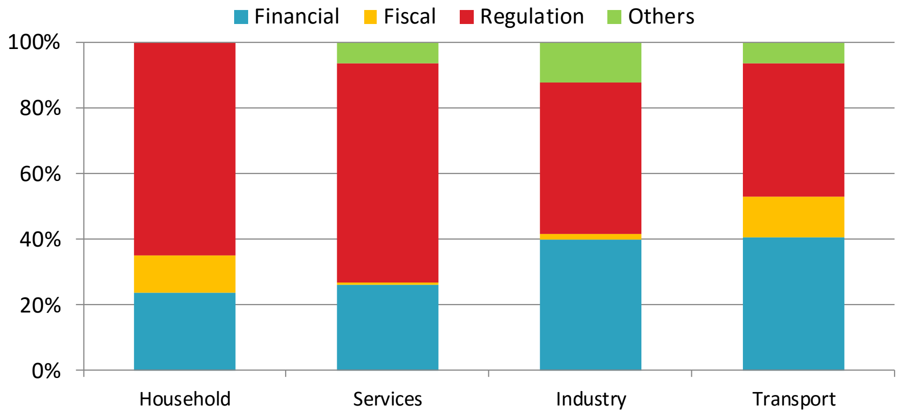
RÉPARTITION DES MESURES PAR TYPE



Source: World Energy Council's energy efficiency 2016 survey
* Others correspond to voluntary agreements, ESCO and certification

If regulations are important in the residential and service sectors (appliances, labelling, building codes & certificates), financial incentives are more important in industry or transport (e.g. grants for energy audits) where competitiveness should not be affected by regulations (Figure 44). Fiscal incentives are less common and are shared between transport (e.g. tax exemption on efficient car or malus/tax on least efficient or pollutant vehicle) and households.

FIGURE 44 : DISTRIBUTION OF MEASURES BY END-USE SECTOR AND BY TYPE - RÉPARTITION DES MESURES PAR SECTEUR ET PAR TYPE

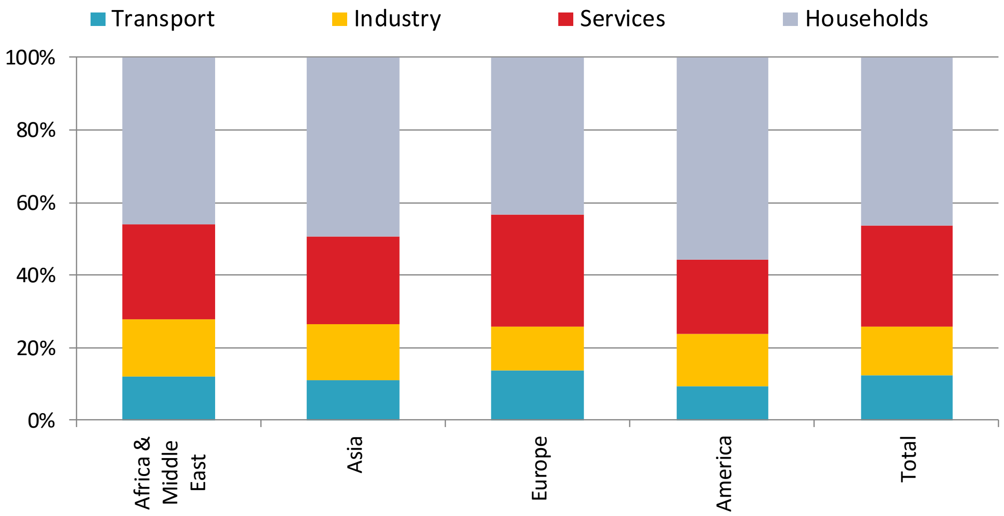


Source: World Energy Council's energy efficiency survey 2016

In all regions, buildings (households and services) account for 75% of all measures, of which around half are for households (46% on average). In Europe there is an increasing focus on services, the only sector where energy demand is still growing. Measures in transport are limited and not in line with its share of the consumption.

FIGURE 45 : DISTRIBUTION OF MEASURES BY SECTOR AND BY REGION

RÉPARTITION DES MESURES PAR SECTEUR ET PAR TYPE



Source: World Energy Council's energy efficiency survey 2016

3.2 LARGE SCALE DEPLOYMENT OF ENERGY EFFICIENCY REGULATIONS TO TRANSFORM THE MARKET

Considering the size and continuous growth of household appliances market worldwide, equipment efficiency is a very significant aspect of energy efficiency strategies. Governments often resort to establishing MEPS and promoting energy labels for electrical appliances, motors or buildings to remove the inefficient products from the markets. These regulations force producers to replace their current product portfolio by more efficient devices. At the same time, consumer awareness is raised and focused on efficient and cost saving solutions.

3.2.1. LABELS TO GUIDE CONSUMERS AND MOTIVATE MANUFACTURERS

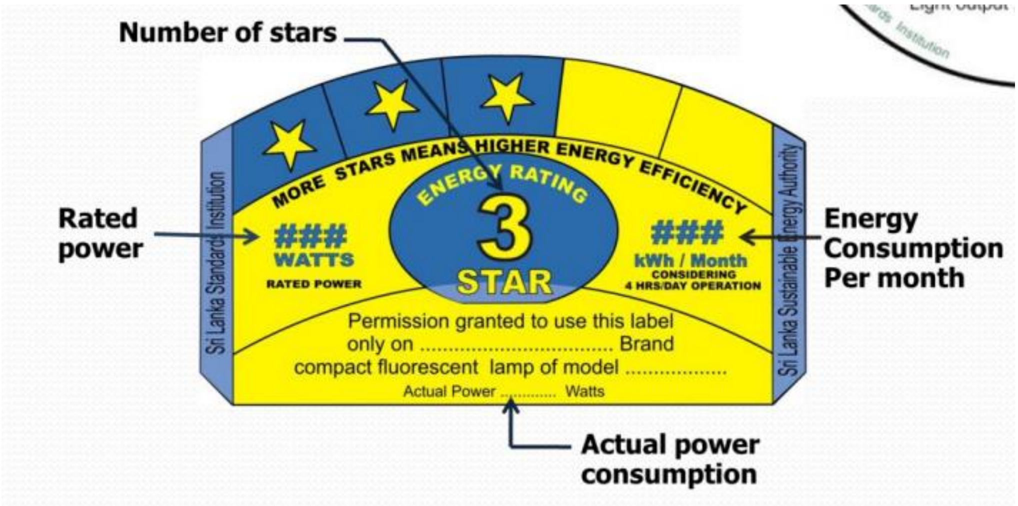
Among regulations, mandatory energy efficiency labels are widely implemented and are important to guide consumers and motivate manufacturers. Energy labels increase the number of efficient appliances or stocks by raising awareness about energy performance, and allowing comparison across all models and technologies. Some countries have however favoured a voluntary approach which is usually just a transition phase before making measures mandatory.

Labels are often among the first measures to be introduced, generally for refrigerators. Labelling encourages consumers to purchase more efficient appliances (refrigerators, washing machines, air conditioning, lamps, etc.) and manufacturers to remove inefficient appliances from the market. Labels are now extended from new electrical appliances to cars, buildings (residential and public or commercial buildings) and electric motors. Labels enable consumers to identify the energy efficiency performance or CO_2 emissions of new equipment and appliances.

There are essentially two types of energy labels in use: comparative energy efficiency labels and endorsement labels. Energy labels are typically comparative with several categories (e.g. 1-5 stars or alphabetical rating).

FIGURE 46 : EXAMPLE OF COMPARATIVE LABEL IN SRI LANKA

EXEMPLE DE LABEL COMPARATIF AU SRI LANKA



Source: Sri Lanka Sustainable Energy Authority

A product receives a label according to pre-set criteria and competition is created between models based on the rating. The system can be mandatory covering all products in a given product group or voluntary when not all products in the market must be labelled. Energy labels can be used in combination with MEPS, whereby the lowest rating is the same as the MEPS minimum level. In design of comparative labels, it is important that the scale is sufficiently broad to allow adequate differentiation between products and to avoid 'bunching' of products within one category at the top of the scale. In programme design of endorsement labels, the threshold for eligibility must be sufficiently high to accurately differentiate the best in the market from the majority. The thresholds for all types of labels should be periodically reviewed and adjusted to reflect advances in technology.

80% of countries have label schemes, or plan to implement one. Labels are mandatory in most countries (Figure 47) and the number of mandatory labels for household equipment exceeds 20 in 8 countries, including Brazil, Chile, Japan and New Zealand. In total 40 countries have more than 10 labels: EU countries, China, South Korea, North America, Costa Rica, for example.

FIGURE 47 : NUMBER OF MANDATORY LABELS FOR HOUSEHOLD EQUIPMENT (2015)

NOMBRE DE LABELS OBLIGATOIRES POUR LES ÉQUIPEMENTS MÉNAGERS (2015)

Source: World Energy Council's energy efficiency policies database 2016

Labelling is well developed for refrigerators, and it is currently mandatory in 60 countries and planned in 11 more. Air conditioning labelling is mandatory in 58 countries and planned in 11 more countries.

FIGURE 48 : LABELS FOR REFRIGERATORS IN RESIDENTIAL SECTOR (2015)

LABEL POUR LES RÉFRIGÉRATEURS DANS LE SECTEUR RÉSIDENTIEL (2015)

Source: World Energy Council's energy efficiency policies database 2016

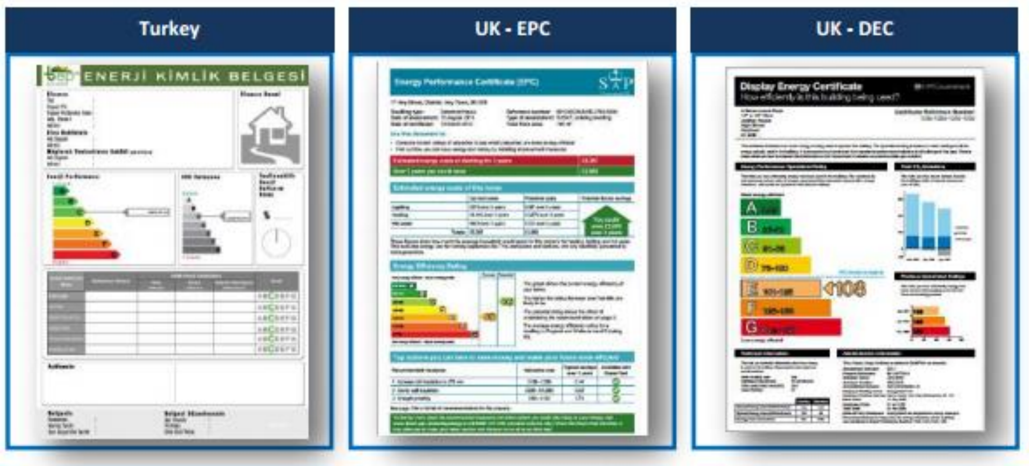
Building Energy Ratings or Energy Performance Certificates

Labelling programmes are now common for new residential buildings: 30 of the surveyed countries have a labelling programme already in place and nine more plan to introduce label on dwellings in the coming years, as well as a significant extension of building codes and standards. These labels, known also as “energy performance certificates” or “building energy rating” (BER), are designed to show the energy performance of buildings based on how much energy they consume (Figure 49). While building codes are widely enforced in new buildings, BERs target both existing and new buildings: 23 countries have labels on existing residential buildings. They evaluate the energy use of buildings, rate them on a particular scale and communicate this information to public through energy efficiency labels or certificates. The labels ensure transparency and the opportunity to compare similar buildings. The overall aim is to raise awareness and push the market towards an increased demand for energy efficient buildings. BERs are mandatory in 18 or in about one-third of surveyed countries, for instance most EU countries, Mexico, Japan Tunisia, China, Turkey and certain cities in USA. In all these countries and in EU member states, the energy rating information has to be disclosed during sale and lease. Real estate advertisements must include the energy performance information in Australia, France, Germany and UK.

Other countries, for example, Brazil, Canada, India and Republic of Korea have voluntary building energy rating systems. In all countries, the rating is done by a governmental department or agency, except in France, UK and certain US and EU states where the rating is done by an accredited expert or organization. Chile has an innovative energy efficiency label with two dimensions: building shell efficiency and heating appliance efficiency.

FIGURE 49 : EXAMPLES OF BUILDING ENERGY RATING LABELS

EXEMPLES DE LABEL DE PERFORMANCE ÉNERGÉTIQUE DU BÂTIMENT



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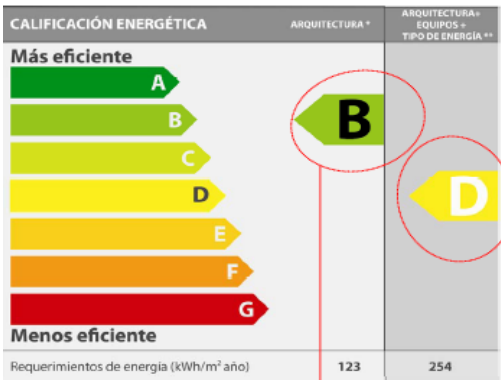


Source: BuildingRating.org

Some countries do not yet have building energy efficiency labels. The countries who have introduced their energy efficiency standards after 2000 might be lacking the information, infrastructure and resources to develop proper building rating tools. However green building rating systems, which assess the full environmental effects of buildings rather than focusing on energy consumption have become the main rating tool in some of these countries and seem to be an efficient tool for implementing energy building code, such as Korea (Green Building Certification KGBC), Australia (Green star), India (Green Rating for Integrated Habitat Assessment-GRIHA or Japan (Comprehensive Assessment System for Building Environmental Efficiency-CASBEE). Thailand shows a good example by making Green Rating Mark mandatory. Also Turkey gives a good example of implementation of Energy Performance Certificate (ECP). China has recently developed green building and building energy-efficiency labelling programmes tailored to its national context in addition to mandatory building codes. These labelling programmes represent the central (and in some cases local) governments' recognition of the need for market-based as well as regulatory measures to promote building energy efficiency. China's MOHURD has taken the lead in establishing a domestic green building label and a building energy efficiency label, both of which are voluntary but beginning to emerge in the building market. The green building labelling programme, in particular, is growing rapidly in coverage and is likely to continue, with concerted government efforts to establish demonstration projects and financial incentives. Both labelling programmes evaluate theoretical and operational energy consumption, but the limited availability of building experts and high transaction costs hinder greater adoption of these labels. In addition, both labelling programmes are new and face the typical challenges of a new programme, including lack of public awareness as well as ambiguity and unclear distinction between the two programmes and resulting consumer confusion between the two labels (more information available on 2016 Energy Building Code World Energy Council's case studies).

BOX 5: THE INDIAN RATING SYSTEMS

India's GRIHA (Green Rating for Integrated Habitat Assessment) and the LEED green building rating systems are the most popular building labelling systems in the country. Both rely on Energy Conservation Building Code (ECBC) guidelines to assess a building's energy efficiency in the commercial sector. Between the two, the GRIHA system is more closely linked with typical India building operational characteristics such as significantly reduced demand for cooling. The national government and several state governments support GRIHA, with four states requiring GRIHA rating for government buildings and the national government requiring GRIHA compliance in all new national government buildings.

The BEE's Star Rating System evaluates buildings based on operational energy use and is the only energy-use-specific building label used in India.

LEED buildings are still more costly than regular buildings. However, despite high costs, LEED received strong initial support and, in 2010, India ranked second in LEED-registered building floor space only to the United States. LEED has registered more than 1.1 billion m2 of LEED building projects until 2013.

ECBC is having a positive effect. Commercial buildings certified for energy efficiency now account for 1.2bn square feet (about 111 Mm2) of space. Although experts say the true impact of the ECBC's implementation may be greater because some building owners are willing to simply secure energy savings rather than going through multiple procedures to become certified.

Source: World Energy Council's case study on Energy Building Code, ECOTECH

Among the lessons learned, the EU experience demonstrates how long time it takes to train the work force necessary to implement a building labelling programme. It took member states from a few to up to six years to implement the EU directive on labelling, in part due to the need to establish a political consensus. Government and industry associations can facilitate training and ensure future high-quality energy assessments by providing well-designed training and guidance tools and software. European experience also shows that labelling programme benefits are enhanced when these programmes operate in tandem with other policies and as part of a package of measures. Many countries have financial incentive schemes in which the performance criteria are determined by a label requirement.

Labelling for electric motors

Electric motors and electric motor-driven systems (EMDS) in industry absorb almost half of the total electricity use. EMDS are estimated to account for approximately 70% of the electricity consumption in the industry. The cost-effective potential to improve energy efficiency of motor systems is roughly 20% to 30%, which would reduce the total global electricity demand by about 10%. Many policies and measures are in place to increase the efficiency of new motors, in particular their labelling.

Comparative or endorsement labels for electric motors on a mandatory (most EU countries, China, Brazil, Japan, Mexico, New Zealand, Korea, USA, Vietnam) or voluntary basis (Argentina, India) are in place in numerous markets. These increase the visibility of energy efficient alternatives. International awards on efficient motors have the same effect, however, they are not as well known by those making procurement decisions. Endorsement labels given to products fulfilling pre-set criteria create market advantage for producers whose products are labelled. An example is the Procel Seal in Brazil (see case studies on electric motors[43]) which is part of the Procel Programme. As of November 2015, 183 models had the label.

In China, to qualify for the label, small and medium motors must meet the requirements specified in the Chinese National Standard GB 18613-2012. The grades are in line with the classes in international standards IEC 60034-30 (IE2/IE3 motors-see Box 6) and IEC 60034-31 (IE4 motors). Motor efficiency must meet the specified level both at 100% and 75% loads. The labelling scheme complements a MEPS scheme whereby the minimum acceptable level is IE2.

In India, the label consists of 1-5 stars depending on the efficiency. The labelling scheme complements a voluntary standard (and a forthcoming MEPS in 2016) whereby the minimum acceptable level is IE2.

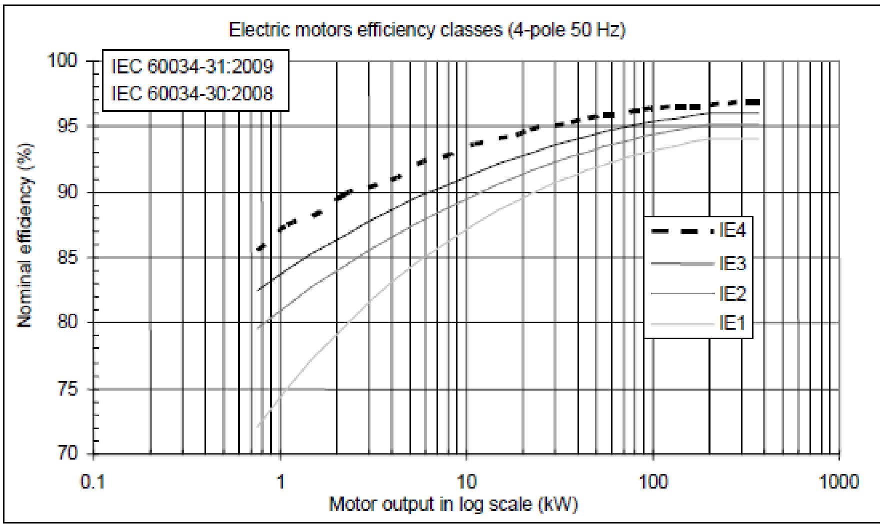
The Extended Motor Product Label Initiative (EMPLI) is a US based collaborative effort to develop voluntary labels for motor-driven systems (e.g., a fan, pump, or compressor and the motor and associated controls) based on test standards, metrics and MEPS concurrently being developed by the US DOE. EMPLI involves over two dozen representatives from the motor-drive equipment manufacturing sector, trade organizations, utilities, energy efficiency programme administrators, and energy efficiency nongovernmental organizations. The American Council for an Energy-Efficient Economy (ACEEE) has functioned as the convening organization. The performance metric has not been decided yet and it could be numerical (e.g., 40, 50, 60, and so on) or strictly comparative (e.g., “good,” “better,” “best”). It is anticipated that companies could require the forthcoming label as a purchasing specification as is the case with the NEMA Premium level for motors. The new labels can also be combined with energy efficiency programmes

[43] http://www.worldenergy.org/data/energy-efficiency-policies-and-measures/

by utilities as they will simplify the measurement and verification (M&V) for incentive programmes by establishing straightforward eligibility requirements and the associated deemed energy savings.

BOX 6: TECHNICAL DEFINITION OF IE CLASSES

The efficiency of an electric motor is the ratio of mechanical output power to electrical input power. IEC 60034-30 is an international standard of the International Electrotechnical Commission for rotating electrical machinery (IEC 2014). It specifies four classes: IE1 (standard), IE2 (high), IE3 (premium) and IE4 (super premium). A new class IE5 is not yet defined in detail but is envisaged for potential products in a future edition of the standard. The following graph shows the nominal efficiencies (%) of different motor sizes in each efficiency class depending on motor size. A motor of a given size is labelled in an efficiency class based on its nominal efficiency.



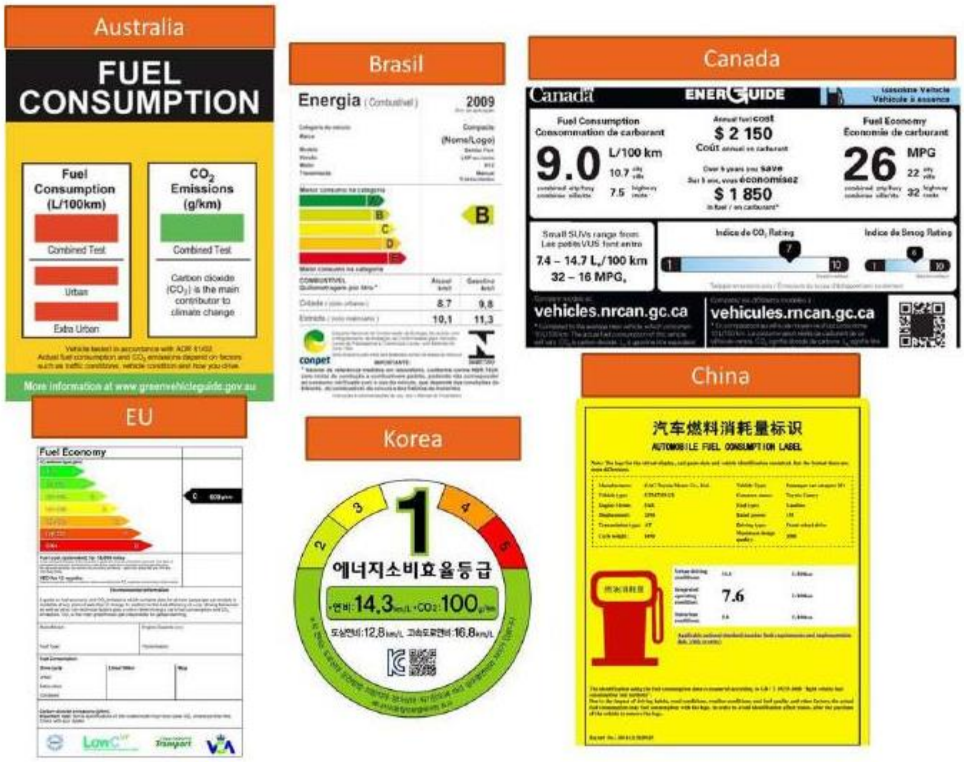
Source: IEA 2011, fig. 3.

Labelling for cars and trucks

As for electrical appliances or motors, energy labels aim to increase the number of efficient cars by raising awareness about vehicle energy performance, and allowing comparison across all models and technologies. The fuel consumption and CO_2 emission of car (per kilometre) are displayed on these labels during sale. Around 40% of surveyed countries have set mandatory energy efficiency labels for cars, and labels are voluntary in 10% of surveyed countries like in Brazil or Nigeria and planned in 15% (e.g. Algeria, Ecuador, Kenya, Swaziland, Thailand, United Arab Emirates or Uruguay).

FIGURE 50 : EXAMPLE OF SOME ENERGY LABELS FOR CARS

EXEMPLES DE LABEL ÉNERGÉTIQUE POUR LES VOITURES



Source: Enerdata from various national websites

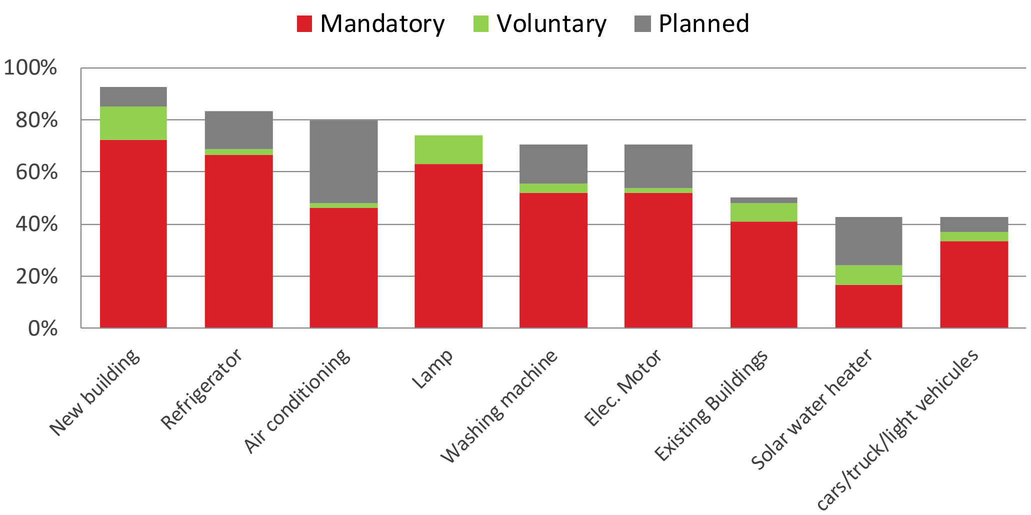
3.2.2. MEPS TO REMOVE INEFFICIENT EQUIPMENT OR PRACTICES

Unfortunately, labels are not sufficient to transform the market alone: they are the first step but need to be complemented with MEPS (Mandatory Energy Performance Standards) to remove inefficient equipment or practices. The effect of labels and MEPS is however linked to the amount of equipment replaced or new investments, which is only a fraction of the total stock.

Almost all surveyed countries (53 countries) have implemented at least one MEPS. Efficiency standards for new buildings are implemented in 85% of surveyed countries (and planned in 13%): they are becoming the most common standards, behind MEPS on refrigerators (see Figure 51), lamps, electric motors and other appliances (washing machines and AC) that are still widely implemented (up to 80% of surveyed countries). MEPS on vehicles and solar water heaters are less common. Japan has opted for a slightly different approach with its well-known Top Runner Programme. This programme triggers race to the top among manufacturers because the product on the market with the highest energy efficiency (the Top Runner) sets the standard (energy efficiency improvement target) for others. In each product group the standard is revised every 3-4 years.

FIGURE 51 : SURVEYED COUNTRIES WITH MEPS (2015)

PROPORTION DE PAYS AVEC DES NORMES DE PERFORMANCES PAR TYPE D'ÉQUIPEMENT (2015)



Source: World Energy Council's energy efficiency 2016 survey

MEPS on electrical appliances

The aim of performance standards is to improve the energy efficiency of new appliances (see Box 7 on the impact of standard and labels on the market) either by imposing a minimum energy efficiency rating to remove the least efficient products from the market – MEPS - or by requiring sales-weighted average energy efficiency improvements ("target values") (e.g. "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. A majority of surveyed countries have implemented at least one MEPS (Figure 51).

FIGURE 52 : MEPS FOR REFRIGERATORS

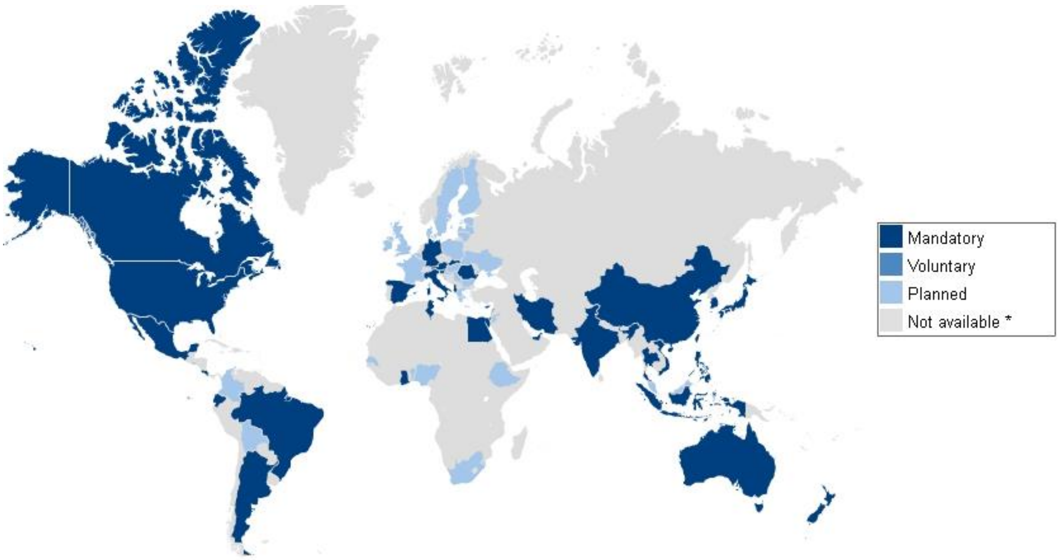
NORMES DE PERFORMANCES IMPLÉMENTÉES DANS LE MONDE POUR LES RÉFRIGÉRATEURS (2015)

Source: World Energy Council's energy efficiency policy database 2016/world overview

Air conditioning (AC) is an important use of electricity in both emerging and industrialized countries, particularly in the service sector. Traditional measures targeting air conditioning include regulations (i.e. label and MEPS) and financial incentives (subsidies and soft loans). Regulations to promote the adoption of efficient AC and remove the least efficient products from the market, or an obligation of maintenance have been introduced in many countries (e.g. all EU countries), MEPS for air conditioning in residential buildings are mandatory in 48 countries (i.e. 50% of analysed countries), voluntary in 2 and planned in 17 countries. MEPS are often linked to label class as presented in the previous section.

A number of countries (e.g. Austria, Denmark, France, Estonia and Poland) have introduced minimum requirements for specific ventilation power (generally expressed in W/l.s or kW/m^3.s.). Given the increasing use of mechanical ventilation system, the ventilation power requirement in low energy buildings is becoming an important issue. Additionally, most countries have requirements associated with the minimum performance of air conditioning systems, and more and more standards on AC are integrated in the building codes and building certificates. MEPS and energy labelling programme 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 have an impact on electric use for air conditioning.

FIGURE 53 : MEPS FOR AIR CONDITIONING (2015)
NORMES DE PERFORMANCES POUR LES CLIMATISEURS (2015)



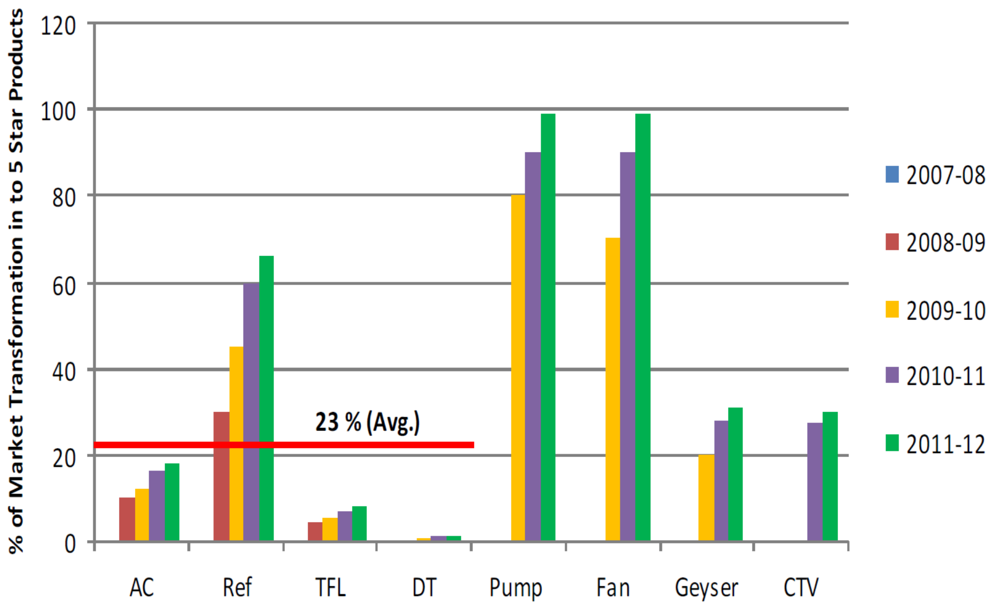
Source: World Energy Council's energy efficiency policies database 2016

Around 75% of surveyed countries have implemented a phase-out of incandescent lighting that is replaced by CFL (Compact Fluorescent Lamps) and increasingly LEDs. 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. In India there is also a public programme (based on ESCO model) under which energy efficient LED bulbs are distributed to all citizens by Energy Efficiency Services Limited (EESL) (see more details in Box 7).

BOX 7: IMPACT OF LABELS AND STANDARDS IN INDIA

It is estimated that the standard and labelling programme in India has avoided 7.8 GW of peak capacity and saved around 30 TWh over the 11th Plan (2007-2012). The marked has been transformed with a greater penetration of the most efficient products (label 5) as shown in the Figure below.

FIGURE 54: MARKET TRANSFORMATION IN INDIA FOR A SELECTION OF APPLIANCES



Source : Dr Sandeep Garg, SIDBI, Dec 2015-Legend: AC: air conditioning; ref: refrigerator; TFL: Tubular Fluorescent Lamps; CTV: Colour Television.

Buildings (EBC)

Energy Building codes (EBC) are minimum requirements for energy efficient design and construction for new and renovated residential and commercial buildings. A component of a complete set of building regulations that govern all aspects of the design and construction of buildings, building energy codes set an energy-efficiency baseline for the building envelope, systems, and equipment (see Box 8).

BOX 8: ENERGY BUILDING CODE – DIFFERENT APPROACHES

Measure	Content
Performance Approach	Energy building code based on the total energy performance: • in primary energy • in final energy End-use uses included: heating but increasingly other uses (e.g. cooling, lighting, ventilation/ auxiliaries, water heating)
Prescriptive Approach	Minimum performance by component (walls, windows etc.) (maximum U value)
Minimum supply from renewables	Maybe explicit (e.g. Spain, Portugal) or implicitly imposed with very severe regulations (e.g. France)

Source: Energy Building Code World Energy Council's case study, 2016, ECOTECH

Today, mandatory minimum energy efficiency requirements in the form of building codes or standards for new buildings exist in nearly all OECD countries. Regulations for energy efficiency in buildings in emerging countries, and especially in countries with rapid economic development, such as India, China and Egypt, are introduced to improve comfort and to reduce the dramatic increase in energy consumption in this sector linked to the spread of cooling or heating systems. Generally, energy building codes target new buildings but sometimes are applied also to existing buildings, as under certain conditions in EU countries. These buildings code address all types of buildings (residential, commercial and public) in OECD countries, but may be restricted to specific type of buildings, such as government buildings in Brazil, large commercial buildings in India and Thailand, or new building size or renovation size for existing buildings.

Figure 55 shows the countries that already have a mandatory building code in place, and in which other countries EBC's are becoming common. 65 countries (or 80% of the surveyed countries) have implemented building codes for new dwellings, and in the great majority the standards are set as mandatory. Indeed, the advantage of mandatory requirements compared to voluntary codes is that mandatory enforcement is the only way to guarantee energy savings. In addition, building designers and construction companies are more likely to comply with the code if they know that everyone else must. Finally, manufacturers will provide more widely energy-efficient products if they know that there is a market.

FIGURE 55 : BUILDING ENERGY CODES FOR NEW DWELLINGS IN RESIDENTIAL

CODES DE L'ÉNERGIE DES BÂTIMENTS IMPLÉMENTÉS DANS LE MONDE

Source: World Energy Council's energy efficiency policies database 2016

There is an urgent need to assist fast growing developing economies where active space heating and/or space cooling are normal practices and where the formal building construction sector plays a large role in urban development. Once a building is constructed, it is more expensive and complicated to reduce its energy consumption. That is why energy efficient actions have to be done from the outset. Energy efficiency requirements in building codes can ensure that the energy efficiency measures are taken into account from the very beginning, i.e. already at the building's design phase.

The objective of energy codes is to protect consumers, improve occupant comfort and business productivity, save energy and money. Altogether, this can result in potential large-scale carbon emissions reductions through reduced energy demand of buildings.

Buildings codes for new buildings should be regularly enforced to take into account technical progress. To avoid that some countries lag behind, the EU regulation requires re-enforcement every 5 years and includes a fixed target for 2020 when all new construction should near Zero Energy Buildings (nZEB). To prepare these revisions, many countries encourage construction to go beyond minimum performance requirements with specific labels e.g. EU countries, USA, Tunisia, Lebanon, Morocco (Box 9).

For more developed countries with an older building stock major renovations of existing buildings are also tackled, as is the case in the EU with the Energy Performance of Buildings Directive (EPBD) requirement. Switzerland has adopted a very progressive approach to improve the performance of existing buildings, where the thermal performance of renovated buildings must not exceed 125% of the new building limit. A number of EU Member States have introduced minimum component performance standards when building elements (e.g. windows, doors etc.) or energy using plant (boilers, a/c equipment etc.) are being replaced. Good examples include countries which have a performance-based requirement as well as requirements for any component that is replaced or refurbished.

How effective an EBC can be, does not only depend on its design and content, but also its enforcement and compliance as well as the tenants' behaviour that can have a huge influence on the success of the code (see Box 9 on USA best practice and next section 3.2.3).

BOX 9: GOOD PRACTICES

Key regulation on buildings codes in the EU (EPBD 1 and 2)

- Implementation of a harmonised calculation methodology to push-up MS minimum energy performance requirements towards a cost-optimal level;
- Minimum energy efficiency standards with mandatory strengthening every 5 years for both existing and new buildings;
- New thermal regulation for major renovation
- All new buildings shall be nZEB (nearly «Zero Energy Buildings » by 2020 (2018 for public buildings);
- Minimum standard performance of new building calculated according to cost optimality basis;

USA EBC: The United States has established a robust infrastructure of policies, programmes, and tools for energy-efficient buildings. Recent code revision cycles have produced increasing levels of energy savings with some leading jurisdictions working towards very low and net-zero energy capable new construction. The number of states adopting or updating building codes has increased significantly in recent years, and new efforts are under way to better evaluate code compliance and improve understanding of compliance deficiencies. Energy rating and labelling programmes are generating a high level of interest and are viewed as trusted sources of information, increasingly influencing purchase and retrofit decisions. In the commercial sector, building rating and labelling have become a core component of many ratepayer-funded efficiency programmes and are part of emerging mandatory energy- use- disclosure programmes. In the residential market, ratings and endorsement labels have a growing presence, particularly for new homes. New rating programmes targeting existing homes are being introduced to spur greater investment in energy-efficiency retrofits. State- level energy- efficiency policies and energy-savings targets are driving ever greater investment of ratepayer funds in efficiency and encouraging innovation in programme design. Beyond ratepayer-funding, federal, state, and local policies are increasing public investment and encouraging greater private financing of efficient new construction and retrofit projects.

Source: Energy Building Codes, World Energy Council's case study, 2016, ECOTECH

MEPS for electrical motors

MEPS are a legislative instruments used by national governments to remove the most inefficient electric motors and electric motor-driven systems from the markets. Already about 70% of electricity consumed by electric motors occurs in countries with motor MEPS. When properly enforced, they are a potentially very strong instrument. However, change takes some time, typically 4-6 years for the complete transition to new MEPS. MEPS most often refer to the label class (Box 6).

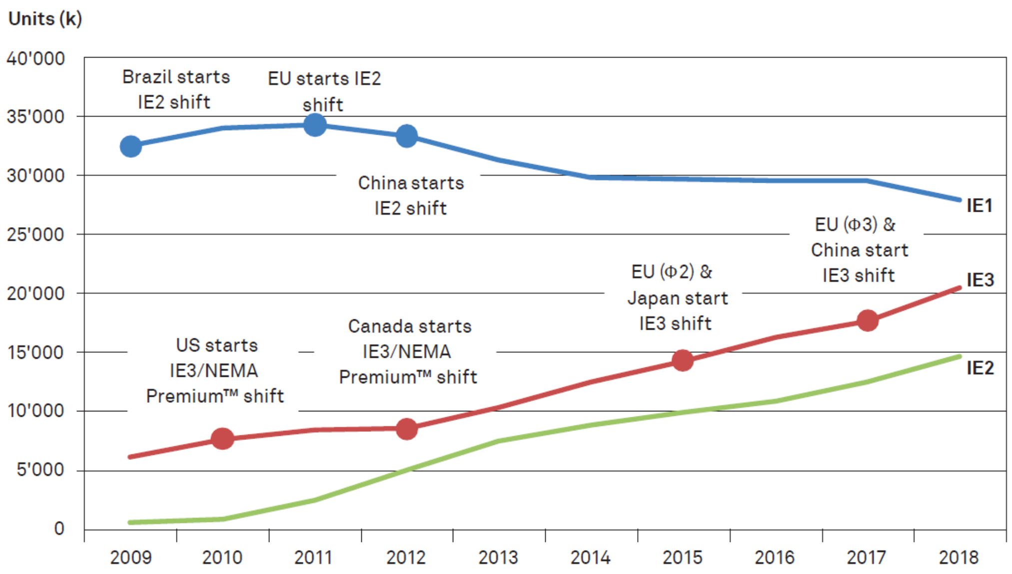
Globally, the regulations on electric motors were first introduced in and around North America. The United States implemented standards in 2007 (EPAct 92 comparable to the IE2 class) but the US has already initiated the IE3/NEMA Premium Motors shift in 2010. In Canada the first requirements came into force in 1997 and Mexico adopted the US EPAct standard in 1998. Brazil and China issued the first MEPS in 2002 for standard efficiency motors. MEPS for IE2 level took force in Brazil in 2009 and in China in 2011 and Brazil is considering shift to the IE3 level in 2017. Australia and New Zealand have set the MEPS at the IE2 level since 2006. In the EU, the first MEPS took effect in 2011 (Eco-design Directive) at the IE2 level with further requirements in 2015. Other countries with MEPS at the level of at least IE2 include Chile (2011), Israel (2008), South Korea (2013/IE2 level, 2015/partly IE3 level), Switzerland (2011/IE2, 2015/same level as Eco-design in Europe), Taiwan (2015) and Turkey (2015, same level as Eco-design in Europe). In addition, a number of countries have implemented requirements at IE1 level. In 2015, Japan included electric motors into its Top-runner Programme. In EU countries, the existing regulation only covers part of the electric motors and the European Commission is considering an extension to motors outside the current power range and to technologies other than three-phase induction motors.

In India a voluntary motor standard was first adopted in 2004 and revised in 2011 covering IE2 and IE3 motors. MEPS at the level of IE2 are under preparation and expected to be adopted during 2016. At present, IE1 motors or those with lower efficiency are imported to India from countries which themselves have issued MEPS and manufacturers take the opportunity to export lower efficiency motors to India as these products cannot be sold in the domestic market anymore. Indian manufacturers of efficient IE3 and IE4 motors usually export their products instead of selling them in the domestic market.

Figure 56 shows the annual realised and expected motor sales by efficiency class in relation to the introduction of MEPS in some large markets. Sales of IE1 motors are expected to decline somewhat by 2018 while the sales of IE2 and IE3 motors are expected to grow strongly. As the total volume of sales is growing, the proportion of more efficient motors in total is increasing.

FIGURE 56 : POLICY IMPACT ON THE SALES OF MORE EFFICIENT ELECTRIC MOTORS

IMPACT DES POLITIQUES SUR LA VENTE DE MOTEURS ÉLECTRIQUES ÉNERGÉTIQUEMENT EFFICACES



Source: EMSA 2014

As an alternative to the regulatory process, agreements with appliance manufacturers (voluntary or negotiated) are used to improve the energy efficiency of appliances. Some countries even moved from unsuccessful voluntary agreements to MEPS (e.g. EU, Brazil). The relatively late introduction of the MEPS in Europe (2011) followed a period of Voluntary Agreement with the industry, which had had a limited impact on the market. 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.

3.2.3. EFFECTIVENESS AND COMPLIANCE OF STANDARDS AND LABELS

Standards are necessary to remove certain inefficient but inexpensive products from the market, which labelling programmes alone cannot do. They are also needed in areas where the selection criteria of consumers totally exclude energy efficiency (television sets for example). 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, consumers to spend less on electricity and manufacturers to improve their products and become more competitive against imported, less efficient products. As shown by various studies, the increased diffusion of more efficient appliances did not result in a price increase for the consumers, as producers were able to adapt and to benefit from the increased sales ("learning effect") and there is no correlation between the price of an appliance and its energy rating.

To be effective, labelling programmes and MEPS must be regularly revised, tested 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.

Electrical appliances

The "Top Runner" programme in Japan 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. Another interesting approach is the one developed by ASEAN (Association of South-East Asian Nations) SHINE that implemented harmonized testing methods of MEPS for air conditioning (see Box 10).

BOX 10: PROMOTION OF EFFICIENT EQUIPMENT IN ASEAN THANKS TO HARMONISED TESTING METHODS

In line with the priorities of the ASEAN (Association of South-East Asian Nations) Plan of Action for Energy Cooperation and more particularly with the objectives of the ASEAN EE&C SSN, a Strategic framework for the Promotion of higher Efficiency Appliances was developed with the technical assistance of the UNEP and the International Copper Association (ICA).

This framework describes a holistic approach to foster a market transformation in favour of higher efficient appliances: harmonization of ASEAN standard (testing methods) to facilitate intra-ASEAN trade on higher efficient appliances, developments and adoption of regional policy roadmaps setting long-term aspirational goals and objectives in increasing progressively MEPS, capacity buildings for local manufacturers and testing laboratories and consumer awareness campaigns.

In 2012, the ASEAN SHINE programme (managed in a public private partnership) was launched and focused first on room air conditionings in Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Thailand and Vietnam. From 2013 to 2016, the following outputs have been achieved:

*** ASEAN standards for the testing methods have been harmonized to ISO5151-2010: only one standard is now applicable to test the energy efficiency of AC, reducing cost of compliance for AC manufacturers. This method paves the way for a future harmonization of standards in ASEAN.**

*** In 2015, the ASEAN Ministers of Energy Meeting (AMEL AMEM) has endorsed the "ASEAN Regional Policy Roadmap for Harmonisation of Energy Performance Standards for Air conditioning" to provide clear guidelines for the adoption of policies and to define targets with regards to the adoption of harmonized standards of ACs by 2020; to agree on a uniform testing method derived from ISO 5151-2010 (to be adopted and notified by countries by 2016-2018); to set a common evaluation method namely CSPF by 2020; to notify ASEAN countries a minimum EER as mandatory MEPS to be reviewed and revised at least every 5 years.**

***ASEAN energy ministries are now developing their national policy roadmaps (to be endorsed by September 2016);**

***Capacity of local AC manufacturers has been built on designing higher efficient ACs**

*** Capacity of testing laboratories has been built**

*** National consumers' awareness campaigns are being designed and will be launched in 2016.**

However, a lot still needs to be done to support ASEAN Member States efforts to promote higher efficient appliances and equipment such as lighting, refrigerators, TV, transformers, electric motors. The ASEAN SHINE has already started to work on efficient lighting in 2016 and intends in the near future to evaluate the energy savings potential of market transformation of refrigerator, transformers and electric motors. The ASEAN SHINE Advisory Committee is chaired by IEA, and includes UNEP, UNDP, US Department of State, SEAD, Australian government, Underwriters Laboratories, the ASEAN Centre for Energy, and the International Copper Association.

Source: Pierre Cazelles, International Copper Association (pierre.cazelles@copperalliance.asia)

Energy Building Code compliance and effectiveness

The World Energy Council's survey shows that the building code is one of the most implemented energy efficiency regulations over the world. These policies have been implemented from many decades in OECD countries, as an answer to the first oil shock. Previous evaluations including those by the World Energy Council and more recently by IPEEC in G20 countries have demonstrated that the impact of these policies is important particularly in the long term due to the low but structuring rhythm of new constructions. These policies are still on top of the agenda in OECD as can be seen from the implementation of the European directive EPBD.

However, many barriers still exist such as the lack of compliance or the lack of skills, especially when the building codes become more stringent. The situation in emerging countries is unfortunately less favourable despite many initiatives to implement building codes. Recently some important emerging countries have adopted building codes (e.g. China, India, Brazil, Thailand, Turkey, Egypt and Tunisia). The barriers encountered in OECD countries are rather similar to the ones of the emerging countries. However, it is clear that the national circumstances in emerging countries may largely influence the conditions of implementation of this kind of regulation (lack of skills, lack of construction material etc.). Compared to OECD countries building codes in emerging countries are implemented more often in the service sector and target above all air conditioning rather than space heating. From experience, we know that there are huge delays between the political decision to implement building codes and the real and concrete implementation. There is also some evidence that the level of compliance is far below expectations.

There is lack of available information on the rate of compliance with energy building codes, which reflects a general failure to monitor compliance in a systematic manner and to evaluate the existing policy measures. Infringements that occur can range from significant to minor, which also complicates the task of estimating additional savings opportunities from enhanced compliance. However, indicative levels of non-compliance span approximately 25% for appliance programmes to 50% for building regulations.

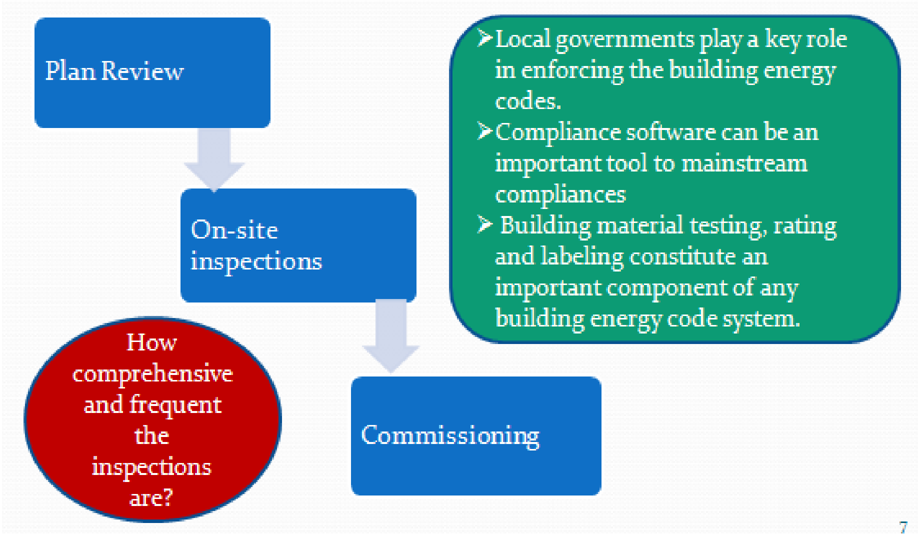
Carrots and sticks can be used to increase the rate of compliance with buildings codes:

- Introduction of specific policy packages and incentives that complement or motivate compliance (e.g. green loan programmes, financial incentives, including for some countries relaxed building height and size restrictions (e.g. Japan and Lebanon).
- Penalties or refusal of permission for occupancy or construction.

Strict enforcement is thus essential to ensure that new buildings are fulfilling the EBC requirements (Figure 57). The World Energy Council's case studies show that in some emerging countries (e.g. Jordan, Egypt) enforcement is not rigorous and the impacts of the EBC are negligible. Strict checks during the construction permitting and construction phase are needed to verify the implementation of the EBC (Turkey is a good example). Penalties for non-compliance secure energy savings during operation of the building (cost-) effectively. Thailand and Singapore can be referenced in this case but most of the studied emerging countries do not apply any penalties for non-compliance.

FIGURE 57 : IMPLEMENTATION PROCESS OPTIONS OF EBC

OPTIONS DE MISE EN ŒUVRE DES CODES DE L'ÉNERGIE DU BÂTIMENT



Source: Energy Building Code WORLD ENERGY COUNCIL case study report, ECOTECH

The permitting process ensures EBC compliance and needs to be simple and clear to avoid confusion and limit costs for both the administration and the building owners. Including the EBC enforcement in the general building permitting process avoids additional costs for paperwork. It also helps to integrate energy efficiency with other building elements such as safety, which creates economic efficiency. In addition, transparent and fair procedures for compliance assessment through clearly outlined enforcement methods (e.g. frequency and scope of checks) support acceptance of such schemes. Since the certification is based on the monitoring process, data on cases of non-compliance can already be gathered. Different actors can be in charge of the Energy Building Code enforcement: state agency (New Zealand, Spain, US); third party (China, France, Singapore, Russia, Denmark, etc).

One example of an initiative to support building codes is an energy inspection of buildings. According to the European Directive on Energy Performance (EPBD) all new buildings must be certified by an independent expert. In Portugal and Denmark, the buildings energy efficiency must be declared before it is constructed. This can be done by the architect or the company responsible for the construction. After construction, a certificate has to be issued by independent consultants including review of the self-declaration. If the building fails to comply with the regulations, the use of the building can be denied until an adequate efficiency level has been obtained. In Denmark these requirements are based on investigations which showed that as many as 67 % of all new buildings failed on the energy efficiency requirements for insulation of pipes and tanks, and that up to 1/6 of total construction costs was used to repair constructions and installations, which were incorrectly carried out in the first place[44]. Several countries use certificates of compliance of energy

[44] IEA

efficiency requirements for new buildings, including many European countries, Japan and Australia.

In case of non-compliance some countries enforce penalties, for instance in Belgium/Flanders regions where fines are set for owners (builders, constructors or installers) who fail the compliance test. This fine is based on the failure in U-values multiplied by the surface area. For example, a one family house with non-compliant glazing was fined €2,500.

BOX 11: GOOD OR POOR PRACTICES OF EBC COMPLIANCE FROM EMERGING COUNTRIES

Egypt: The enforcement rate of building codes is still very low. The new building law of 2008 has created a scheme to include the EBC in the licensing process, but by itself will not solve the enforcement problem.

Chile: Thanks to the mandatory EBC for new residential buildings introduced two decades ago, Chile is a pioneer in Latin America. Since 2000, the compliance for all new residential buildings in Chile is required by the Municipal Works Department (DOM) in every municipality, all over the country. In this way, concepts regarding housing thermal insulation are introduced in the field of architects, builders, and realtors, generating knowledge about the insulation of building elements and its application is regulated by the DOM. The Housing Energy Rating (CEV) implies the fulfilment of two consecutive energy performance certificates: first, a provisional certificate for the architectural design on the design stage; and a second one after construction.

Turkey: Municipalities check projects regarding Code compliance, as well as verification and enforcement of thermal regulation. Construction inspection companies control Code compliance during construction phase of residential and commercial buildings. The Ministry of Environment and Urbanization controls the code compliance during the construction phase for public buildings.

China: The compliance rates reported by the Ministry of Housing and Urban Rural Development (MOHURD) have increased significantly from 5% design compliance and 2% construction compliance in 2001 to 54% design compliance and 20% construction compliance in 2004, to over 90% compliance for both construction and design in 2010, based on annual inspection surveys in selected urban areas. The improved compliance can be linked to strengthening the loop inspection system for code implementation, instituting a detailed Code of Acceptance checklist for inspections in final approval phase for projects, and establishing strict noncompliance penalties.

Source: World Energy Council's 2016 case study on Energy Building Codes, ECOTECH

3.2.4 OTHER REGULATORY MEASURES FOR CONSUMERS

The other regulations are mandatory requirements for designated consumers that are usually large consumers, identified from energy consumption thresholds, in selected sectors. Among these other regulations, energy audits, either in the form of walk-through audits[45] or detailed energy audits, are necessary to have a better understanding of the current status of energy use and to identify potential actions for energy savings. Other regulations also include mandatory maintenance, mandatory installation of solar water heaters and obligation of energy savings imposed on utilities. Some other regulations, not directly linked to energy efficiency that can also have a significant impact on energy use (e.g. speed limit for vehicles), are not included in this review.

Mandatory energy audits have been implemented mainly in Europe and Asia. In Europe, there is a greater focus on commercial, public and residential buildings compared to mandatory energy audits in industry. The energy efficiency directive has made mandatory energy audits in companies of certain size in industry and services from December 2015 (Article 8). The definition of large enterprises is left to the countries[46]. In Asia, audits are imposed in several countries, mainly in industry and to a lesser extent in commercial buildings. In Africa and The Middle East, few countries require mandatory energy audits and they apply to large 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. In South Korea, energy audits are mandatory for energy-intensive companies whose annual energy consumption is over 2 000 toe. Small businesses consuming less than 10 000 toe of energy annually are eligible for a 70% discount on the energy audit fees as charged by the government. Energy audits do not lead to energy savings per se: the realisation of the measures proposed during the audits is another critical point, unless there is a legal requirement to carry out the measures found (Norway for instance). Quite frequently, the mandatory audits are therefore accompanied by supporting measures such as subsidies for the audits or for investments, training and seminars for the auditors and the staff of companies (both management and technical staff).

The mandatory training of professionals increases the quality of audits or energy management: 27 surveyed countries have implemented mandatory training for professionals, more than half in the EU.

In the building sector in EU, the recast Directive makes several references to the importance of training. In most countries, energy building codes call for changes in conventional construction practice. Architects and engineers who know how to design safe, sturdy, and attractive buildings may not know how to incorporate energy-efficient measures.

[45] A walk-through audit is a basic and cost-effective exercise to identify opportunities for energy cost saving.
[46] For instance, in UK, large enterprises are defined as companies >250 employees or >€50m turnover and >€43m balance sheet. Audits have to be done every 4 years.

Most countries have training programmes including written guidelines and example calculations. Almost all of these countries also organized seminars, conferences, or workshops on the topic. But usually this training tends to be focused on introducing the standard rather than providing ongoing support for its use and is most of the time done on a voluntary basis. The European Commission, through its Intelligent Energy Europe programme, is providing support for training programmes.

Mandatory energy consumption reporting implies that designated large consumers report their energy consumption, either directly to the government or in their annual report. This measure is seen as an incentive to companies to monitor closely their energy performance. Such measures exist in about 37% of the surveyed countries and are more frequent in Europe and other OECD countries than in the other regions. This measure is mainly applied in industry and public buildings.

Mandatory energy managers are imposed in companies above a certain size in about 25% of the countries surveyed. This measure usually applies to large consumers in industry (14 surveyed countries) and in the service sector (20 surveyed countries). In some surveyed countries, transport companies are also included (e.g. Japan, Romania, Vietnam and Portugal).

Mandatory energy saving plans are required in slightly fewer than 25% of the surveyed countries for large consumers, generally in industry. This measure exists for several sectors, including in some countries municipalities.

Mandatory maintenance of energy-consuming equipment is another important field of regulation. The concern is that without proper maintenance, the efficiency of some energy consumers' equipment (e.g. boilers, vehicles) decreases over time: the objective of the regulation is to maintain as long as possible the initial efficiency of the equipment. This measure concerns mainly EU countries, as a building directive (EPBD) makes mandatory the maintenance of heating boilers and air conditioners above a certain size. In a few countries (Italy, Romania), regulations on maintenance exist for the transport sector. The mandatory technical controls for cars that exist in many countries may to some extent contribute to save energy, depending on the items that have to be controlled.

Energy savings obligations for consumers

Several major energy efficiency programmes are based on an obligation on some part of the energy supply chain to save energy in their customers' premises, or to pay a levy for energy efficiency, see Box 12 for Chinese and Box 13 for Indian example.

BOX 12: CHINA'S TOP-10,000 ENTERPRISES ENERGY EFFICIENCY PROGRAMME.

Building on a previous, successful programme for the top 1,000 enterprises, the 12th FYP highlights the Top-10,000 Enterprises Energy Efficiency Programme (Top-10,000 Programme) as a central approach to helping China achieve its energy intensity reduction target. The Top-10,000 Programme actually covers more than 16,000 of China's biggest energy using enterprises, including more than 14,000 industrial enterprises. These enterprises account for 85% of China's total industrial energy use and more than 60% of total national energy use. The Programme aims to achieve a cumulative savings of 250 Mtce (625 Mt CO2e) by 2015. Energy savings agreements between enterprises and the government set out responsibilities for both parties and include mandatory, quantified energy savings targets for each enterprise. Enterprises are also required to report on energy use patterns in specified formats, assign energy management personnel, and meet minimum energy efficiency performance standards for certain processes and equipment, as well as achieve their savings targets.

Source: ACEEE

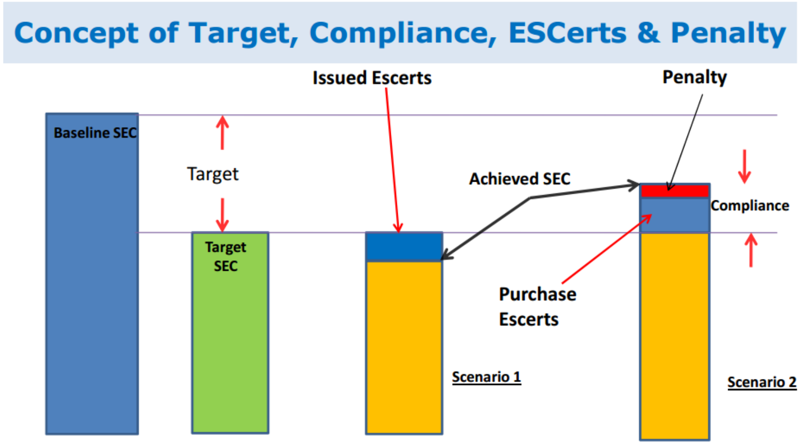
BOX 13: PAT SCHEME IN INDIA

Perform Achieve and Trade (PAT) scheme was established in India in 2012 under the Nation Mission for Enhanced Energy Efficiency (NMEEE) as to contribute to energy efficiency improvement in large energy intensive industries. The scheme consists of a regulated market based certification trading system, where the certificates (ESCerts, see explanation below) indicate the excess energy savings that can be exchanged. In this way the specific energy consumption can be reduced while improving cost effectiveness. The nine sectors that are notified under the scheme are aluminium, cement, chlor-alkali, fertilizers, iron & steel, pulp & paper, railways, textiles and thermal power plants with 478 industrial units in total at the first cycle (2012-2013 to 2014-2015); these nine sectors accounted for about 36% of the total consumption (or 60% of electricity's industrial consumption) in India in 2010.

Energy Saving Certificates (ESCerts) show specific energy consumption (SEC) savings achieved compared to a baseline level and a target level. These targets are tailored for each facility on a relative basis of energy efficiency: more efficient plants have lower targets, while less efficient ones have higher targets on specific consumption. There is a different target range in % and in absolute consumption values for each sector. The period for achieving the target is three years. 1 Mtoe is equal to 1 ESCert. When the target is surpassed in an industrial facility, the ESCerts are earned and can be sold on the power exchange market (e.g. Indian Energy Exchange-IEX) to other facilities which have not fulfilled their SEC target requirements. There is a penalty in case of non-compliance with the trading system.

FIGURE 58: PAT SCHEME AND ESCERTS – INDIA

SYSTÈME PAT ET CERTIFICATS D'ECONOMIE D'ENERGIE - INDE



The registration and trading process of ESCerts is supervised by BEE and the Central Electricity Regulatory commission (CERC) functions as the market regulator. The ESCerts can be exchanged only through the power markets. The ESCerts can be banked in each cycle to be used in the next cycle. Currently the scheme is in the second cycle (2016-2017 to 2018-2019) and the number of industrial facilities covered is expected to double.

Source: Enerdata from BEE India

3.2.1. REGULATION WITH ENERGY COMPANIES: ENERGY SAVINGS OBLIGATION

Energy saving or efficiency obligation was initiated at the end of the 2000's and is an innovative measure in which energy companies (supplier/retailer or distributor) have a legal obligation to undertake energy efficiency activities with their customers. If this obligation can be met by trading energy saving certificates, this is usually called "White Certificates". In North America it is often called Energy Efficiency Resource Standards

As a consequence of the EU Energy Efficiency Directive (article 7), there are now 16 countries in Europe that have implemented or are planning to establish energy efficiency obligation schemes: Austria, Bulgaria, Croatia, Denmark, Estonia, France, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Slovenia, Spain, United Kingdom. Energy saving obligations also exist for electricity suppliers in Kenya, Korea (where no quantitative targets are set but the total investment budget for Demand Side Management programmes implemented by energy utilities must exceed the total investment budget of the previous year), South Africa, Brazil, Uruguay, Australia and USA.

The characteristics of energy savings obligation schemes depend on several factors that explain differences among countries and change over time for a country:

- Who are the obliged parties? And in the case of trading, who can participate in the trading?
- Who are the eligible consumers?
- The volume of the targets and its mode of expression
- 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 or Italy.

The eligible consumers are only households in UK, but cover all end-use sectors in other countries (including transport in France or Italy). In Poland, energy producers, and distributors are also included (mainly for district heating and electricity grid). The energy intensive industries under the Emissions Trading System scheme in EU countries are excluded. More and more the obliged energy companies are required to ensure that there are savings for low income households (e.g. UK, France).

BOX 13: PAT SCHEME IN INDIA

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[47] (e.g. Italy since 2005), $MtCO_2$[48] (e.g. UK), US$ (e.g. Brazil)[49]. 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 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 energy label A+ or A++).

Most countries have penalties for those energy companies which do not fulfil their energy efficiency obligation (e.g. UK). In practice, no penalty has been issued as virtually all companies have met their targets[50].

The energy savings are evaluated ex-ante for standard operations/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, that needs to be published well in advance of the obligation starting[51]. The counterpart of this approach is that it is difficult to properly assess the reality of savings.

The targets have been increasing over time and are becoming more ambitious[52]; the initial targets were deliberately low to leave time to market actors to get 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. France). The scheme acts as an accelerator of decisions that households or other consumers are always hesitant to undertake; utilities also contribute to inform consumers about actions they can take and about the existence of these incentives.

[47] 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.

[48] For UK, since 2008, the target is explicitly set in CO_2 savings: the UK Department Energy & Climate Change requires the largest energy suppliers to install measures in homes that will cumulatively reduce CO2 emissions by a certain amount.

[49] In Brazil the target is in terms of annual expenditure; each distribution company submits proposals to ANEEL with estimates of the expected energy savings.

[50] The targets have been for instance exceeded by 20% in France over 2006-2009 and by 30% for the second period 2011-2014.

[51] In France, standardized technical file have been prepared to specify the amount of savings linked to all eligible energy savings actions or equipment. See http://www.developpement-durable.gouv.fr/Le-secteur-du-batiment-residentiel,42724.html (in French).

[52] The present targets have been multiplied by 2 in France for the third period and by 2 in UK compared to the previous target.

The impact of the schemes, but also of the other incentives, is significant, in terms of economic impacts: induced investments[53], employment, reduced imports (balance of payment) and lower expenditures for consumers.

The savings have been obtained mainly in the household sector (about 80% in France or Italy and 40% in Denmark), from actions with low investment cost or taking advantages of existing financial incentives: simple insulation (about 75% of savings with cavity wall insulation in UK), CFL (about 75% of savings in Italy), heating appliances (efficient boilers) (about 2/3 in France and Denmark).

But some certification programmes also target the industrial sector; one of the eligible measures in Italy[54] is improving the efficiency of electric motors in industry. Each of the eligible projects is expected to issue tradable white certificates for a period of five years. In Poland[55], investors prepare investments and take part in a tender procedure organised by the Energy Regulatory Office. The right to issue tradable white certificates based on projects savings is liked to success in the tendering procedure. For example, the replacement of electric motors and installation of variable speed drives to industrial motors is listed among the eligible project types.

The cost is shared by consumers, companies and public budget, as these obligations are combined with other measures (e.g. incentives). The cost for companies may be passed to end 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 requirement to get half of the saving obligation with low income households is quite innovative, as these households do not take advantage of usual financial incentive schemes and have a strong constraint for the upfront cost. Its combination with a financial scheme (the “Green Deal”), enables them to tap more expensive investments. In total the UK Department of Energy spent £240m on the Green Deal between 2011 and 2015, it cost £3m to energy suppliers of meeting their energy consumption obligations between 2013 and 2014, £94 overall cost per tonne of carbon saved by the schemes compared to £34 for the previous set of scheme, and 2.3 million of fuel poor households benefited from this programme[56].

[53] For instance: around €25bn estimated in France over 2011-2014.

[54] The Italian white certificates scheme, which has been in operation since 2005, imposes obligations on electricity and natural gas distributors with more than 50 000 customers.

[55] The Energy Efficiency Act of 2011 introduced a white certificate scheme and it started at the end of December 2013, an obligation is placed on suppliers of electricity, heat and gas fuels to end-users.

[56] https://www.nao.org.uk/wp-content/uploads/2016/04/Green-Deal-and-Energy-Company-Obligation-Summary.pdf

Under an energy saving obligation scheme energy suppliers or distributors are obliged to achieve certain energy savings among their customer. White certificates are documents certifying that this saving has been achieved and the certificates can be traded.

Energy savings certificates can also be traded by direct contract between an Accredited Certificate Provider and a buyer. Contracts and prices vary and there are currently no standard contracts or a recognised exchange for trading energy savings certificates. This market based mechanism enhances the cost effectiveness of improvements in energy efficiency such as in energy intensive large industries in India (Box 13: PAT Scheme in India). It requires the control and registration of savings. Although trading may be allowed in the absence of formal certification, certificates enable and add a layer or credibility to the trade.

3.3 INCENTIVES ARE STILL NECESSARY TO SUPPORT INVESTMENTS AND REGULATIONS

3.3.1. TRADITIONAL INCENTIVES: FINANCIAL AND FISCAL INSTRUMENTS

These are 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.

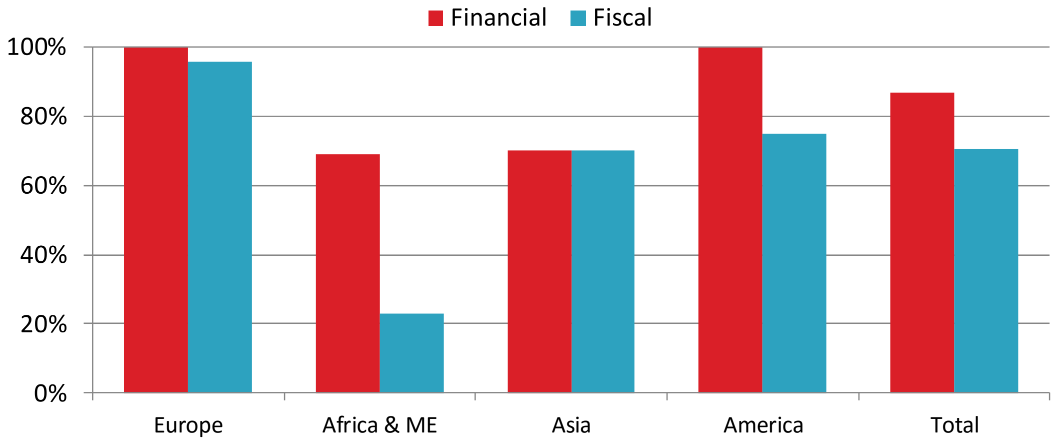
Even a moderate financial support (e.g. a subsidy or tax rebate) can be the final trigger for an energy efficiency investment being implemented as they tend to be of secondary importance in decision making compared to investments in production - regardless of their cost-effectiveness. For instance, in industry, the requirements for pay-back times of energy efficiency projects are usually between 1 and 2 years, and depend on the type of investment (shorter for pure energy efficiency investments and longer for process investments). And despite typically very short pay-back times for some industrial motors (e.g. Variable Speed Driver) and relatively short pay-back times of efficient motors in comparison to their lifetimes, financial incentives still have an important role in the implementation of improvements.

In buildings, the pay-back times are much longer and can exceed 10 years and even 20 years with deep renovations. Without economic incentives and well-designed financing schemes only few investments are done.

More than two thirds of surveyed countries have implemented some kind of fiscal or financial measures. Financial incentives are dominant compared to fiscal measures in all regions (87%, Figure 59).

FIGURE 59: SURVEYED COUNTRIES WITH ECONOMIC INCENTIVES

PAYS AYANT DES INCITATIONS ÉCONOMIQUES



Source: World Energy Council's energy efficiency survey 2016

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 for the public budget has to take into account other positive feedback, such as increasing investment that will bring additional tax revenues for the State as well as reduction in employment benefits and thus in social expenses[57].

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 targets of the schemes (small to medium industries, and low income households) do not take advantage of them because they are unaware of their existence. This demonstrates the challenges of informing a multitude of consumers adequately about the existence of incentives. For instance, energy subsidies (electricity or fuel) provide more benefit to higher social classes in emerging countries that have access to energy- in addition energy subsidies can be counter intuitive (economically speaking) as they are implemented to lower higher price while these kind of incentives should be offered to encourage consumers when prices are low.

[57] The World Bank (WB) looked at energy efficiency financing and leverage effect than went up to a factor 9 for China: when WB invested USD0.4bn in energy efficiency, investments from private sector or any counterpart were equivalent to USD5bn.

- Subsidy schemes may have a negative impact on the market by leading to an increase in the cost of equipment, if manufacturers or contractors raise their prices in anticipation of the rebates that purchasers will be granted;
- Economic incentives may result in the spread of poor quality equipment (e.g. CFL[58]).

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[59], tenants). They are also restricted to certain types of investments (from a selected list of equipment), with a long payback time but high efficiency gains (e.g. renewables, co-generation), or to innovative technologies (demonstrative or exemplary investments[60]).

In areas where the cost effectiveness of energy efficient technologies is not too high, subsidies are viewed as a temporary measure to mobilise consumers, to prepare for new regulations, or to promote these technologies by creating a larger market than would otherwise exist, with the objective of a cost reduction for the subsidised technologies. Once the critical mass has been reached, economic incentives can be reduced and even stopped without slowing down the diffusion dynamics.

However, the experience of several countries (e.g. Tunisia and Taiwan) with subsidies for solar heaters shows that, if subsidies are discontinued prematurely, sales drop suddenly when the market is not sufficiently mature. 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 and not stopped suddenly so that market actors can anticipate their phase out.

In areas where the payback times are too high and not motivating investors (e.g. the retrofitting of dwellings) financial incentives are necessary and cannot be removed before investments become cost effective.

Financial and fiscal incentives are increasingly conditional upon quality label as a way of promoting 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 (e.g. in Spain the Plan RENOVE for efficient electrical appliances where the level of grants depends on

[58] Since a few years back lighting subsidy programmes focus essentially on support for LED or efficient CFL like in Nigeria where a total of 1 million high quality CFL have been distributed free of charge to selected households across the country. This saved about 40MW of electricity.

[59] UK has had for several years a strong programme targeted on low-income households. In Brazil, power utilities must invest at least 60% of the 0.5% of their net revenue (mandatory investment in energy efficiency) in low income households. Most of these resources are used for the replacement of old refrigerators by new certified by INMETRO.

[60] In Australia, the Clean Technology Innovation Programme offers grants of AUD 50,000 - 5 million (€33,300- 3.3 million) to companies investing in R&D in energy efficiency. In addition, merit-based grants provide support for investment in energy efficient capital equipment and low emissions technologies and products.

the type of appliance and energy label)[61]. In the same way these incentives can be granted to encourage the use of qualified installation contractors[62].

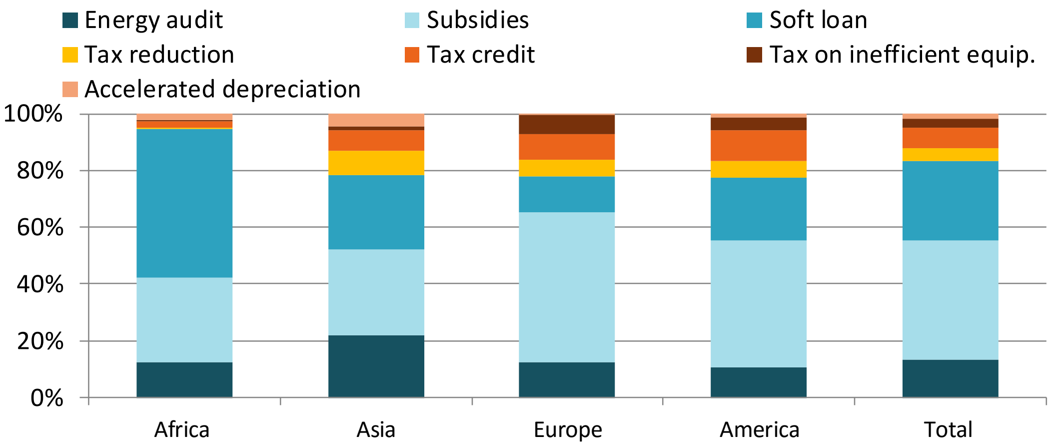
To be effective, financial and fiscal incentives need to be combined with public information and awareness campaigns to stimulate public interest in energy efficient equipment (see next section on information measures). Where regulations have been introduced, additional economic or fiscal incentives 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 consumers.

Financial incentive programmes

Financial incentives fall into three broad categories: subsidies for audits, investment subsidies and soft loans. According to the survey, among financial measures, subsidies are dominant, except in Africa and Asia, and represent on average 50% of financial measures, followed by soft loans (33%, Figure 60).

FIGURE 60: DISTRIBUTION OF FINANCIAL/FISCAL MEASURES BY TYPE AND WORLD REGION

RÉPARTITION DES MESURES FINANCIÈRES / FISCALES PAR TYPE ET PAR RÉGION DU MONDE



Source: World Energy Council's energy efficiency survey 2016

Investment subsidies

Investment subsidies are popular in OECD countries where more than 80% of the surveyed countries have subsidy schemes.

[61] In South Africa, subsidies for replacing old motors are conditioned to a purchase of highly-efficient motors through motor suppliers registered with Eskom and for the motors technical specifications to be verified and approved.

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

Investment subsidies exist to retrofit existing buildings, dwellings or industrial facilities, and thus shorten the payback times. In some countries incentives to fulfil the energy building code are given through encouragement systems, which support compliance with requirements. There are subsidies, which can only be obtained if certain energy efficiency requirements are fulfilled. These are based on the pure compliance with requirements in the codes or on measures stricter than the energy efficiency requirements in these codes. In different regions of Austria there are subsidies combined with energy efficiency requirements, which are stricter than the minimum requirements in the building codes. This can be additional insulation, improved windows or installation of renewable energy sources such as solar collectors, photo voltage or biomass ovens or boilers. In some Austrian provinces this has led to nearly all buildings being constructed with an energy efficiency which is better than the requirements in the codes, but as a minimum the requirements are fulfilled.

Subsidies are also used to lower the price of efficient equipment that is usually more expensive than the market average price (e.g. CFL, efficient motors or boilers, solar water heaters), and are often conditional on old inefficient equipment being replaced:

- Boilers in Denmark: subsidies for old oil-fired boilers (if replaced either by a heat pump (geothermal heating or air-to-water), solar heating in combination with a new oil/natural gas/wood pellet boiler, or if the residence is connected to district heating).

- Electric motors in South Africa: Eskom launched an Energy Efficient Motors Programme in mid-2007 to subsidise the replacement of old motors with highly-efficient motors[63]. Efficient motor suppliers registered with Eskom are directly paid by the subsidy, resulting in an immediate discount for the consumer. The purchaser must trade in their old motor, along with all components, for scrapping.

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.

Subsidies for energy audits

Spreading energy audits is a way of providing well targeted information to consumers to help them undertake investments. Audit is a service where the energy efficiency of factories or buildings is evaluated with the aim to suggest the best ways to improve energy efficiency. Thus subsidies for energy audits aim at making them more attractive to consumers, if they are not mandatory.

The subsidy is either a fixed amount or a percentage of the audit cost (e.g. 30%). Audit subsidies are more frequently distributed in industry and public/commercial buildings than in residential buildings.

[63] Subsidies ranging from ZAR 400 to 3 500 (27-233 euros) are offered for premium efficiency motors. Eskom regularly performs random process compliance audits, while an independent measurement and verification body verifies the savings achieved by the programme.

The Energy Audit Programme (EAP) is one of Finland's longest standing energy efficiency grant schemes (since 1992). The EAP is a voluntary programme supported by a 40% to 50% subsidy by the Ministry of Employment and Economy. The implementation and operation of the EAP is run by Motiva Oy (the Operating Agent), a state owned company. Its duties include the promotion of audit activities, development of auditing models, monitoring, the training of energy auditors and the quality assurance of audits. Audits are carried out mainly by private consulting companies, which send all audit reports to Motiva, who systematically controls the quality of the first audits undertaken by newly certified auditors and also regularly controls the quality of audits through representative sampling.

Soft loans

Easy access to credit with appropriate conditions for financing the initial investment is a fundamental measure to overcome the initial cost barrier. This is achieved by proposing to consumers who invest in energy efficient technologies and equipment soft loans which are loans at subsidised interest rates, i.e. lower than the market rate. Soft loans have the advantage of being easily implemented by banking institutions. Specific credit lines with the help of donors and the establishment of credit guarantee scheme by the State will encourage banks to be more active by providing soft loans to finance energy efficiency investments. Typically, soft loan programmes target small and medium sized enterprises (SMEs). According to the World Energy Council's database on Energy Efficiency Policies and Measures, these programmes are equally common both in OECD and non-OECD countries. In non-OECD countries loans are often provided by international development organisations. Example of soft loans programmes include:

- In Brazil, soft loans for commercial and public buildings have been provided by BNDES - National Bank for Economic and Social Development. Those for dwellings, mostly low income, have been provided by Caixa Econômica Federal (Main federal housing agency).

- In Taiwan low-interest loans are provided for SMEs for the purchase of energy conservation machinery and equipment, including high-efficiency motors and compressed air systems. The low-interest loans can cover up to 80% of the investment cost. Up to 90% of interests are supported by the Small and Medium Businesses Foundation. The loan period is seven years including a 3-year grace period.

- In France the Eco-Energy Loan Programme, running since 2012, is designed for SMEs to finance certain particularly energy-intensive technologies including electric motors. Loans have a 2% interest rate and range from 10 000 to 50 000 euros for a period of five years, including one-year grace period. No additional guarantees may be required.

- In France again, the 0% Eco Loan supported by the French government to finance energy-saving works in "old" properties (i.e. built before 1990). The purpose of renovation work done under this programme is to reduce energy consumption and greenhouse gases and promote the use of renewable energy sources. In order to ensure that this is the case, the Eco Loan must, except for special circumstances,

> be used to finance either a "package" of at least 2 renovation actions, or, alternatively, work to improve the overall energy performance of a property, as measured by an approved expert. The Eco Loan can be granted either to private individuals or, as from January 2015, to a collective body (i.e. the residents association).

In the same way, the German KfW bank offers soft loans to private buyers and homeowners, landlords and housing companies. The programme promotes the energy-efficient refurbishment of older residential buildings with loans at favourable conditions (the loan is conditioned by the energy standard met after refurbishment; e.g. loan up to 100,000€ per housing unit for energy-efficient refurbishment plus a repayment bonus calculated on the loan amount).

Fiscal incentive programmes

Fiscal incentives include first of all measures to reduce the annual income tax paid by consumers who invest in energy efficiency: they comprise accelerated depreciation (industry, commercial sector), tax credits and tax deductions (households)[64].

Another form of fiscal incentive is to reduce the tax to be paid when purchasing energy efficient equipment (VAT, import duties[65] or purchase for cars) or when investing to improve energy efficiency in buildings (reduction in VAT rate on labour cost). In the US, tax incentives have been given in recent years to increase the level of insulation and to encourage the constructer and building owners to go further than the minimum requirements. These incentives have probably also helped to increase compliance with the codes.

VAT reduction on labour costs to reduce the investment in building renovation is in use in several European countries.

Accelerated depreciation is used mainly in industry and it is relevant for less than 7% of surveyed countries. Fiscal measures also include tax reduction for the use of efficient cars (annual registration tax). Reduction on the purchase tax and/or annual registration tax for cars has been introduced in several European countries to promote the uptake of efficient cars: they are usually linked to the CO_2 emission of cars and therefore indirectly to their energy efficiency. The objective is to offer consumers incentives to buy more efficient cars.

Tax concessions for companies that make concrete commitments to energy efficiency gains/ CO_2 reduction and meet their target are also another innovative way to promote investment in energy efficiency. In Sweden, a possibility for a tax rebate on electricity tax has been used as a ‘carrot’ in the voluntary energy efficiency agreements provided that energy management system is implemented and savings are achieved. Singapore allows one-year depreciation instead of the normal three years to replace old, energy-consuming

[64] 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.
[65] In Sri Lanka, energy efficient CFLs enjoy a lower import duty.

equipment in its scheme ‘One-Year Accelerated Depreciation Allowance for Energy Efficient Equipment and Technology’ (ADAS).

The list of eligible equipment includes high efficiency electric motors. Similarly, in the United Kingdom, the Enhanced Capital Allowance (ECA) scheme provides businesses with a first year 100% tax allowance on designated energy efficient equipment investments, including energy efficient motors and VDSs. The list of eligible products (the Energy Technology Product List, ETPL) is updated monthly. In the Netherlands, an asset is eligible for 41.5% deduction from the taxable profit when it is more energy efficient than standard equipment used; this means a net discount of approximately 10% of the investment costs given the 25% taxation level for Dutch businesses.

Tax on inefficient equipment (appliances and cars) can discourage and thus incentivize end-users to purchase new efficient products. Road charges are also considered as a fiscal measure with an effect on energy use although their primary goal is to reduce congestion and pollution. Several cities have implemented such schemes[66].

Tax on electricity consumption can make the use of electricity more expensive and give an incentive for energy efficiency, such as in Sweden where a general tax on electricity consumption is set (about 0.03 $/kWh) on which VAT is also charged.

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 and are more suitable for well-developed countries. However, unlike subsidies, tax credits do not lower the barrier of the initial upfront payment.

3.3.1. ENERGY EFFICIENCY FUNDS TO SUPPORT INCENTIVE PROGRAMMES

Energy efficiency funds provide resources to support economic incentives. These funds are usually implemented jointly by energy efficiency agencies, financial institutions or dedicated institutions. 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 special credit lines with soft loans. The World Bank, Global Environment Facility (GEF)[67], UNFCCC (see UNDP, regional development banks (EBRD, ADB where energy efficiency is becoming the first type of investment project), AFDB, EIB, national development banks (e.g. KfW, AFD, CAF and national aid agencies (GIZ, USAID) are very active in financing energy efficiency programmes. These funds are often set up as revolving funds (a good example is the Thailand Energy Efficiency Revolving Fund or other revolving funds in Eastern Europe)

[66] Singapore, the pioneer since 1975, several. Norwegian cities (e.g. Oslo, Trondheim and Bergen), London in 2003 and Stockholm in 2006.

[67] The Romanian Energy Efficiency Fund is financed by the World Bank and GEF (US$ 2M/per annum). Or in Vietnam the Loan Guarantee Fund for energy efficiency in SME is financed thanks to GEF grants.

Different types of funds can be identified. Funds can be supplied partially or in total from dedicated taxes to have more stable funding and be less dependent on annual budget allocations. Funding from energy tax exist in different countries. For example, in Tunisia, the Energy Transition Fund (aiming at promoting and encouraging renewable energies and the industrial sector) is funded by tax on the sale of AC or by tax collected during the first registration of tourist cars; or in Switzerland the building refurbishment programme is financed through and earmarking CO_2 tax. In Thailand the ENCON fund is supplied by a tax on gasoline[68].

To involve national banks a guarantee mechanism should be put in place. In Uruguay, a trust fund for Energy Efficiency (FEE) projects is expected to operate by 2016. This fund will guarantee up to 50% of bank loans for energy efficiency projects. Commercial and public buildings will be able to apply to this scheme.

In Brazil, there is tax reduction on energy efficient appliances or investments, using a specific funding (Financial Support Facility for Energy Efficiency Projects – PROESCO) in the National Bank of Social and Economic Development (BNDES). In Austria, the Industrial energy conservation is promoted through the Environmental Support Programme. This initiative is managed by a special-purpose bank called Kommunalkredit Austria on behalf of the Federal Ministry for Agriculture, Forestry, the Environment and Water Management. Under this federal scheme, companies can obtain subsidies for thermal improvement of buildings, other energy efficiency measures, or connection to the municipal district heating and/or CHP systems.

BOX 14: THE UNFCCC GREEN CLIMATE FUND

The financial mechanism Green Climate Fund (GCF, adopted in 2011 and fully operational since 2015[69]) is a fund within the framework of the UNFCCC founded as a legally independent institution to assist developing countries in adaptation and mitigation practices to counter climate change. More precisely the GCF was established by 194 governments to limit or reduce greenhouse gas emissions in developing countries, and to help adapt vulnerable societies to the unavoidable impacts of climate change. Over time it is expected to become the main multilateral financing mechanism to support climate action in developing countries.

Heading into COP 21 in Paris, this Climate Finance Fundamental provides a snapshot of the operationalisation and functions of the Fund. The Fund’s role in a post-2020 climate regime as the major finance channel under the Convention as well as the scale of its resourcing remain to be clarified and confirmed in Paris. Past editions of this Climate Finance Fundamental detail the design and operationalisation phases of the Fund.

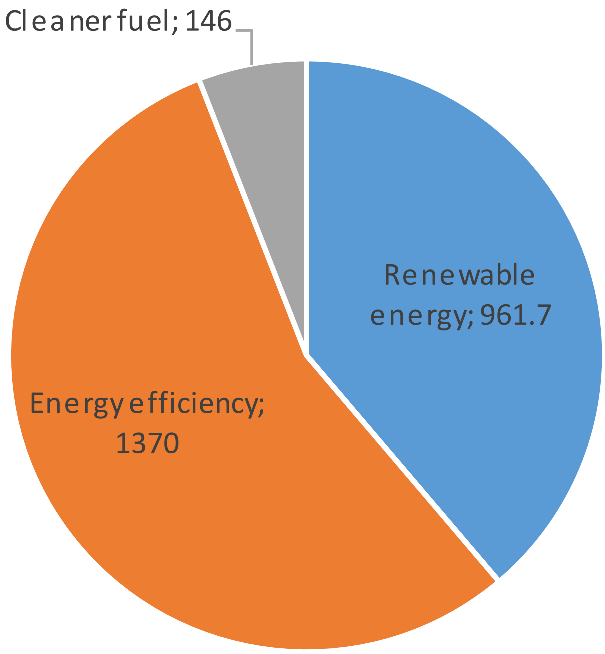
Source: Overseas Development Institute

[68] A similar fund exists in Thailand; the ENCON fund collects the revenue from a tax of 0.07 THB/l (0.002 US$) on all petroleum products (annual revenue US$200 m).

[69] Approving USD 168 million for its first eight projects just weeks before COP 21.

FIGURE 61: ADB'S CLEAN ENERGY INVESTMENT BY PROJECT TYPE (IN US$ MILLION)

INVESTISSEMENT EN ÉNERGIES PROPRES DE L'ADB PAR TYPE DE PROJET (EN MILLION DE DOLLARDS)



Source: ADB, ACEF in Manila, 2016

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 T&D losses), an increasing share is now going to end consumers or demand side management (Box 12 and 13).

BOX 15: DEVELOPMENT BANK OF LATIN AMERICA-THE CORPORACION ANDINA DE FOMENTO

CAF's Financial and Technical Assistance for demand side energy efficiency

In partnership with KfW, the Government of Germany, and the European Union´s Latin American Investment Facility (LAIF), CAF has begun structuring an Energy Efficiency Regional Programme that seeks to mobilize support for energy efficiency measures in Latin America, both on the supply and demand side. The programme has two main tools: a credit line and a technical assistance fund. The technical assistance fund aims to help mitigate the complexity of the proposed projects. It will provide assistance for the identification, structuring and pre-feasibility studies of energy efficiency projects. The fund will allocate non reimbursable resources provided by the Government of Germany, the Latin American Investment Facility (LAIF) of the European Union and CAF. Once the projects have been identified as feasible, they will be financed through a credit lines made available by local banks.

While CAF´s main focus has historically been on providing funds and technical assistance to supply side players, it is now developing expanded regional programmes and working with multilateral, regional and local institutions, to boost its financial and technical assistance for demand side projects as well.

Source: International Development Finance Club

BOX 16: THE JESSICA FUND IN LITHUANIA

JESSICA - Joint European Support for Sustainable Investment in City Areas, is an initiative of the European Commission developed in co-operation with the European Investment Bank (EIB) and the Council of Europe Development Bank (CEB). It supports sustainable urban development and regeneration through financial engineering mechanisms.

During the period (2010–13), the Joint European Support for Sustainable Investment in City Areas (JESSICA) financing mechanism was introduced, which provided €227 million from EU structural funds and state budget in the form of renovation loans administered by financial intermediaries and subsidies to cover 15 percent of investments. For several years, utilization of this mechanism and its implementation were slow. However, project applications began to accelerate after the introduction of municipal renovation programmes based on the EnerVizija model, an energy service company (ESCO)–type investment model that created an additional alternative for city- or district-wide renovation programmes (a) initiated by municipalities and (b) managed by authorized building administrators, who became borrowers of the renovation loans instead of apartment owners. It is supported with up to a 15 percent subsidy; later, further incentives were introduced, including an additional 25 percent subsidy from the Climate Change Fund and soft loans with a 3 percent fixed interest rate from the JESSICA funds.

On 18 February of 2015 the Ministry of Finance and the Ministry of Energy together with the Public Investment Development Agency established the Energy Efficiency Fund. The Fund will provide investments in energy efficiency projects using the following financing tools: loans for the modernization of central government buildings and guarantees for loans from commercial banks for the modernization of street lighting projects. The Fund manages 79.65 million EUR. The first loans and guarantees from the Fund were provided in the summer of 2015.

Source: World Energy Council, 2016 case study on Energy Building Codes, ECOTECH

Energy efficiency funds can be entirely supported by the state budget, as in India where the government has launched a new fund aiming at providing state governments with financial help to promote energy efficiency. The Energy Conservation Fund is formed by contributions from the state governments which can later request grants to promote energy efficiency programmes.

3.3.2. ESCO AND PUBLIC PRIVATE PARTNERSHIPS TO ALLEVIATE THE PUBLIC FINANCING

An increasing and widely keen interest for ESCOs

Due to the pressures 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.

An Energy Service Company (ESCO) is a company delivering energy efficiency services that is wholly or partially paid based on the achievement of energy savings and/or on the meeting of other performance criteria. ESCO's generally cover a wide range of services from energy audits, feasibility studies, engineering design, equipment procurement, subcontractor management, construction, measurement and verification, operation and maintenance and project financing. 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.

ESCO activities exist in many countries to different degrees: introduced in 78% of surveyed countries, e.g. 5,000 in China, over 1,000 in Spain, or around 500 in USA or Germany. In China, the ESCO market has grown very rapidly and now represents a US$10 billion business; it has been pushed by several measures that have been already mentioned in this report, e.g. the five Year National Plan that sets energy efficiency targets, the 10.000 enterprises energy efficiency programme, mandatory energy efficiency standard for buildings, etc. The other large emerging countries, such as India, Turkey and Thailand, etc. have seen a limited development of ESCOs so far.

FIGURE 62: ESCO GLOBAL EXPERIENCES AND RESULTS-EXAMPLE OF SUCCESS

EXEMPLES DE SOCIÉTÉS DE SERVICES ÉNERGÉTIQUES ET LEUR RÉSULTAT

Country	Market size	Results	Projects
United States (FEMP)	US$3.8 billion	- 18 trillion BTU/year (2006) - US$7.1 billion energy cost savings	460 ESPC projects
Canada (FBI)	US$240 million	- 20% energy intensity reduction - US$30 million energy cost savings - 285 kit CO2 reduction	85 EPC projects (7,500 + buildings)
Germany	~US$220 million	- 20-30% energy cost reduction - US$30-50 million energy savings/year	2,000 properties
Japan	~US$100 million	- 12% energy intensity reduction - 265 kt CO2 reduction	50 ESPC projects in FY06
South Korea	~US$190 million n/a	n/a	~1,400 public ESCO projects

Source: World Bank, ACEF in Manila, 2016.

ESCO's are widely promoted by the European Commission, the European Investment Bank, the European Bank for Reconstruction and Development and the International Energy Agency, as they provide a framework to encourage private funding to support energy efficiency investments with a minimum role for governments. Article 18 of the European Energy Efficiency Directive of 2012 contains a list of measures that Member States shall adopt in order to promote energy services market, including the ESCO market.

Innovative packages have been implemented mixing the involvement of ESCOs to share the burden and the risk or the combination of ESCOs with public subsidies (e.g. EESL or PRSF in India or even an ESCO type approach within public administrations (see section below on public-private partnership).

BOX 17: INDIAN INITIATIVES

Energy Efficiency Services Limited (EESL) is a joint venture of four National Public Sector Enterprises[70] and is a Super Energy Service Company (ESCO). It also acts as the resource centre for capacity buildings of State Power Distribution Companies, upcoming ESCOs, financial institutions, etc.

EESL is leading the implementation of world's largest LED programme for the residential sector named UJALA (Unnat Jyoti by Affordable LEDs for All). The initiative is public programme under which energy efficient LED bulbs are distributed to all citizens by EESL. The programme was launched in 2015 and within one year, 100 million LEDs were distributed (www.ujala.gov.in). The programme has resulted in annual energy savings of close to 35 GWh and avoided 2500 MW of capacity. The overall objective of UJALA is to replace 770 million incandescent bulbs used in residential sector with LEDs, which could result in annual energy savings of above 100 TWh and a peak saving of 20 GW.

EESL has devised two financing models for implementing the UJALA programme.

1-ESCO Model: under this model, a utility purchases energy savings and/or demand reductions using a pre-determined rate. Implementation of the LED programme results in savings which are monetised. EESL is paid fixed amounts per kWh or kW upon completion of the LED project. The amount is periodically paid over the tenure of the project.

Project Information: Andhra Pradesh (AP) and Union Territory of Puducherry.

2-On-bill financing (OBF): under this model, EESL makes the entire investment for distribution of the LED bulb and the cost recovery is made directly from the consumers. Consumers have option of paying upfront full payment for the LED bulbs or may pay a token money and pay back the remaining cost through instalments added to the electricity bills. The OBF model is successfully implemented in a majority of states (Karnataka, Rajasthan, Maharashtra, Uttar Pradesh and Himachal Pradesh).

[70] National Thermal Power Corporation Limited, Power Finance Corporation, Rural Electrification Corporation and Power Grid Corporation of India Limited, was set up under the Ministry of Power, Government of India.

BOX 17 INDIAN INITIATIVES CONTINUED

Market Price of the bulb
USD 7

Price of Bulb under UJALA
USD 1.5

Price of Bulb under OBF Model
USD 1.6

Annual cost saving from one bulb
~USD 4.3

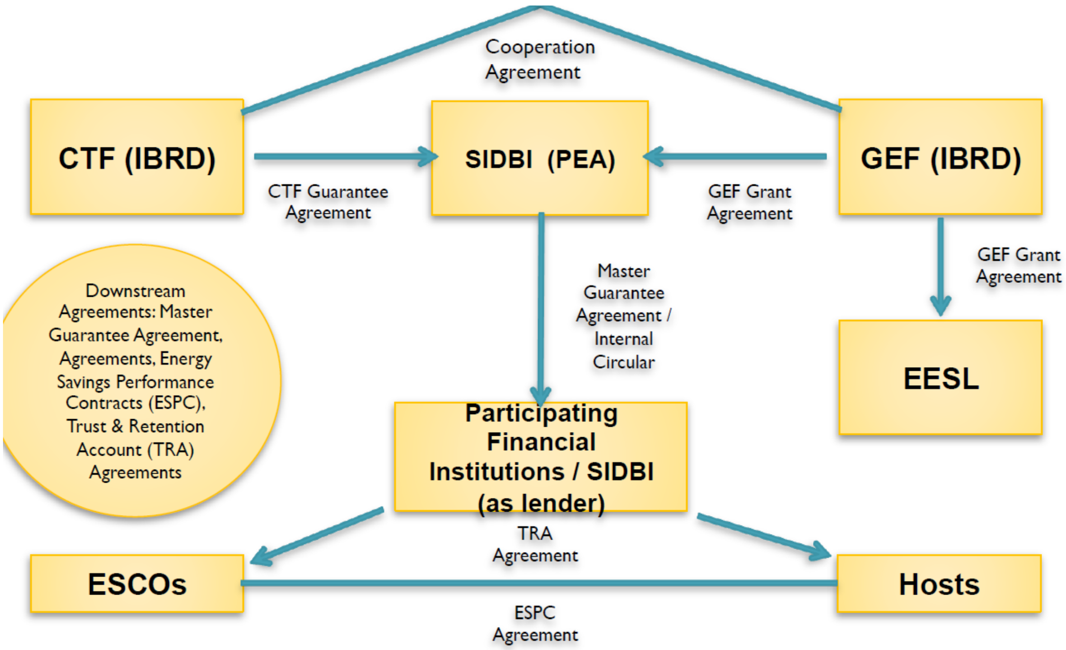
Return of investment
Under 1 year

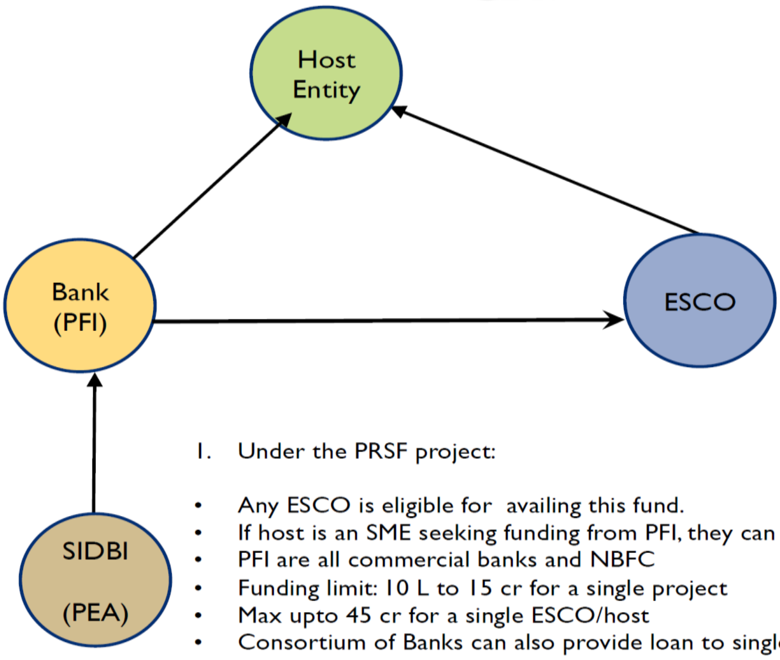
EESL followed a principle of aggregation of demand and undertook large e-procurements for LEDs in a transparent and efficient manner to ensure that there are economies of scale and there is continuity in demand generation. This has had a positive impact on bulk and retail prices of LED bulbs – the bulk prices have reduced by 83% (from $4.7 in January, 2014 to $0.84 in March, 2016). The retail prices have reduced from $6-9 range in 2014 to $ 2-3 in 2016.

Source: EESL

BOX 17 INDIAN INITIATIVES CONTINUED

PRSF (Partial Risk Sharing Facility for Energy Efficiency): it provides commercial banks with a partial coverage of risk involved in extending loans for energy efficiency projects





I. Under the PRSF project:

- Any ESCO is eligible for availing this fund.
- If host is an SME seeking funding from PFI, they can be covered.
- PFI are all commercial banks and NBFC
- Funding limit: 10 L to 15 cr for a single project
- Max upto 45 cr for a single ESCO/host
- Consortium of Banks can also provide loan to single ESCO
- Documents can be shared
- PEA can also be PFI.

Source : Dr Sandeep Garg, SIDBI, Dec 2015

Replacement of electric motors, installation of variable speed drives (VSD) and compressed air systems can be among the technologies covered by ESCOs. More recently there has been increasing interest by VSD manufacturers to install VSDs in industrial facilities using the ESCO model. In some cases, the VSD manufacturers have teamed up with an existing ESCO serving industry. For instance, in Finland, the ESCO has provided an energy audit, arranged financing, provided technical guarantees and monitored the savings.

BOX 18: KEMIRA IN FINLAND

In Finland, VSDs were installed in five industrial fans (1 290 kW) in a fertilizer factory. Power demand was cut down to 480-580 kW and annual energy savings totalled 4 000 MWh per annum The savings opportunity was identified in an energy audit and implemented through the ESCO model. An investment subsidy of 25% was given to the investment. The contract period with the ESCO company was three years during which the ESCO received 80% of the avoided costs of electricity.
Source: World Energy Council, 2016 case on Electric Motors, MOTIVA

An increasing interest for public-private partnership in particular for municipalities

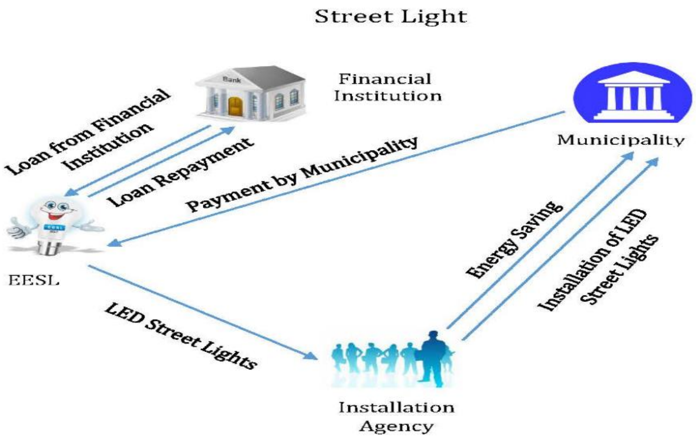
Public-private partnerships (PPP) include private sector provision of a government service, normally coupled with public oversight of the contracted entity. This way, private money is used for investments and operational budgets. There is a spectrum of possible contractual arrangements between public and private entities: these can range from relatively short term service contracts to long-term joint venture arrangements. PPP offers a range of risk-sharing mechanisms, it recognises the differing characteristics of public and private stakeholders, and seek to optimise the effectiveness of public service delivery by allocating risks to parties most suited to address them. And in line with contractual conditions and risk-sharing arrangements, PPP proposes financial reward for private parties.

PPPs can be considered as part of the range of policy and financial instruments available to public authorities to “leverage” private finance. Municipal governments provide many essential and basic infrastructure services, for example the delivery and management of electricity, urban passenger transport, and street lighting services. And as the proportion of the world’s population living in urban areas continues to grow (according to the United Nations, 66% of the world’s population will live in urban areas in 2050 up from 54% in 2014), municipalities will face increasing demand for new and improved infrastructure services.

Traditional sources of financing are often inadequate to fund local investment needs and municipal governments often lack the capacity and resources to deliver quality services alone. Thus urban environments provide interesting context for the design, testing and implementation of PPPs, for example with regard to infrastructure development, such as public lighting. They are characterised by the proximity and interaction of public and private stakeholders to deliver highly context-specific services.

BOX 19: STREETLIGHT NATIONAL PROGRAMME (SLNP) IN INDIA

Streetlight National Programme (SLNP) is another initiative of EESL, where it replaces the conventional streetlights with LED streetlights at its own cost (without any need for urban local bodies or municipalities to make upfront investment in the project) and consequently reduction of energy and maintenance cost of the ULB or municipalities is used to repay EESL over a period of time. The contracts between EESL and municipalities are typically 7 years long where it not only guarantees a minimum energy saving of 50% but also provides free replacement and maintenance of lights at no additional costs to the municipality.



EESL has implemented several streetlight projects in various states and cumulative LED streetlight installations have reached 0.8 million units (http://www.eeslindia.org/slnp). These streetlight installations are fitted with smart centralised control and monitoring systems to enable remote operation with features for real time energy monitoring and fault logic controls. The overall objective of the SLNP is to replace 35 million conventional streetlights with LEDs, which would result in annual energy savings of 9 TWh and peak reduction of 1500 MW.

Project information: EESL has implemented the LED streetlight project in Greater Visakhapatnam Municipal Corporation (GVMC), where around 92,000 traditional streetlights were replaced with LEDs. The project has resulted in a 50% reduction of energy consumption.

Before LED Installation				After LED Installation			
No.	Month	Units in Hundred Thousand (MW)	Amount in Hundred Thousand (USD)	Month	Units in Hundred Thousand (MW)	Amount in Hundred Thousand (USD)	% Cost Savings
1	Jan-14	23.80	2.9	Jan-15	12.70	1.4	52.18
2	Feb-14	23.89	2.8	Feb-15	12.72	1.3	49
3	Mar-14	17.08	2.6	Mar-15	11.85	1.4	48.19
	Total	64.78	8.4	---	37.27	4.2	50%

Source: EESL, India

ESCO's are however facing several barriers

The Joint Research Centre of the European Commission (JRC) has studied the general barriers for ESCOs including e.g. low awareness, lacking motivation and small project size particularly in SMEs. In addition, the following specific barriers were identified:

- Difficulty to predict energy consumption and assess the project risk for consumers
- High transaction costs for consumers
- High technical risk perceived and concerns over the safety and reliability of equipment
- Fear of job losses
  Energy savings are "not tangible" and payment of savings are perceived as full of risks for banks. Lack of trust in ESCOs from banks

Because of those barriers, the ESCO market in India has struggled to develop and expand in part due to its inability to obtain commercial financing from local banks and financial institutions. The Partial Risk Sharing Facility for Energy Efficiency (PRSF) seeks to overcome the barriers to commercial financing for ESCOs. The first component of PRSF supports establishing and operating the facility to provide sub-guarantees to sub-financiers and developing energy efficiency markets through end-to-end solutions and measurement and verification activities. The partial risk sharing facility for energy efficiency is managed by Small Industries Development Bank of India (SIDBI), funded from a Global Environment Facility (GEF) contribution and backstopped by a Clean Technology Fund (CTF) Guarantee, in the form of contingent finance[71]. Component two supports technical assistance, capacity building, and operations support comprising.

The JRC proposes to alleviate the problem particularly in the SME segment of industry by creating "mini-ESCOs" of the mechanical/electrical service contractors who already work with SMEs. Most SMEs already have trusted service contractors who know their facilities well and there is an on-going working relationship. The contractors provide preventive maintenance, breakdown repairs and sometimes small capital upgrades. Small contractors are particularly sensitive to maintaining good customer relations meaning that complex contracts are not necessarily needed to cover contingencies of savings being less than a guaranteed level.

A larger role of ESCO's is still limited by the price being too low in many countries (due to subsidies and low international prices), the reluctance of consumers to outsource energy efficiency investments and the low involvement of the local banking system that is needed to support the ESCO's projects. Several actions can be implemented to raise the private sector participation: ESCO facilitators to act as an intermediate between ESCO's and consumers (e.g. Thailand) and guarantee mechanisms attached to energy efficiency funds. To overcome the barriers linked to the ESCO's risky investment, technical advisors are required to evaluate or guarantee the expected savings (e.g. Johnson Controls).

[71] $25 million in Clean Technology Fund resources to develop a Partial Risk Sharing Facility for Energy Efficiency in India to leverage the market for implementing energy efficiency through risk sharing mechanisms.

3.4 INFORMATION DISSEMINATION TO MOTIVATE CONSUMER TO UNDERTAKE ACTIONS

Information and communication are key components of an energy efficiency policy to motivate consumers and inform them about the technical and financial solutions to improve energy efficiency. Beyond the traditional information campaigns and energy awards, more targeted modes of information and communications have recently been developed, such as energy efficiency platforms, information centres and their new form of “one stop-shops”, and mobile applications.

3.4.1. ENERGY EFFICIENCY PLATFORMS

Energy efficiency platforms have been developed at different scales to create common places of exchange. These platforms provide information on main topics of energy efficiency and bring together industrial stakeholders, research organizations, academic stakeholders, representatives of governments (national or regional), regulators, civil society and NGOs. The collective knowledge within the platforms will generate new perspectives which can strengthen the key energy efficiency policies.

The **Global Energy Efficiency Accelerator Platform**[72] launched by the Sustainable Energy for All (SE4ALL) offers a public-private collaboration to expand and create actions to accelerate energy efficiency in five areas: vehicles, lighting, appliances, buildings and district energy. The platform gives countries the opportunity to assess their needs and priorities through a standardized menu of policy options and technical support leveraging best-in-class toolkits, databases and subject matter experts.

The European Commission’s Joint Research Centre launched recently its **European Efficiency Platform**[73] (E3P). The platform intends to overcome the fragmentation of data and knowledge of energy efficiency and foster cooperation among relevant stakeholders. The core features are 4 collaborative tools:

- The data hub, a one-stop-shop for the collection of data;
- The wikEE for experts’ collaboration;
- The Community to work in groups, where any specific can be discussed;
- The Calls: if specific data, content or an expert is needed, a request can be published on the platform.

[72] http://www.se4all.org/energyefficiencyplatform
[73] http://ec.europa.eu/environment/resource_efficiency/re_platform/index_en.htm

Sectoral platforms have been developed to go further on specific issues of energy efficiency, especially for buildings, such as:

- **In Europe, the BUILD UP platform**[74] that is the official European portal for energy efficiency in buildings. The comprehensive database of information covers news, events, case studies, webinars, links to publications and other resources on energy efficiency in buildings. Its interactive web portal catalyses and releases Europe's collective intelligence for an effective implementation of energy-saving measures in buildings.

- **The Global Buildings Performance Network (GBPN[75])** platform is a worldwide platform dedicated to buildings. The web-based tool stimulates collective research and analysis from experts worldwide to promote better decision-making and help the building sector to effectively reduce its impact on climate change. It is composed of four exclusive online interactive and collaborative tools, including a Policy Comparative Tool enabling comparison of the world's best practices on policies for new buildings (residential and commercial), by reviewing 25 state of the art building energy efficiency codes and using 15 criteria developed with some of the world's leading experts in the field.

3.4.2. SIMPLIFYING CONSUMER ACCESS TO INFORMATION: ONE-STOP SHOPS

To inform households on energy efficiency actions many countries have set up information centres in the main cities to be as closed as possible of the consumers. In OECD countries, the main target is to increase the rate of renovation of existing dwellings. It was found after some years of operation that providing technical solutions was not enough and that these centres should also provide financial solutions including information on existing public support in terms of subsidies, tax credit or soft loans, information which was often previously scattered among different organisations. Thus these information centres were turned into the single place where households and small consumers can obtain information on the existing technical and financial solutions in order to simplify consumer access to the information necessary to enable energy saving actions. This new form of energy efficiency information centres is often called “one-stop shops”.

Energy efficiency information centres and one-stop-shop services allow governments or other information providers to provide better and more cost-effective services to their target audiences. The centre or shop can be a physical place (permanent or mobile) or it can be virtual, using telephone services, Internet services or increasingly a smart phone.

There are different types of one stop shop depending on their information level:

[74] http://www.buildup.eu/en
[75] http://www.gbpn.org/

FIGURE 63 ONE STOP SHOPS CATEGORIES BY LEVEL OF INFORMATION

CATÉGORIES DES GUICHETS UNIQUES PAR NIVEAU D'INFORMATION

Centre Type	Explanation
Information	One-way communication (generic)
Advice	Two-way communication between" expert" and client
Practical services	Offering/facilitating implementation services that save energy

Source: Energy information centre/one stop shop case study, 2016, ECEEE

The one stop shops allow to:

- **simplify** the process of information gathering by supplying relevant materials to users in one, easy to use place;
- **advise** one or more groups, more often but not limited to end users. Advice may be about energy efficient purchases or purchasing, available programmes, installation or technical. That advice can be pre-prepared (e.g. booklets) or bespoke (individualised to meet specific needs of consumer or person/organisation seeking advice);
- **navigate** the landscape of support, finance, technical and service provision, at the very least signposting these services;
- **translate** technical content;
- **motivate** the energy user to take action to reduce energy use;
- **build capacity** in the market to deliver both technical and non-technical services;
- **empower** consumers or audience to take action by providing related services, such as installation and/or financial and may link to other available government or utility programmes.

The objective of the one-stop-shop measure is to address barriers, such as lack of awareness and visibility, lack of information and knowledge in both client and supply chain, fragmented offers from the commercial sector and in public sector incentives for sustainable building renovations, the absence of more singular and universal opportunities to which a service can be attached and the diversity of financial assistance and eligibility.

The efficiency of one-stop-shops can be evaluated through a survey of people who received advice. A case study on the evaluation of one-stop-shops done by ECEEE reveals conversion rates of different countries (number of clients who contact the service that go on to undertake concrete measures) can be high and varied: 30% (Vietnam), 60% (France); and 78% (Austria's business focussed energy audit programme). However, it is not clear from the reporting to what extent pre-disposition has been taken into account, if at all, in these figures. A small number of cases evaluate and report on headline energy savings from the service:

- USA reports savings of 43 GWh in 2014 compared to a target of 38 GWh, with a budget of US$11.8 bn).

- France reports in its latest assessment of the direct environmental impact of EIE carried out in 2011 by the ADEME a reduction of GHG emissions of 134 kt CO_2 per annum.

3.4.3. INNOVATIVE SMART PHONE APPLICATION

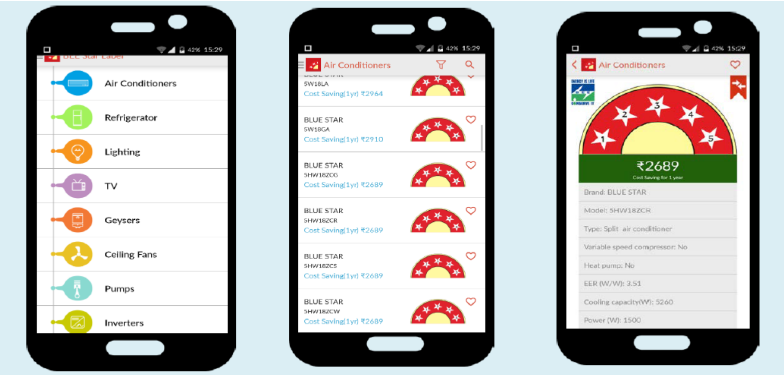
One of the newest innovations in energy efficiency policies is using mobile applications for tracking labels. Some countries have been very innovative in making use of mobile applications to provide consumers with clear and easily accessible information about the energy saving properties of various types of equipment, such as white goods, lighting equipment, water heaters etc. The consumers get real-time information and can compare the products characteristics in a fast and user-friendly way, which is expected to increase the market penetration speed of efficient appliances, as well as to overcome the barriers related to consumers understanding the information on the label. Another important aspect of mobile applications is to gain consumer feedback and thus better market surveillance and information about compliance. India and China are the two big pioneers in this area (Box 20).

BOX 20: MOBILE APPLICATIONS FOR EFFICIENT APPLIANCES IN INDIA AND CHINA

In India, 21 types of appliances were regulated by standards and labels in 2015. The Bureau of Energy Efficiency maintains a product database where relevant information on labels for different brands is registered and can be explored. In 2015, it launched a mobile application with a link to the product database providing daily updated information. Users can filter products, see the energy saving and cost saving and make comparisons between products. In the near future, the application plans to include information on prices and product availability in retailer's stores. This feature will especially help to boost the sales of efficient appliances as in this way customers can have easy access to the best performing products with the best prices available.

FIGURE 64 MOBILE APPLICATION FOR LABELS – INDIA

APPLICATION MOBILE POUR LES LABELS - INDE



The China Energy Label (CEL) (also known as the Energy Efficiency Label-EEL) covers 29 products in 5 categories and features on products from over 9.000 manufacturers since 2005. To support the mandatory energy labelling programme a smart phone application together with a QR code was added to the labels in 2013. The QR code is a detachable part of the label, which can be scanned and contains a web link. providing all registered data and information by product model.

Source: Enerdata from BEE India and http://www.energylabel.gov.cn/

3.5 GOING BEYOND CLASSICAL ENERGY EFFICIENCY POLICIES AND MEASURES

The efficiency of equipment and electrical appliances can be raised by adopting MEPS. However, the age, maintenance and mode of use of the equipment are also very important and have efficiency implications.

One important factor is the advanced replacement of old equipment to raise the effectiveness of existing regulations because much equipment, especially in developing countries, is used well beyond its planned service life.

Another important factor is the maintenance of equipment that can be crucial to avoid bad practices. Since 2003, the inspection of heating boilers and air conditioning systems is mandatory in EU (EPBD). Maintenance of cars and other vehicles is also mandatory in many countries.

Governments also have to tackle the rebound effect that offsets the impact of policies. Rebound effect can be defined by the phenomenon that an increase in energy efficiency may lead to less energy savings than expected because of behavioural changes, mainly increase use of the equipment. Communication, information campaign and trainings can limit such behaviours.

Energy management systems to promote best practices in industry

Energy management systems (EMS) comprise a systematic and structured approach for reviewing the energy needs of a company and for implementing measures to reduce consumption, including putting in place monitoring and reporting systems. EMSs also cover organizational issues, like purchasing rules for buying and installing highly efficient equipment, maintenance procedures, training personnel and tracking and evaluation of suggested and implemented energy saving opportunities.

Energy audits are an important energy management tool providing data on possible energy efficiency improvements and their cost-effectiveness. They can also pave the way for better commitment for implementing improvements. On the other hand, energy audits are often also classified as an information instrument. A certified energy management system necessitates the implementation of an audit.

The success of auditing schemes is closely linked with **training of energy experts conducting audits**. Therefore, particularly in developing countries, audit schemes should be accompanied by capacity development programmes. Among other activities, energy audits are part of the Brazilian National Electricity Conservation Programme (PROCEL) for industry. Recently, PROCEL Industry has focused particularly on measures for optimising motor driven systems. In addition to energy diagnoses, the programme has had a strong focus on capacity development. Training in motor system optimization has been given to multipliers like university professors and consultants, and motor system laboratories and education centres have been established in different universities.

Next, multipliers trained industry staff in order for them to be able to conduct energy audits within their own companies. A project implemented by Unido in Indonesia aims to promote pilot industries to have ISO 50001 certification during the project period from 2012 to 2017. The project is also building capacity through tools and training on energy management, including industrial systems optimization, to enable industries comply with ISO standards. Over 70 projects on system optimizations were identified during the pilot assessments, many of them involving motor driven systems with improvement potentials of 20% to 25%.

Box 21 describes an example of an innovative new approach developed in Sweden to help in energy management. The novelty of the MOVE Model is that it involves visualization, mutual learning, knowledge and experience sharing and can be implemented for identifying continuous improvement actions. The method involves a "train the trainer" concept which implies that corporate and process managers are trained by the project manager leading MOVE workshops. In this way, the knowledge stays within the company at the end of the project. [76]

[76] Svensson and Paramonova, 2015

BOX 21: THE MOVE MODEL IN SWEDEN

The MOVE Model (Method for optimizing system efficiency in electric motor systems) was developed as an analytical methodology for identifying and addressing energy efficiency improvement opportunities in existing and new industrial electric motor systems. This participatory approach allows information acquired and knowledge gained by industrial personnel working with energy issues, maintenance, and production processes to be immediately used for improvement suggestions.

MOVE is a four-step chronological model. An energy audit may be needed in order to define possible areas for improvement but it is not a requirement.

Start: An external 'process leader' coordinates the process. It provides an overview of the methodology to the 'process owner' from the company. The process owner is a person employed by the manufacturing company and has formal major responsibilities in the manufacturing process analysed.

In step 1, the company organizes and sets up a 'case study team' consisting of at least of four experts with knowledge and expertise in the relevant field, collects critical data for the chosen manufacturing process and determines an internal strategy to carry out the activities in the following steps. The collected data is summarized and analysed by the external process leader. This is followed by a feedback procedure involving the process owner and experts.

In step 2, a process mapping visualizes the process requirements affecting energy use, the product value flow and how it contributes to internal customer satisfaction. During this process mapping, the most interesting requirements are identified and make up the overall criteria to identify new energy efficiency measures. Process mapping is followed by brainstorming to involve all the participants and to capture efficiency measures which are outside the system boundary.

In step 3, data is collected to describe the current system routines, automation controls and technical components and sort them out into seven motor system levels ranging from the motor (level 1) to full motor systems (level 3) and human factor (level 7). The existing system is described and the data are evaluated in three energy efficiency categories. Step 3 concentrates on internal efficiency by choosing the best technology and methodology to meet the requirements identified for external efficiency.

Step 4 combines solutions into a list of summarized energy efficiency measures. The measures are analysed, evaluated and placed on an evaluation matrix. Measures from different levels are combined to create new system solutions, meaning that improvements from multiple levels are merged into system efficiency measure. The matrix considers two important aspects of each measure, the impact and complexity of implementation. Finally, the measures are voted for and the highest-rated measures represent the area for the implementation process.

Source: Svensson and Paramonova 2015

Energy efficiency training to share best practices

Training courses for building sector professionals can help to enhance energy efficiency in buildings or in industry and transport companies. For instance, the FEE Bat scheme “Energy savings training for building firms and craftsmen” launched in 2008 in France offers companies and individual craftsmen in the building sector the cross-disciplinary knowledge and tools needed for:

- a comprehensive analysis of energy performance when constructing or renovating residential or commercial buildings.
- more relevant advice for clients, including trades which the firm does not offer itself.
- proposal and implementation by the firm or craftsman either alone or in conjunction with other trades, of more comprehensive solutions in terms of energy savings, incorporating building insulation, ventilation, high-performance equipment, renewable energies, maintenance, etc.

The aim of the scheme is to increase and systematise the degree to which energy-related aspects are taken into account in all building renovation work, based on high-performance technologies and innovative solutions. ADEME measured energy savings from renovation when the craftsman has received the Fee Bat training and estimated 5% gains.

Drivers can also significantly impact fuel efficiency of a tractor-trailer. For example, a report completed by the American Trucking Associations’ (ATA) Technology and Maintenance Council found a 35% difference between the most and least efficient drivers[77]. Drivers can also influence fuel consumption through appropriate route selection and by ensuring proper tire pressure. Training for drivers is a promising opportunity to improve the driver’s impact on fuel costs. This training can take the form of courses in a classroom, online training tools, or messages via phone or telematics systems to the truck, among others.

Studies from other countries have demonstrated that driver training can benefit carriers by increasing fuel efficiency and reducing costs. For example, a study conducted by the European Commission found that a one-day driver training course could result in a fuel efficiency increase of five percent. In addition, Canadian researchers found that for combination truck drivers, training and driver monitoring could result in a 10 percent fuel efficiency increase[78]. Many driver incentive strategies are being deployed by fleets to improve fuel economy and driver retention. Drivers can receive pay bonuses, per-mile pay increases, or prizes for attaining predefined fleet-wide efficiency goals or out-achieving other drivers.

[77] Technology and Maintenance Council, A Guide to Improving Commercial Fleet Fuel Efficiency, American Trucking Associations, Arlington, VA (2008).
[78] Whistler, D., “Fuel Economy 101,” FleetOwner Magazine, http://fleetowner.com/fuel_economy/fuel-economy-0701 (2011).

Inform consumers on benefits of replacement of equipment

To improve the energy efficiency of vehicles, boilers, windows, etc., scrappage programmes are largely used because they are efficient for removing high polluters (section 3.3.1). The measure is a government budget programme to promote the replacement of old products with modern and efficient ones. To encourage the replacement of equipment, the Bonus-Malus is also a well-known measure to subsidize products that generate an environmental benefit while taxing those that generate a negative impact. For example, according to the Ministry of Ecology in France, the automobile bonus-malus had significant impact on new vehicle sales:

- the average emissions from new vehicles fell to 127gCO_2/km in 2011 (compared to 149.3 in 2007);
- over the first ten months of 2012, although the overall market shrank by 13.6% compared with the same period of 2011, each of the tranches eligible for the bonus saw its new vehicle registrations increase strongly (+75%) whilst those subject to the "malus" saw their registrations fall (-28%).

Public benefit campaigns to drive or educate consumer's usage

Public benefit campaigns aimed at raising consumer awareness of the costs and environmental impacts associated with energy consumption address a variety of stakeholders, primarily energy consumers, but also children (future energy consumers), educators (educating/ training/ propagating consumer values/ attitudes and consumptions patterns in future will-be energy users), manufacturers and other businesses, as well as government agencies.

The Irish Power of One campaign (http://www.powerofone.ie) builds mainly on Education and Communication. The campaign focuses on three issues: awareness of energy sources, costs and environmental impacts. The campaign informs consumers about inefficient energy uses that have an impact on costs and environment and calls on the responsibility of the individual. An innovative approach is the presentation of examples:

- In the “Power of One Street” project, the energy efficiency of 8 families from different geographical and social backgrounds is tracked. Every month, the participants were set a challenge to improve their energy efficiency. The savings measured were announced to the media.
- Another example is the “Power of One at Work” initiative, encouraging employers and employees to be more energy efficient in the workplace. The initiative provides basic guidance on energy efficiency for employees, business owners and managers through an advertising campaign, a website and a toolkit for implementing a workplace energy awareness campaign at the local level.

Rebound effect

The "rebound effect" is the phenomenon that an increase in energy efficiency may lead to smaller energy savings than would be expected by simply multiplying the change in energy efficiency by the energy use prior to the change. Rebound effects are normally expressed as a percentage of the expected energy savings from an energy efficiency improvement, so a rebound effect of 20% means that only 80% of the expected energy savings are achieved. In the transport sector, e.g. for a trucking company, this could be the increase in vehicle-kilometres driven after improved fuel efficiency in the vehicles used. In buildings the saving after insulation of a dwelling may be less than expected because consumers will raise their heating temperature after the insulation. The existence of the rebound effect has been clear for a long time. However, the size of the rebound effect is much less clear.

This rebound effect corresponds to the **direct rebound effect.**

There is also an **indirect rebound effect**[79]. For example, drivers of fuel-efficient cars may spend the money saved by buying other energy-intensive goods and services, such as an overseas flight. Similarly, large reductions in energy demand will alleviate the tension between demand and supply and translate into lower energy prices which encourage increased energy consumption.

Both direct and indirect effects appear to vary widely between different technologies, sectors and income groups and in most cases they cannot be quantified with much confidence. There have been several studies published that attempt to estimate direct rebound effects for specific energy efficiency programmes. These studies indicate that direct rebound effects will generally be about 10% or less[80]. A literature review from the same ACEEE study estimates that the indirect rebound effect amounts to 11%.

Smart energy systems require certain behaviour from users and extensive maintenance. If the users are inadequately trained to use the new systems or to replace equipment, the energy savings expected will not be achieved. To prevent this rebound effect resulting from improper use, environmental certifications in the building sector increasingly contain a new section that informs and trains users of the building on energy management systems set up and maintenance. For example, in the French certification HQE, the section "care and maintenance management" requires users to take into account and plan maintenance during the construction of the project.

[79] The sum of direct and indirect rebound effects represents the **economy-wide rebound effect**. When the rebound exceeds the savings, resulting in increased energy consumption from efficiency, the rebound effect is called **backfire**.

[80] The Rebound Effect : Large or Small ?, An ACEEE White Paper, Steven Nadel, August 2012.

Chapter 4
The international dimension and the spill over effect of energy efficiency: multiple benefits

4.1 THE INTERNATIONAL DIMENSION OF ENERGY EFFICIENCY

In the European Union, as part of its strategy, the European Commission presented proposals to deliver a new deal for energy consumers, to launch a redesign of the European electricity market, to update energy efficiency labelling and to revise the EU Emissions Trading System. The package is an important step towards implementing the Energy Union strategy with a forward looking climate change policy. The strategy gives prominence to the **"energy efficiency first"** principle and puts households and business consumers at the heart of the European energy market.

When the government of China took over the G20 presidency in 2016, it was clearly stated that energy efficiency would remain a priority on the agenda of the G20 Energy Sustainability Working Group (ESWG). The final communiqué by Energy Ministers recognizes that *"energy efficiency, including energy conservation, is a long-term priority for G20. Improving energy efficiency brings social, economic, environmental and other benefits, and plays a key role in shaping a sustainable future."* In a major step for energy efficiency cooperation, G20 Energy Ministers adopted the *G20 Energy Efficiency Leading Programme* (EELP), thereby "[agreeing] to take the lead in promoting energy efficiency." The EELP encourages countries in the G20 and beyond to pursue collaborative activities on energy efficiency. It also opens new areas of cooperation: The Energy Ministers called for International Partnership for Energy Efficiency Cooperation (IPEEC[81]) to work closer with the International Energy Agency and other international organizations to "strengthen the global voice for energy efficiency" and to "explore the feasibility of innovative collaborative arrangements for international cooperation on energy efficiency."

In Asia where the potential of energy savings is a top priority, during the plenary sessions of the ACEF 2016 conference, Rachel Kyte, CEO of the Sustainable Energy for All and Special Representative of the UN Secretary General said that, *"We are ready for an extraordinary new era of clean energy. The industrial revolution started in Europe, but the future of clean energy is in Asia," […]. "In order to turn around climate momentum, we need to have GHG emissions peak in 2020, and not 2025. Efficiency must come first. It is the cheapest fuel source and is available to everyone. Access need to be placed at the heart of any clean energy transition. We need to delink ourselves from the carbon intensity of a centralized power system that is failing and not providing the energy services people need."*

The declaration of the Energy and Mining Commission of the Latin American Parliament set stated in November 2012 in Panama that "Energy efficiency must be part of energy policy, and integrated in sustainable development strategy "… and that the following actions should be promoted:

- Correcting price distortions that undermine demand management
- Approve national energy efficiency financing programmes
- Improve government leadership-in its role of implementer, developer and regulator
- Monitor data management based indicators

[81] http://www.ipeec.org/

The fifth edition of the Sustainable Development Report on Africa (SDRA) produced by the Economic Commission for Africa in collaboration with partner institutions states in its key messages that ….“*Energy efficiency and demand-side management practices need to be enhanced” and that “African governments should capitalize on the under-tapped renewable energy and energy efficiency opportunities, to meet sustainable energy requirements for increased valorisation of its natural resource endowment and generate productive employment and income for its citizens, particularly the young*[82]*”.*

After COP21: high potential of energy efficiency improvement

Ban Ki-moon, UN Secretary-General emphasized at COP21 that "energy efficiency is our best tool to reduce CO_2 emissions".

Hundreds of governments, businesses and financial institutions pledged major action on energy efficiency at COP 21 (Paris, December 2015), recognizing it as the basis of the energy transition. The mobilisation of all actors around energy efficiency is gaining attraction because it delivers significant economic and environmental gains:

- Some 775 companies from 33 countries, more than 130 national, regional and local governments and over 100 financial institutions are committing to ramping up energy efficiency measures and investments under the Sustainable Energy for All (SE4All) initiative's '100/100/100' campaign.

- Of these, 75 companies have made specific commitments to increase their energy efficiency in action that will save up to 62 TWh over the next five years.

As said previously more and more financial institutions are committing to better financing of the energy transition. And during the COP21, 106 banks from 42 countries with a financial capacity of US$ 250 billion and a group of Investors, managing close to US$ 4 trillion in assets, have committed to a major increase in energy efficiency lending in their portfolios. Led by the European Bank for Reconstruction and Development (EBRD) and the UNEP Finance Initiative, this is a major undertaking toward the four-fold increase needed to realize the full energy efficiency potential for climate change. According to ADB, by 2020 *“Investment needed to meeting national targets in PRC, India and Southeast Asian countries totalled $943 Billion; of which, 92% in PRC, 7% in India and 1% in Southeast Asia.” And by 2030 “Investments of 1%-4% of overall energy sector spending can meet up to 25% of the projected increase in primary energy consumption”.*

The potentials for energy savings gained thanks to energy efficiency actions is tremendous, and is becoming a priority in energy policies. For instance, UNEP estimated energy savings in top 6 high consuming products[83] can reduce global electricity use by over 2.500 TWh (or the equivalent to 600 large power plants, see Figure 3).

[82] http://www.uneca.org/sites/default/files/PublicationFiles/sdra_5_keymessages_eng.pdf
[83] Lighting, air conditioning, refrigerator, computer, electric motors and transformers.

4.2 THE SPILL OVER EFFECT OF ENERGY EFFICIENCY: MULTIPLE BENEFITS

Independence and supply security

A crucial contribution on the road to energy independence is energy efficiency. At a time of rising and volatile oil and natural gas prices, Europe is the largest importer of energy worldwide. The EU currently imports approximately 50% of its energy consumption. This ratio may increase to 70% in 2030 if no further measures are taken. Given the very limited opportunities for increasing domestic natural gas production, increased energy savings and development of local renewable sources are the main options for decreasing imports over the long term. Ukraine is particularly reliant on natural gas in its energy balance, and most of this gas is imported. It is particularly dependent on Gazprom, the Russian gas company, for the supply to 14 million of households. Since the military conflict over Crimea, energy efficiency measures are the priority of Ukrainian government to help ensure its supply security.

Climate

Energy savings contribute directly to reduce GHG emissions and mitigate climate change. Energy efficiency measures became one of the main tools used by climate policies. Worldwide, the COP21 negotiations have resulted in agreement on which energy efficiency is the main driver to keep the increase in global average temperature to well below 2°C above pre-industrial levels. Energy efficiency is taking its place as a major energy resource, the “first fuel” (as presented in Figure 1), in the worldwide context. Energy efficiency measures also contribute to the overall resilience to climate change as they play a protective role against extreme weather events. Energy efficiency improvements may be considered as part of a strategy to pursue and expand the scope of climate change adaptation measures.

Job creation

An investment in energy efficiency will first create opportunities for workers in industries that are more labour intensive than average (for example a retrofit project will create jobs in the construction sector). Many of the assessments include direct employment (directly related to on-site operations), indirect employment (resulting from the supply of materials to on-site operations), and induced employment (employment that arises from the generation of revenue by the direct and indirect workers). Additionally, energy efficiency generates energy bill savings over the life of the investment, which releases funds to support more jobs in the economy by shifting jobs in the energy generation and distribution industries (lower labour intensity) to jobs in all other industries (higher labour intensity). According to the IEA, the potential for job creation ranges from 8 to 27 job years per €1 million invested in energy efficiency measures. The American Council for an Energy-Efficient Economy (ACEEE) estimates in its last available analysis (2010) that there were 830.000 energy efficiency jobs in the United States (approximately 0.5% of the labour force of U.S), and predicts numbers were increasing at a 3% annual rate some figures are given by sector:

FIGURE 65 JOB CREATION FIGURES BY SECTOR

NOMBRE D'EMPLOIS CRÉÉS PAR SECTEUR D'ACTIVITÉS

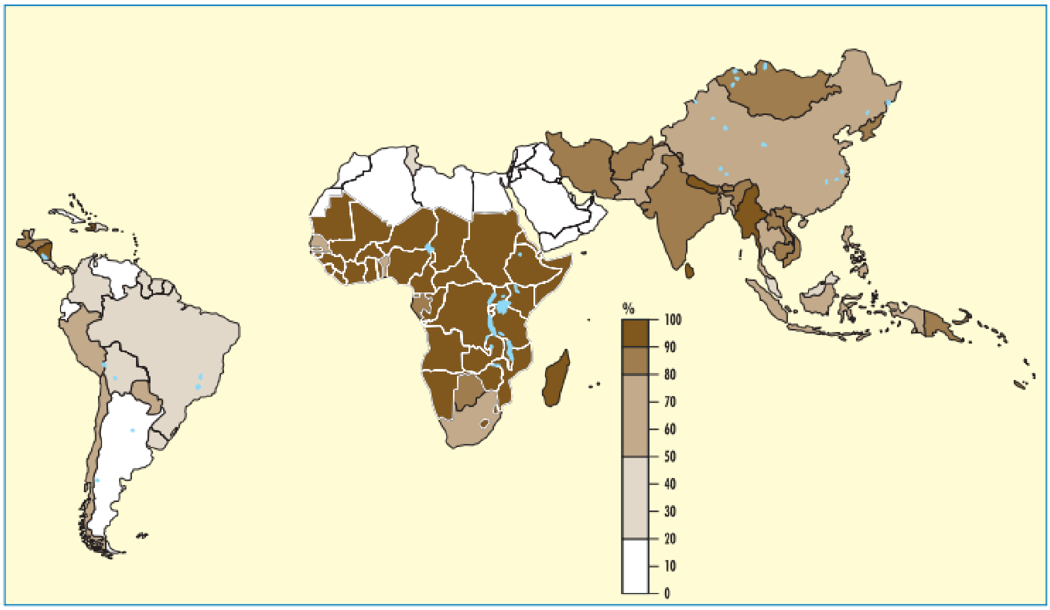
Sector	Job creation figure	Source
Appliances	2010 federal appliance standard had generated 340.000 jobs and should increase to 380.000 by 2030	Environmental Entrepreneurs
Buildings	Green building sector will support more than 3.3 million jobs by 2018 (1/3 of all U.S. construction jobs).	U.S. Green Building Council
Public Transportation	In 2013, newly announced projects, projects under construction and projects in operation created 11.449 new jobs.	Environmental Entrepreneurs
Smart grid and Demand management	The smart grid programme, part of the 2009 American Recovery and Reinvestment Act, supported a minimum of 47.000 jobs	U.S Department of Energy

Deforestation (indirect effect)

According to the IEA, 2.5 billion people or 52% of the population in developing countries depend on biomass as their primary fuel for cooking (Figure 66). Over half of these people live in India, China and Indonesia. However, in many parts of sub-Saharan Africa region, more than 90% of the rural population relies on fuelwood and charcoal.

FIGURE 66 : SHARE OF TRADITIONAL BIOMASS IN RESIDENTIAL CONSUMPTION BY COUNTRY

PART DE LA BIOMASSE TRADITIONNELLE DANS LA CONSOMMATION DU SECTEUR RÉSIDENTIEL PAR PAYS



Source: IEA

Inefficient and unsustainable cooking devices, such as open fires (15 to 30% of efficiency), can have serious implications for the environment, such as deforestation. Clearing land for timber is one of the main causes of deforestation in developing countries. Fuel substitution and improved stove efficiencies would help relieve the environmental damage of biomass use.

Industry and services competitiveness and productivity

In the industrial sector, energy use is a significant operational cost for the paper industry that energy savings can make the difference between operating or shutting down a plant. Analysis of the most important industrial energy efficiency technologies has shown that a productivity increase can be expected if energy efficient process technologies are introduced (Walz, 1999).

Improving the energy efficiency of commercial building can result in gains in worker productivity in addition to generating energy cost savings. Staff costs, including salaries and benefits, generally account for about 90% of business operating costs. Considering this, even a small percentage gain in productivity, multiplied by the number of employees, can result in considerable savings. Comfort in offices through temperature, indoor air quality, lighting, acoustics, physical space and humidity plays a key role in productivity as well. A study used by the World Building Green Building Council estimated for example a reduction in performance of 4% at cooler temperatures in offices and a reduction of 6% at warmer temperatures.

Energy prices

Reducing consumption of the energy product reduces automatically the amount of energy that participants must purchase. The same demand reduction also slides the market-clearing point on the supply curve, backing down the most expensive supplies, resulting in lower prices for all the remaining loads.

According to a study from Ecofys, the main effects of energy savings in energy prices in Europe are:

- the reduction of fossil fuel prices (1% for every 1% of energy saved),
- lower electricity prices due to lower electricity demand,
- infrastructure investments could be cancelled and will reduce prices further.

Income effect

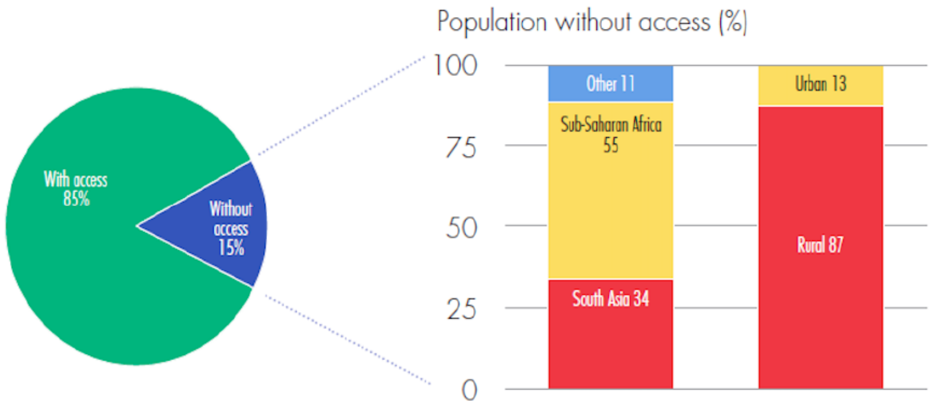
When the enhancement in energy efficiency reduces the cost of a particular good or service, consumers need to spend less on it to get the same output as before. This saving represents an extra disposable income.

Energy/Electricity access

Over one billion people globally lack access to electricity and more than half of them are located in Sub-Saharan Africa.

FIGURE 67 : POPULATION ACCESS TO ELECTRICITY IN 2012

POPULATION AYANT ACCÈS À L'ÉLECTRICITÉ EN 2012



Source: World Bank Global Electrification database 2015 (World Bank 2015)

Efficient and high quality energy services and applications can reduce the total cost of providing off-grid energy by as much as 50% and decrease the need for expensive peak capacities. Super-efficient appliances, income-generating equipment and other end-use technologies can provide access to other energy services such as communication, cooling or water pumping and also reduce the required energy supply investment to make off-grid energy services more affordable. So energy efficiency can enable expanded energy access.

Energy poverty

Recent estimates suggest more than 10% of the European population are unable to keep their homes adequately warm (indicators from the EU Statistics on Income and Living Conditions - EU-SILC). Other evidence points to particularly high levels of energy poverty in specific regions of Europe, including Central Eastern Europe and Southern Europe. Research suggests that energy poverty has important consequences if not addressed, such as impacting health, further entrenching poverty and making other objectives less attainable, e.g. addressing climate change.

Under the Third Energy Package, the EC put obligations on Member States to define vulnerable consumers in the energy markets, and put in place measures to provide for their adequate protection. Specifically, the Directives in question (2009/72/EC & 2009/73/EC) state, "Member States shall take appropriate measures to protect final customers, and shall, in particular, ensure that there are adequate safeguards to protect vulnerable customers. In this context, each Member State shall define the concept of vulnerable customers which may refer to energy poverty.

The Directives also state, “Member States which are affected and which have not yet done so should therefore develop national action plans or other appropriate frameworks to tackle energy poverty, aiming at decreasing the number of people suffering such situation.” Energy efficiency retrofits of low-income housing offer a more enduring solution to these problems than energy tariff subsidies or fuel payments because they address the cause of fuel poverty, rather than the symptoms. A study using data from New Zealand’s Warm Up NZ: Heat Smart programme evaluation indicated significantly higher monetised benefits among families on low to modest incomes of USD 519 per year after the retrofitting compared to USD 183 for higher-income families (Telfar et al., 2011).

Promotion of innovation

Minimum Energy Performance Standards and energy efficiency labels encourage but also speed up research programmes and the development of innovative equipment in all sectors. For example, in the building sector, the specific consumption of light has been improved with the emergence of LED lamps. Smart grids are also a good illustration of innovation to enhance the energy management of cities.

Governments have integrated that low-carbon or energy efficient technologies are part of economic growth and job creation drivers and that innovation allow the emergence of leader companies at national level.

Health effects

Changes of buildings that increase energy efficiency, for example improved insulation and ventilation control, can reduce indoor air pollution with corresponding health benefits, particularly for respiratory conditions, such as asthma. During extreme heat period or in areas of warmer climates, efficient cooling devices can help reduce mortality. Improving the energy efficiency of light allows lighting systems in cities and roads to be expanded. The number of road accidents is reduced and cities are safer. Several studies that quantified total outcomes found benefit-cost ratios as high as 4:1 when health and well-being impacts were included. Apart from influencing residential well-being, from a public health point of view such measures also reduce public health expenditure.

Focus on the multiple benefits of deep retrofitting

BOX 22: DRIVERS FOR HOME ENERGY RENOVATION: A WHOLE SET OF BENEFITS TO BE CONSIDERED

The benefits coming from energy efficiency improvements in buildings are many and affect different socio-economic levels. At the macro-level, deep renovation of the existing building stock in the EU has multiple positive impacts:

- the potential to **reduce CO_2 emissions** by 80% by 2050, thus contributing to **climate change mitigation**;
- every investment of €1 million in upgrading the building stock in the EU can create 19 new direct jobs in the construction sector, of which the vast majority is local and non-transferable, thus leading to economic vibrancy in the EU[84];
- in terms of improvements in energy security, the EU could **gain up 130 days of additional energy independence**: the EU is importing nearly 54% of its primary energy per year, spending more than €400 billion each year[85] – and buildings account for over one-third of the total final energy consumption in the EU. This means that for a large part of the year, the EU is 100% dependent on foreign energy imports. In 2011, the EU became fully dependent on imports as early as June 18. But, by unlocking the energy efficiency potential in its buildings, the EU could **reduce the energy imports** and keep its independence until October 26 each year[86].

At the micro-level, as people spend almost 90% of their life in buildings, the benefits of deep renovation are numerous as well:

- the improved indoor climate of renovated buildings with better ventilation systems leads to **clear health benefits** (such as the relief from symptoms of respiratory and cardiovascular diseases, allergies and rheumatism);
- the lower energy bills from renovated buildings **reduce the stress** that often arises from the concern of not being able to pay (the so-called **"heat or eat" problem**[87]), this way **addressing fuel poverty** at the same time;

[84] Janssen and Staniaszek, 2012
[85] Eurostat, 2013
[86] EuroACE, 2014
[87] IEA, 2014

- days off work and associated productivity impacts can be monetized through a calculation of lost earnings[88]. **Including the value of reduced absenteeism** of the workforce due to better indoor climate has been shown to increase the NPV of overall benefits (e.g. comfort, energy savings, enhanced cognitive ability) by 11.5%.In order to take into account the multiple benefits of building renovation, governmental and financing instruments should therefore follow the "**total cost of ownership**" principle, taking a systematic approach to balancing: maintenance costs, operating costs (annually budgeted expenses for all activities necessary for the routine, day-to-day use, support, and maintenance of a building or physical asset, energy consumption, etc.) and replacement/refurbishment costs over the life of the asset. This way, investments in renovation would be assessed by taking into account the whole range of costs and revenues of the building's entire use phase, having a holistic view that includes the multiple benefits.

Source: BPIE from literature[89]

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[88] Chapman et al, 2009

[89] Buildings Performance Institute Europe (BPIE). Atanasiu B., Kontonasiu E., Mariottini F. (2014). *Alleviating Fuel Poverty in The EU – Investing in Home Renovation, a Sustainable and Inclusive Solution*. Brussels.

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Chapter 5

Conclusions and recommendations

5.1 ENERGY EFFICIENCY TRENDS

The primary energy intensity is decreasing in 80% of World Energy Council's member countries and most regions. However, the world economic crisis lowered the energy productivity improvement **(1.6% per annum between 2000 and 2008 compared to 1.3% per annum since 2008).**

The energy productivity improved more rapidly at the level of final consumers than at the overall level for the world and in half of the regions since 2000 **(1.7%per annum decrease in final intensity vs 1.5% per annum for the primary intensity at world level)**[90].

Without these energy productivity improvements since 2000, world energy consumption would have been **3.1 Gtoe higher in 2014**, which avoided 7 $GtCO_2$.

Since 2000, the average efficiency of thermal power generation has generally increased slowly, except in China (addition of more efficient coal plants) and Latin America (adoption of CCGT) where there was a rapid progress.

Since 2008, there has been a net slowdown in the intensity reduction in most regions and at world level, because of the global crisis (-1.6% per annum between 2000 and 2007 and only 1% per annum since 2007).

The energy consumption of transport is generally growing much slower than GDP.

There is a decreasing trend in energy consumption per household. In OECD countries, the main driver is energy efficiency improvement for space heating and appliances. In emerging countries, it is the substitution of biomass with modern fuels for cooking.

Everywhere there is trend towards more efficient electrical appliances because of the regulations in place (MEPS and labels), which almost stop the growth in electricity demand in OECD countries and is slowing down the progression in emerging countries.

There is however a rapid increase in electricity consumption per value added in some countries in which the service sector is expanding with the diffusion of AC and ICTs.

North America, Europe, CIS and Pacific OECD represent a decreasing share of total world CO_2 emissions from energy combustion (44% in 2014, compared to 63% in 2000). This reduction is explained by the large increase in CO_2 emissions in China (+ 14% for the share of China in world emissions) and to a lesser extent in India (+ 3%) and the decrease of these emissions in Europe and a relative moderation in other OECD countries.

[90] This trend is mainly the result of growing losses in energy conversion, a phenomenon that is linked to two factors: on the one hand, the increasing use of electricity by final consumers and, on the other hand, the fact that electricity is predominantly produced from thermal or nuclear power plants, i.e. with losses. In other regions (like North America, Europe or Africa) reverse trends are observed thanks to the development of high efficiency power generation (mainly renewables with 100% efficiency).

5.2 ENERGY EFFICIENCY POLICIES AND MEASURES TO CONSIDER

The increasing number of countries with an energy efficiency law (+ 10 countries compared to 2012 survey) can be considered as a sign of a strengthening and consolidation of the institutional commitment on energy efficiency.

At world level, there is a global convergence of P&Ms (in particular for regulations that are becoming widely implemented in some sectors) with local specificities.

Wide introduction of energy efficiency regulations (labels and MEPS) to transform markets

Among regulations, energy efficiency labels are widely implemented and are important to guide consumers and motivate manufacturers on energy efficiency products, Labels are not sufficient to transform the market alone: they are the first step but need to be complemented with MEPS to remove inefficient equipment or practices.

Information dissemination to motivate consumers to undertake actions

To inform households on energy efficiency actions many countries have set up information centres. Some of these information centres were turned into the single place where households and small consumers can obtain information, so called "one-stop shops".

Spreading energy audits is also a way to provide well targeted information to consumers to help them undertake investments. Audit is a service where the energy efficiency of factories or buildings is evaluated with the aim to suggest the best ways to improve energy efficiency.

Financial incentives are still necessary to support investment

Regulations cannot address all areas of energy efficiency and economic incentives are still crucial to encourage investment in energy efficient equipment and processes by reducing the investment cost, either directly (financial incentives) or indirectly (fiscal incentives).

The role of ESCOs and EPC (Energy Performance Contract) should also be enhanced.

Users need to be pushed to avoid inefficient practices (human factors)

The efficiency of equipment and electrical appliances can be raised by adopting MEPS. However, the age, maintenance and mode of use of the equipment are also very important and have efficiency implications.

One important factor is the advanced replacement of old equipment to raise the effectiveness of existing regulations because much equipment, especially in developing countries, is used well beyond its planned service life.

The multiple benefits of energy efficiency

In addition to promoting sustainable development and saving energy, energy efficiency implies several positive side effects that have been described in this report.

5.3 RECOMMENDATIONS

Recommendations	Implemented	In progress	Status quo	Comment
Energy prices reflecting real costs				Subsidized energy prices need to be adjusted to reflect the real cost of energy supply in order to give the right signals to the consumers. Although most countries realize the need for this (e.g. in Mexico[91]), the deregulation of energy prices is often a long process due to public opposition and the need to change progressively. Due to the decrease of oil recipes, many oil producer countries in the Gulf region are increasing energy prices (since 2014, Qatar, Kuwait, Egypt, Bahrain, Angola, Saudi Arabia, Nigeria and Oman) but also India, Argentina and Venezuela have removed part of their fuel subsidies. In Tunisia as well, the government did not pass the recent decline in energy prices at international level on the domestic prices to lower subsidies. As G7 nations recently pledge to end fossil fuel subsidies by 2025, the countries should set **deadlines to gradually reform energy pricing**. In addition, a wider strategy is needed to enforce the price reform through an independent body (e.g. regulatory commission) responsible for pricing and explicitly linking the additional revenue with specific public expenditure goals introducing a "safety net" to protect the economically disadvantaged part of the population.
Consumers better informed				As information is one of the main drivers of habits, it is necessary to **simplify messages on energy efficiency actions** and integrate information channels **to reach the majority of consumers**. Advice to households should be simplified by establishing contact/entry points and harmonizing messages for instance through local energy information centres, in particular one stop shops. To facilitate consumer actions, updated lists of local service and equipment suppliers could be provided if possible in these local centres. The guidance for possible actions, through audits for instance, is also a key to facilitate consumer action. A larger audience can be reached by using innovative ways of communication (e.g. mobile applications in India and China). The training of professionals through guidelines,

[91] In Mexico, the prices of gasoline and diesel have been increased each month in 2014 to bring them closer to international levels.

Recommendations	Implemented	In progress	Status quo	Comment
				example calculations, seminars and workshops aims at increasing the quality of audits and energy management.
Smart billing and meters				**Smart billing and meters represent a significant potential for energy savings**, as it improves consumers' ability to monitor and control their electricity and gas use, ultimately leading to reduction in consumption. During recent years, smart meters have been widely deployed worldwide: China became the leader of the smart metering market (250 million of smart meters) and Asia planned to reach 70% in coverage rate; 40% of American households have a smart meter; at European level, Italy and Sweden are the best examples (close to 90% of consumers with a smart meter) and the Energy Efficiency directive requires EU Member countries to deploy smart meters by 2020. To realize savings, smart meters must be used in conjunction with in-home (or on-line) displays or web applications and well-designed programmes that inform, engage and motivate people (feedback meters).
Innovative financing tools				Financial and fiscal incentives are still necessary to support investment. However, financial measures are relatively expensive for the public budget, especially when a large share of equipment is covered or for long-term investments. Thus to alleviate the public financing, **private investments in energy efficiency should be facilitated by supporting the development of intermediate third parties** (e.g. ESCO's, PPP) **playing a role of aggregator** and filling the gap between projects and finance. ESCOs are spreading all over the world: especially in Europe, U.S., Canada but also in Asia where China recorded a very fast spread. However, for some regions (e.g. India), their development is still limited. A larger role of ESCO's is still limited by the prices being too low in many countries (due to subsidies and low international prices), the reluctance of consumers to outsource energy efficiency investments and the low involvement of the local banking system that is needed to support the ESCO's projects. Several actions can be implemented to raise the private sector participation: ESCO facilitators to act as an intermediate between ESCO's and consumers (e.g. Thailand) and guarantee mechanisms attached to energy efficiency funds.
Control of				Even if regulations are widely implemented over the world, their impact depends on effective compliance.

Recommendations	Implemented	In progress	Status quo	Comment
compliance				**Policy and programme effectiveness should be evaluated during and after implementation**. For instance, strict checks during the construction permitting and construction phases are needed to verify the implementation of the energy building code.
Strengthened and wider regulation				To be effective, labelling programmes and **MEPS should be regularly revised and upgraded**, as a way of stimulating technical progress and ensuring steady energy efficiency improvements. In emerging and developing countries, regulations need to be more much widely implemented, including in the power generation sector (e.g. India, China where the electricity demand grows significantly with the increasing use of thermal power plants) and in electricity transmission (egg Latin America). With the sharp rise of annual construction rate in these regions, the building sector also require the development of regulations.
Monitoring				Monitoring achievements and the impact of measures is necessary to check the real impact of energy efficiency policies. The monitoring and assessment tools include: development of end-use data collection; development of energy efficiency indicators; evaluation of measures that work and do not work; promotion and use of standardized procedures for measuring energy savings (e.g. ISO 257); development of Energy Management Systems; development of regular mandatory energy audits. In that sense, the G20 IPEEC Building Energy Efficiency Task Group (BEET) work to promote uptake of best practices in the field of building energy performance codes and to develop and track building energy efficiency metrics. Policies should also incorporate in their implementation and evaluation the positive side effects of energy efficiency. These multiple benefits include: climate change, energy independence, opportunities for workers, productivity increase, lower prices, energy access, development of innovative equipment, health benefits etc. One additional barrier to energy efficiency is the multi-level and multi -sectoral context of policy measures. For instance, improving energy efficiency in transport falls under the responsibility of multiple public stakeholders including the Energy Ministry, but also the Transport Ministry and the administrations of cities and regions for urban and regional transport. In buildings, the control of

Recommendations	Implemented	In progress	Status quo	Comment
				building permits, including building codes fall under the responsibility of cities that often lack the resources and expertise to carry out the necessary control; public support may come from the Energy Ministry but also the Housing Ministry, as well as again the administrations of cities and regions. This institutional setting should be taken into account when designing energy efficiency policies; any coordination or simplification in the decision making can only have positive effects.
International cooperation				The development of **international** or **multi-national standards could help enhance international and regional cooperation, in addition to regional testing and harmonization facilities and certifications**. For instance, the harmonization of ASEAN standard (testing methods) facilitates intra-ASEAN trade on higher efficient appliances. Moreover, energy efficiency platforms (e.g. SE4ALL, BUILD UP and GBPN) should be used to exchange experiences in order to benchmark policies and identify best practices

Chapter 6

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Figures
Tables
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