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CONSEIL MONDIAL DE L'ÉNERGIE
For sustainable energy.

World Energy Perspective

Energy Efficiency Policies – What works and what does not

Key Messages

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World Energy Council

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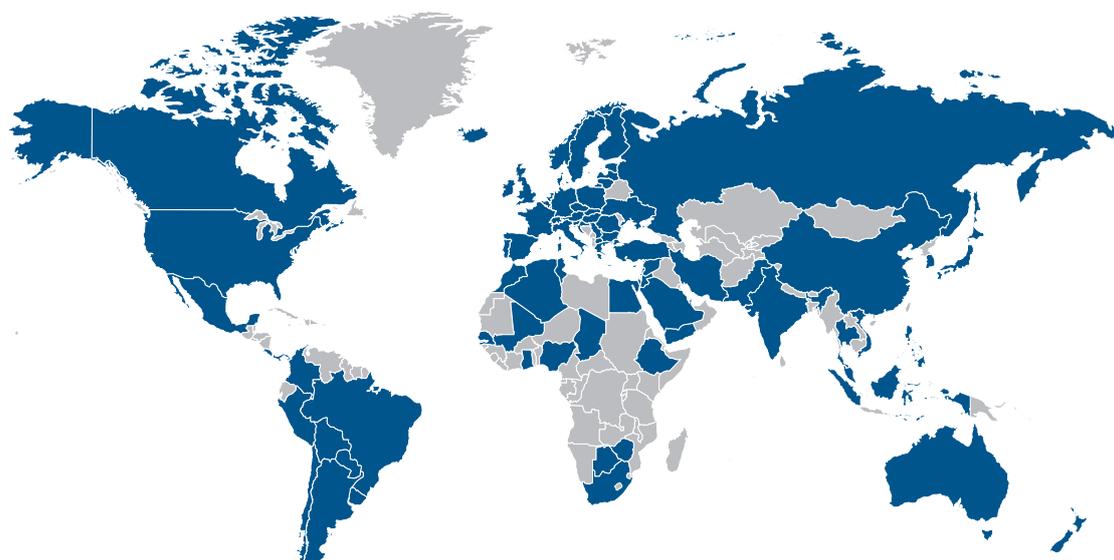
Introduction

This is a summary of the 8th triennial study report produced jointly by the World Energy Council and ADEME with technical support by ENERDATA. The study project which was launched in 1992 is focused on the identification, documentation and evaluation of energy efficiency policies and trends around the world. The present report covers 85 countries, which together account for over 90% of the total global energy consumption. The full report can be downloaded www.worldenergy.org/publications

Figure 1

Countries covered by the WEC survey on energy efficiency policies

Source: WEC ADEME survey 2012–2013



Given its broad geographical coverage and the combined analysis of established correlation between energy efficiency indicators and policy measures, the study takes an original approach to the evaluation of the interaction between energy efficiency policies and energy efficiency performance of national economies. Energy efficiency helps address the **“Energy Trilemma”** i.e. energy security, environmental sustainability and energy equity. Improving energy efficiency allows energy savings and reduction in the environmental impacts of energy production and use to be achieved.

Although the benefits of energy efficiency are obvious and the potential for its improvement is significant, the progress so far has not matched the expectations. Therefore, it is important to identify the factors that are holding back the progress. The first objective of this study is to review the recent trends in energy efficiency in the WEC member countries. A number of indicators has been agreed and used for that purpose, and they are available on the WEC web site.¹ These indicators are thoroughly reviewed and compared with each other by region and a few by country using maps.

1 <http://www.worldenergy.org/data/efficiency-indicators>

The second objective of the study is to describe and evaluate energy efficiency policies implemented in a large number of countries throughout the world. All detailed information related to the energy efficiency policies implementation can be viewed on the WEC web site.² In addition, as has been done for previous reports, there are comprehensive case studies on policy measures which have been prepared by experts in the relevant areas and focused on

four policy measures:

1. Innovative financing schemes for buildings.
2. Measures to accelerate the penetration of efficient air conditioners and their efficient use.
3. Smart billing.
4. Measures to improve the efficiency of road transport of freight.

The study however goes beyond a mere review of already implemented energy efficiency policies and measures. It demonstrates also the results of a thorough assessment of these policies to pinpoint the most interesting experiences and draw general conclusions regarding advantages and deficiencies of different policies. The information in this report should enable governments embarking on the development of energy demand management policies and programmes to benefit from the experience of other countries.

The way forward

In addition to a survey carried out in WEC Member Countries, the following examples of energy efficiency policies have been selected for their proven impact based on the cumulative experience of policy implementation in various countries and organisations worldwide including WEC, IEA, IPEEC, Cepal/Eclac, Medener, EU Commission) and benefit from case studies conducted for the report.

The study concludes by a summary of nine main recommendations:

- ▶ Energy prices should reflect real costs of supply and thus ensure that consumers get the right price signals.
- ▶ Consumers need information to be able to make informed decisions.
- ▶ Smart Billing represents a significant potential of energy savings
- ▶ Innovative financing tools are needed to support investments by consumers.
- ▶ The quality of energy efficient equipment and services should be verified.
- ▶ Regulations should be properly enforced and regularly strengthened.
- ▶ Consumer behaviour should be examined and addressed, especially in terms of growing reliance on ICTs.
- ▶ It is necessary to monitor the trends in energy efficiency to be able to evaluate the real impact of energy efficiency policies.
- ▶ Finally, international and regional cooperation in support of energy efficiency should be enhanced.

2 <http://www.worldenergy.org/data/energy-efficiency-policies-and-measures>

However, many energy efficiency measures require upfront investment, and in certain cases, the investor does not recover the full benefits of the original investment. This creates difficulties for effective implementation of energy efficiency measures.

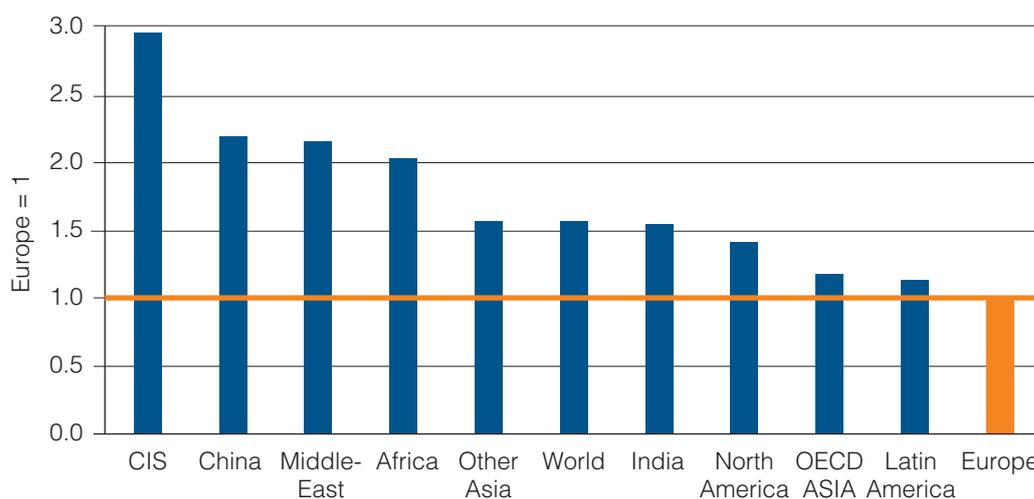
What's new: energy efficiency trends by region

Most countries have significantly reduced their total energy use per unit of GDP over the last three decades. The decline in energy intensity has been driven largely by improved energy efficiency in key end-uses such as vehicles, appliances, space heating and industrial processes. Governments have implemented a wide range of policies and programmes such as energy efficiency standards, educational campaigns, obligations for market participants and financial incentives to accelerate the development and adoption of energy efficiency measures. These policies and programmes have contributed to the improvement in energy efficiency recorded in OECD countries, along with on-going technological development, response to rising energy prices and growing competition in industries forcing businesses to cut energy costs.

Western Europe is currently the region with the lowest energy intensity, while among the large consumer countries; **CIS uses almost 3 times more energy per unit of GDP than Europe.** In China, Africa and the Middle East, the energy intensity is two times higher than the average in Europe. High energy intensities can be attributed to a number of factors, including the structure of the industry, the share of energy intensive sectors, low energy prices and other. Latin America and OECD Asia & Pacific are about 15% above the European level, while India and other Asia are at the same level as the world average with energy intensity 50% higher than in Europe and slightly less than North America.

Figure 2
Primary energy intensity levels by world region (2011)

Source: WEC/ENERDATA



In the European Union, there are many laws (Directives) to promote energy efficiency (EPBDB, Eco Design, Eco Labelling, Energy Efficiency Directive and others such as CO₂ emissions standard for vehicles). Each Member state has strong commitment to energy efficiency through indicative national targets for 2020, long-term strategies for buildings renovation and

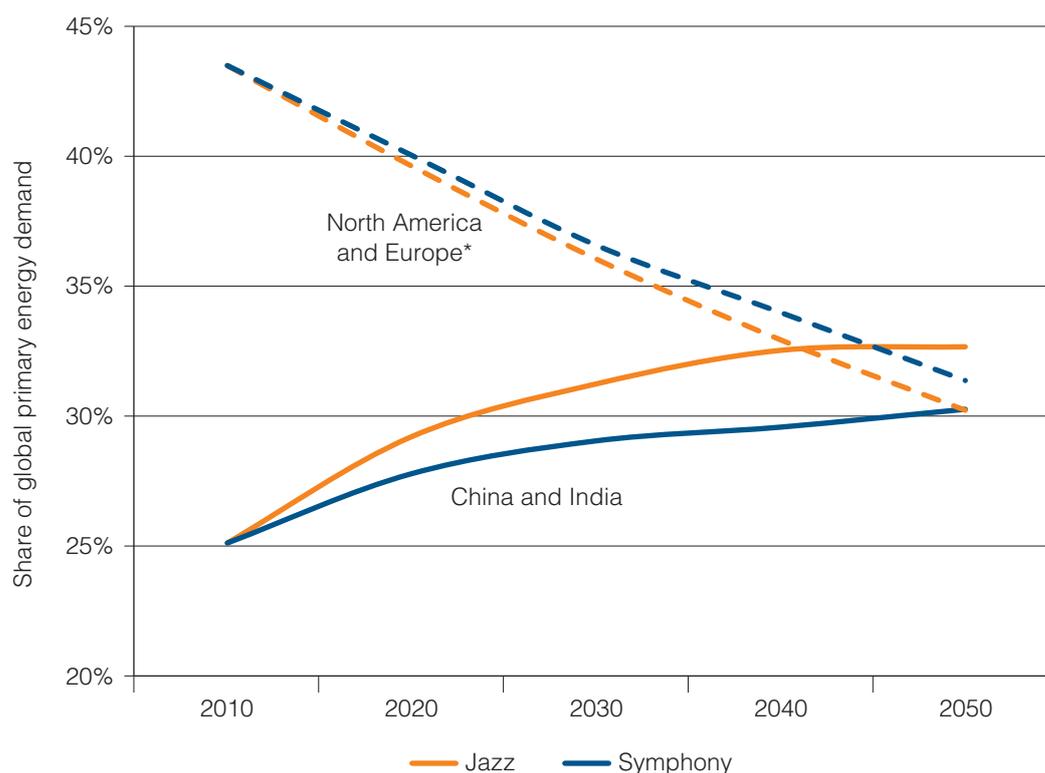
others. Public sector can lead by example. On top of all these initiatives, EU still develops other innovative measures for the new Energy Efficiency Directive, which include provisions for energy efficiency obligation schemes (or alternative policies) to achieve 1.5% total annual new end-use savings over 2014–2020 period and also the creation of national energy services providers register, the implementation of accurate and frequent individual metering and billing, mandatory and regular audits for large companies, mandatory targets for governmental buildings and incentives for SMEs.

According to *World Energy Scenarios: Composing energy futures to 2050*, global energy demand will grow by one-third between 2010 and 2035, and 90% of this growth will take place outside OECD countries. China and India lead the way in energy demand growth representing over half of the total. China alone accounts for nearly one-third of this growth. Nevertheless China's per capita energy consumption in 2035 will still be less than half of the United States or Australian levels. In non-OECD countries, often because of fuel subsidies and institutional barriers, the energy efficiency improvement potential is not being fully or even partially achieved.

Figure 3

Evolution of regional and major country shares in global primary energy demand

Source: World Energy Scenarios: Composing energy futures to 2050



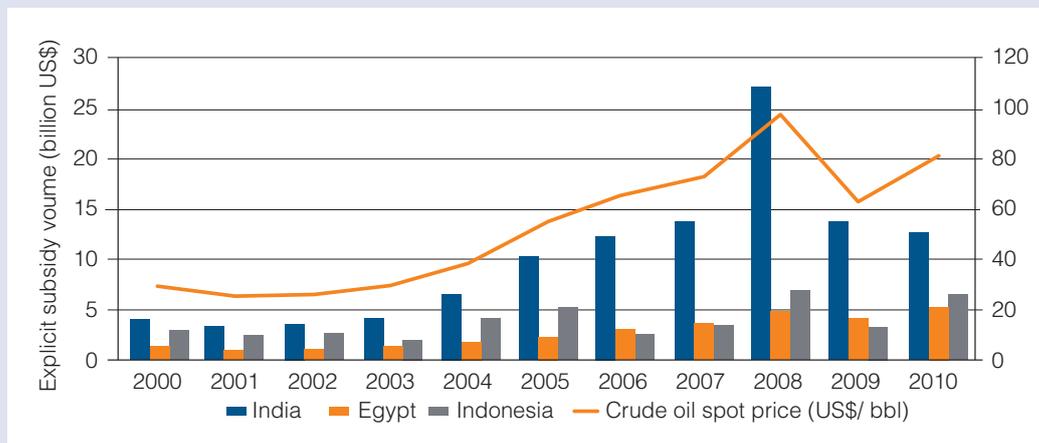
*Combining Canada, the EU (and all other European countries), Mexico, Russia, Turkey, and the USA

Oil subsidy trends in large and emerging economies: impact on GDP and budget

Subsidies on oil products are strongly correlated to the crude oil spot market price and can represent a heavy burden on public budgets. The share of oil subsidies in GDP varies between 1 and 3% depending on the countries and specific time periods. Energy subsidies have a strong impact on public budgets diverting funds that could be invested in infrastructure or social development. Egypt and Ecuador spend around 20% of their budgets on oil subsidies, Indonesia and Morocco between 10 and 15%; India, Tunisia and Bolivia between 7 and 10%. In Tunisia, energy subsidies increased by a factor of 5 between 2010 and 2012 reaching 10% of the public budget in 2012. Many countries are trying to remove subsidies but this is both unpopular and difficult to implement. The easiest and best strategy is to increase energy efficiency as saving energy also saves subsidies.

Oil subsidies in India, Egypt and Indonesia

Source: WEC/ENERDATA

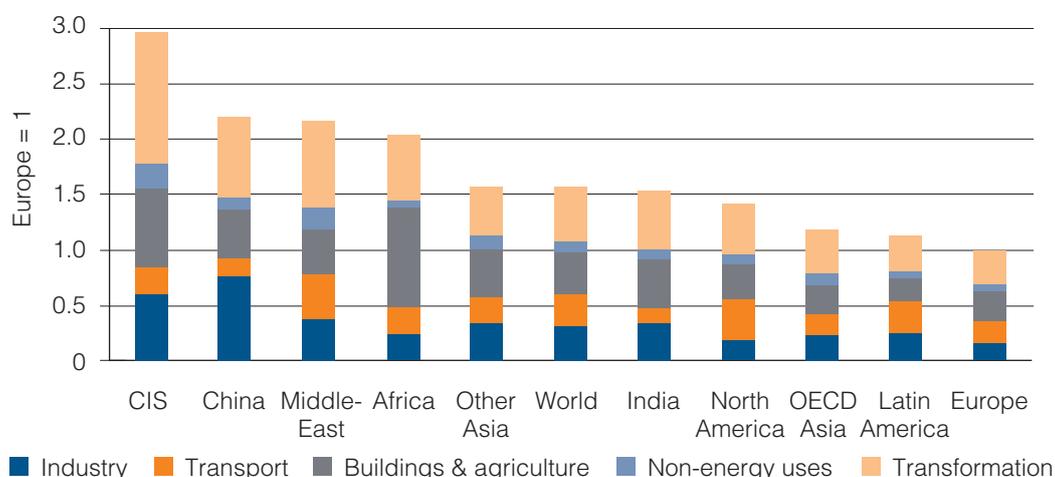


What's new: energy efficiency policies and trends by sector

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

Figure 4
Industrial sectors shares in primary energy intensity (2011)

Source: WEC/ENERDATA



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

In China and India, a strong decoupling of transport consumption and GDP is due to the dominant role of rail transport and the lower numbers of cars. Even if the average fuel efficiency of passenger vehicles is expected to increase in emerging economies during the next decades, these gains will be offset by the increasing stock of cars. In addition to labels and mandatory fuel efficiency and CO₂ standards already in use, policies to improve the performance of non-engine components that affect vehicle fuel efficiency should be put in place (e.g. tyres for which labels have been recently introduced in Europe, air conditioning, lighting etc). Governments should continue to enforce measures such as labelling, as well as various incentives and taxes to encourage the purchase of more efficient vehicles and trucks.

Energy use in **road-freight transport** has dramatically increased in both OECD and non-OECD countries and current forecasts do not suggest the reversal of this trend. Therefore, the current measures targeting transport are insufficient. Few countries have implemented regulations for transport companies such as mandatory audits, mandatory energy managers, mandatory energy consumption reporting, mandatory energy savings plans or mandatory eco driving. There is a general trend of modal shift to more road transport, due to a strong preference for individual mobility and greater flexibility. This is one of the reasons why the most common energy efficiency policy measures for transport do not reach far enough and should rather focus on modal shift and alternative transport infrastructure development.

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

appliances has been the implementation of stricter building codes and MEPS for appliances. In addition, OECD countries extend multiple financial incentives for improving energy efficiency of buildings, the majority offering loans at low interest rates often combined with grants to retrofit existing buildings. In emerging economies, the main reason is substitution of biomass with modern fuels. Building codes are becoming widely spread for new buildings.

Electrical appliances are targeted by policies on a large scale: the most common measures being labelling, with an increasing number of appliances labelled, and the spread of MEPS. Use of standards and labelling represent a cost-effective way to overcoming market failures in the sale of energy efficient appliances and equipment.

Air conditioning is becoming a priority as it is a fast growing end-use application in most emerging countries. Despite all efforts to date, there is still a large energy saving potential across all sectors, especially in the existing buildings sector. Governments are advised to implement packages of policies to improve the energy efficiency of existing buildings and ensure the compliance of the implemented measures. To ensure effectiveness of policy measures, labelling programmes and performance standards must be properly enforced.

What can we learn from the experience?

The recent developments in energy efficiency trends confirm the important role of market instruments, such as voluntary agreements, targeted information campaigns, modern means of market communications, to name just a few. Economic incentives and price signals also appear to have an impact on the user. At the same time, the use of regulations is increasing, too, in particular in sectors where the market fails to give appropriate signals (e.g. buildings, appliances, etc. *World Energy Trilemma 2011: Policies for the future – Assessment of country energy and climate policy*). Due to budgetary constraints in many countries, there is an increasing involvement of private sector in supporting investments in energy efficiency, through Energy Services Companies (ESCO's), energy utilities and other arrangements. The study highlights a number of innovative measures, including smart billing, energy savings targets by sector, mandatory installation of efficient equipment and obligations for energy savings for energy companies.

Evaluation of policies

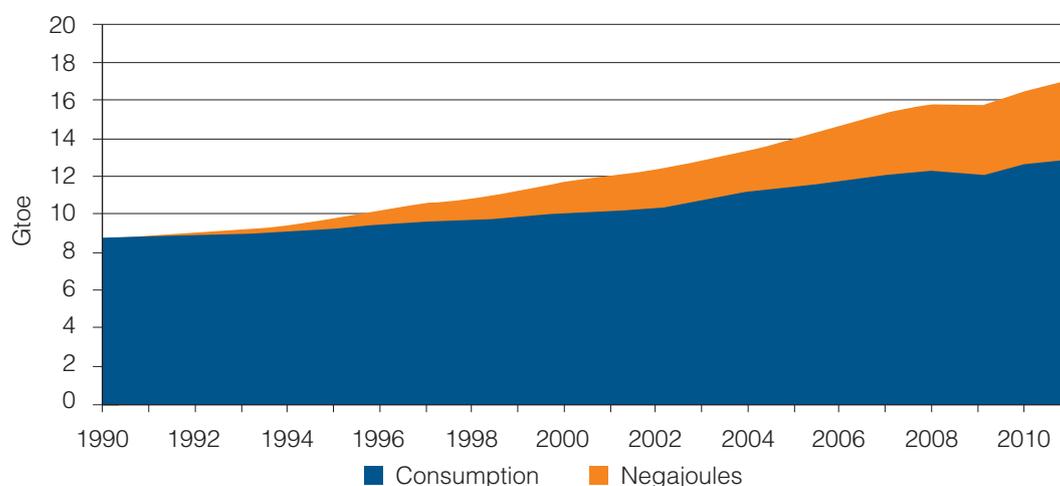
The evaluation of selected energy efficiency policy measures around the world covered in the report contributes to the on-going debate about the real potential of energy efficiency improvements and the best ways of achieving them. What is the importance of energy efficiency measures? What are the priorities? What are the trends in policy implementation? What measures prove popular and why? What are the innovative measures? What are the results? Which measures are cost effective? The report helps to find answers to these and other questions.

Higher GDP for less energy resulting in large energy savings at global level

Improvements in primary energy intensity between 1990–2011 resulted in savings of 4.2 Gtoe in 2011. The final energy intensity at the global level decreased more rapidly than the primary energy intensity (1.6% per year against 1.3% per year between 1990 and 2011). In other words, energy productivity improved by 20% more rapidly at the level of final consumption than at the overall level.

Figure 5
Energy savings from energy intensity decrease at world level

Source: WEC/ENERDATA



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

The final energy intensity at the global level decreased more rapidly than the primary energy intensity (1.6% per year against 1.3% per year between 1990 and 2011). In other words, globally, 20% of the energy productivity gains at the final consumer level were offset by increasing losses in energy conversion, mainly in power generation (66% in OECD Asia, 33% in CIS, 36% in India).

These growing losses do not arise because power generation is becoming less efficient, but rather due to the rapid growth of electricity demand at the end-use level, as electricity is predominantly produced by thermal power plants with 60–70% conversion losses. The share of electricity in final energy consumption at the global level increased from 13% in 1990 to 18% in 2011. In China and other Asia, the electricity penetration was particularly rapid (from 5 to 20% in China or 8% to 15% in other Asia).

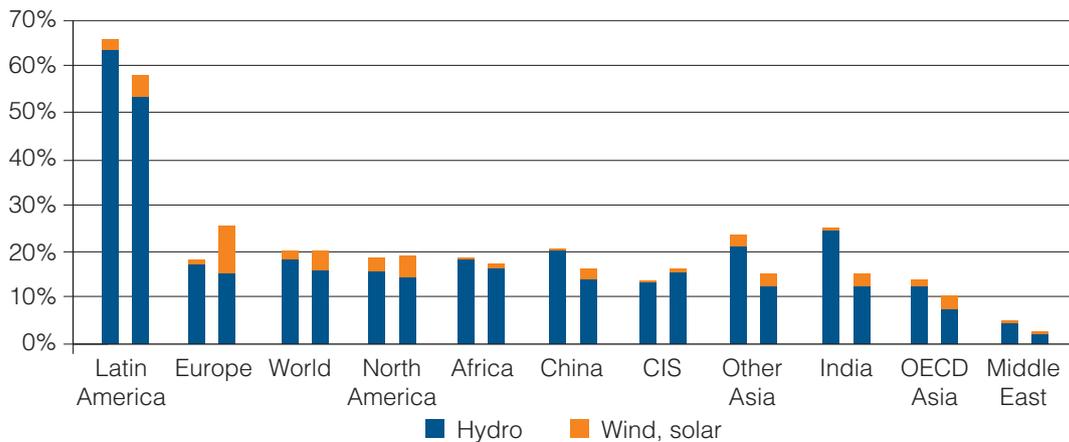
Slow energy efficiency achievements in the power sector

The average efficiency of thermal power generation has improved slowly over the last two decades, by 3.5% at the global level, from 32% in 1990 to 35.5% in 2011. The average efficiency at world level is still far below the OECD Asia average (40%) or world best practice (Italy and Spain over 46% due to a large share of Combined Cycle Gas Turbines (CCGT)). The largest improvements can be seen in China with the commissioning of new efficient coal plants, as well as in Europe and Latin America with the spread of CCGT. Globally, CCGT represent 18% of the total installed thermal capacity, an increase by 10 points since 2000.

Since renewable energy sources like hydro, wind and solar in energy statistics are counted as having 100% efficiency, the penetration of renewables in electricity production is improving the average efficiency figure for power generation. The share of renewables in electricity production remained quite stable at the world level, with two divergent trends. It has increased in Europe, to a lesser extent in the CIS, remained stable in North America and decreased in all other regions. In Europe, the higher penetration of renewables was driven by wind and solar, which reached 10% of installed power generation capacity in 2011 (7% globally).

Figure 6
Share of renewables in electricity production (1990 vs 2011)

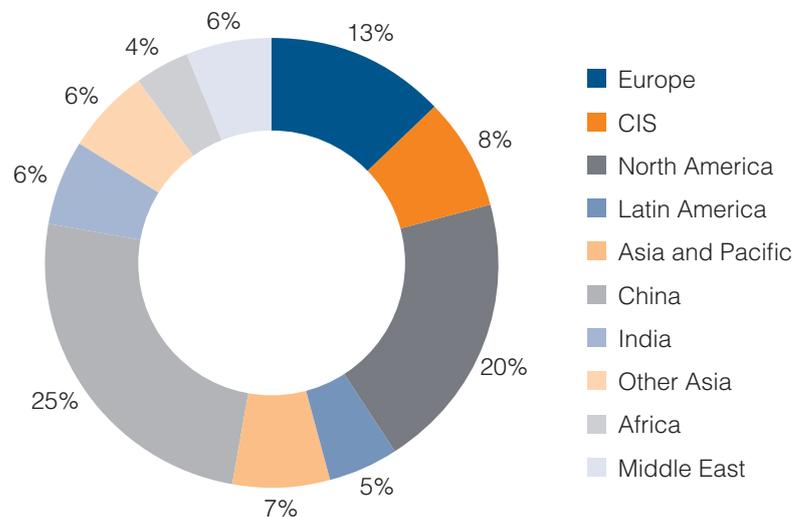
Source: WEC/ENERDATA



At world level, the rate of power transmission and distribution losses remained quite stable over the period (9% in 2011), with large differences among regions. Latin America, CIS and Africa suffered from increasing losses (over 15%), mainly due to poor reliability of the T&D infrastructure, irregular power supplies or unpaid bills and Non-Technical losses i.e. Theft in some countries.

Figure 7
Distribution of world CO₂ emissions from energy use (2011)

Source: WEC/ENERDATA

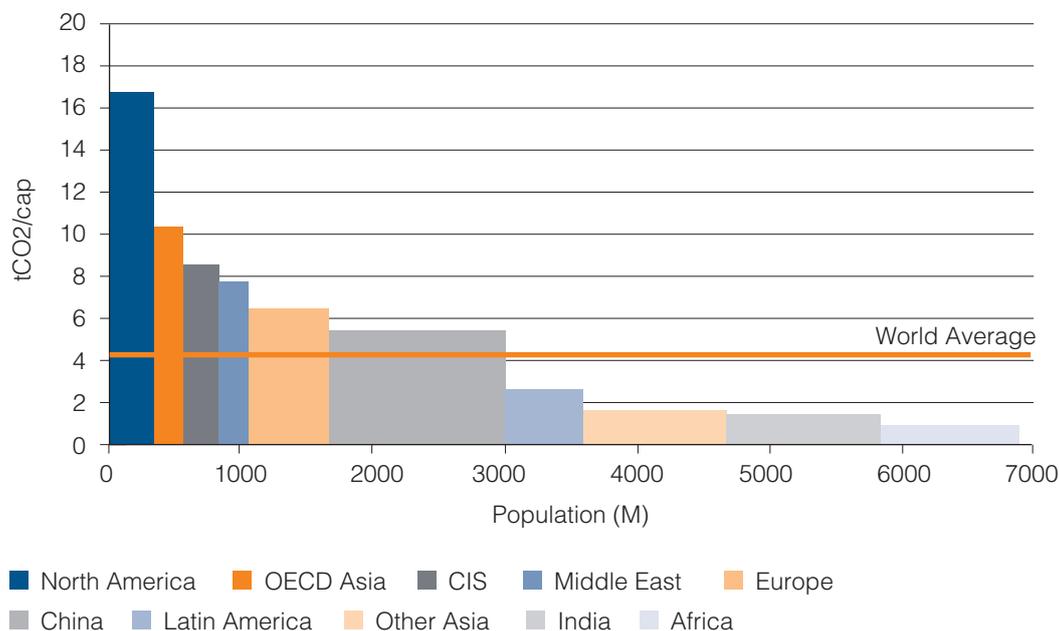


Two thirds of world CO₂ emissions from energy combustion generated by 10 countries

North America, Europe, CIS, Asia & Pacific OECD together accounted for slightly less than half of total world CO₂ emissions from energy combustion in 2011, whereas they only represent one fifth of the population. However, their share is decreasing rapidly, from almost three fourths of total emissions in 1990 to 65% in 2000 and 48% in 2011. Since 2008, China has become the largest emitter of GHG in the world overtaking the United States. Now China

Figure 8
CO₂ emissions per capita from energy combustion

Source: WEC/ENERDATA



accounts for 25% of total global CO₂ emissions, up from 11% in 1990. The top five countries with the highest energy related CO₂ emissions in addition to China, include USA, India, Russia and Japan, which in total represented 58% of global emissions in 2011). Adding the cumulative emissions of the next five countries: Germany, South Korea, Iran, Canada and Saudi Arabia demonstrates that the top ten countries accounted for slightly more than two thirds of world emissions in 2011.

About 50 countries in the world have CO₂ emissions per capita above the world average, i.e. 4.2t CO₂ per capita). About 20 countries, 10 of which from Sub-Saharan Africa, have low emissions, i.e. below 1.2t. Nearly 40 countries are above 7t, i.e. the European average. In total, 27 countries have high emissions, above 8.5t (the CIS average), of which 14 with very high emissions, above 15t CO₂/cap, including mostly countries with abundant energy resources, such as Saudi Arabia, Canada, USA and Australia.

At the global level, CO₂ emissions per capita increased only moderately (+10% since 1990). There was even a slight drop between 1990 and 2000, followed by a surge of 14% between 2000 and 2011, regardless of the economic crisis which had a significant impact in 2009, when the emissions level per capita decreased by -3%. This is the result of two opposite trends: a rise of CO₂ emissions per capita in most regions, on the one hand, and a decrease in Europe, CIS (until 1998) and North America (since 2000), on the other hand. The largest increase has taken place in China and India, where emissions per capita in China increased by a factor of three and in India by 2.5 respectively, and the Middle East (+75%), due to the high economic growth.

There is a reduction in CO₂ intensity all over the world except in the Middle East. And most of this reduction was driven by energy intensity decrease: up to 80% in Africa, North America and at world level; and 70% in Europe. Fuel substitution accounted for the remaining variation. In Asia and Latin America, fuel substitution for fuels with higher CO₂ content (e.g. coal) have offset a part of the energy intensity reduction.

Recommendations

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

In countries with subsidised energy prices, efforts should be made to adjust the domestic energy prices to the real cost of energy supply to give the right signals to the consumers. Although most countries realise the need for this, very few have succeeded to deregulate energy pricing. To soften the initial impact, the energy price reform can be introduced in phases instead of introducing the total change at once. A 'smoothing' energy pricing mechanism can be introduced to adjust in phases domestic energy prices to reflect actual costs. 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. In countries where energy prices are already high and taxed, the issue is to provide incentive price signals for energy efficiency investments, through progressive pricing and also dynamic pricing based on TOU (Time of Use) especially for large consumers. Long-term signals for consumers and investors (ESCO's) will help avoid the negative effect of price fluctuations.

2. Consumers should be better informed

It is necessary to simplify messages on energy efficiency actions and integrate information channels to reach majority of consumers. Governments should establish or develop local energy information centres as close to consumers as possible. Advice to households should be simplified by establishing contact/entry points and harmonizing messages. To facilitate consumer action updated lists of local service and equipment suppliers could be provided. The promotion of targeted information and guidance for possible actions through appropriate channels is also important, for example, energy audits.

3. Smart billing, smart meters and in-house displays

Smart billing, meters and in-house displays combined with smart phone applications represent a significant potential of energy savings, as it improves consumers' ability to monitor and control their electricity use, ultimately leading to reduction in consumption. Sectoral benchmarking and voluntary agreements where companies set individual energy savings targets should be promoted. This type of policy measures has already demonstrated its effectiveness in terms of energy efficiency promotion in commercial buildings, offices, hotels, etc.

4. Innovative financing tools should be implemented to support consumer investments

Given the increasing number of financial programmes and the different time frames for their implementation, it is important to simplify and integrate processes and centralize the information about existing support schemes. However, financial measures also have some deficiencies, the main being the cost to the public budget. This is especially obvious if the financial incentives cover large numbers of equipment or investments over a long period of time. Economic incentives should

be linked to energy or environment funds that are stretching over diversified sources rather than coming from the public budget alone: funding from dedicated taxes, from the banking system, or from international financing institutions. Private investments in energy efficiency should be facilitated by supporting the development of intermediate third parties (ESCO's, utilities, installers, etc.) playing a role of aggregator and filling the gap between projects and finance (possibly by defining an Energy Efficiency Public Service).

Governments should support Energy Performance Contracts because they provide a framework to encourage private funding for energy efficiency investments with a minimum involvement from governments. Energy efficiency obligations are another important tool for financing energy saving measures by including energy companies as investors. Ensuring low interest rates for loans for a period long enough to enable acceptable monthly loan reimbursements should be encouraged as it is a condition for large scale building retrofitting and for a large diffusion of costly equipment such as solar heaters. In less developed countries micro finance can be promoted to subsidize energy efficient equipment in rural areas (e.g. cooking stoves).

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

Governments should ensure quality control of locally produced and imported products, in particular where CFL are used, as well as their installation, through the certification and standardisation of equipment, installers and auditors. Moreover, harmonisation of testing procedures at regional level should be promoted. Public incentives conditioned to quality labels for equipment and services should be encouraged.

6. Regulations should be enforced and regularly strengthened

Regulations represent a powerful instrument to promote energy efficiency but their impact depends on good implementation and effective compliance. Policy and programme effectiveness should be evaluated during and after implementation. Indeed, non-compliance alters significantly the actual energy-savings.

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

7. Behaviour should be addressed as much as technologies. ICT could help

It is important to know what can be expected from the necessary changes in behaviour to promote the dissemination of technologies and services (e.g. information on specific fuel consumption, tyre pressure in vehicles). Technologies that limit the impact of inefficient behaviours should be promoted (e.g. sensor device for lighting, speed limiters, programme automatically set to saving modes).

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

Monitoring achievements and the impacts of measures is necessary to be able to evaluate the real impact of energy efficiency policies. The monitoring and assessment tools should include:

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

9. Enhanced international and regional cooperation

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

Energy efficiency is the “win-win” strategy which helps address a variety of policy objectives at the same time: security of supply, climate change, industrial competitiveness, balance of trade, investment needed to meet growing energy demand in emerging countries, local pollution and others. For some consumer groups, in particular poor households, improvements in energy efficiency can reduce poverty and improve living conditions. Finally, an energy efficient asset, whether a factory or a private residence, has a higher asset value and better conditions. Despite the fact that improvements in energy efficiency can bring considerable benefits to the entire society, these improvements are often held back by market, financial and institutional barriers.

WEC's contribution to advancing energy efficiency policies

Enhancing international cooperation is one of the main recommendations of the study. The development of international energy efficiency standards could help enhance international and regional cooperation. Harmonisation of certification processes and testing facilities between regions and countries would facilitate the dissemination of energy efficient equipment. WEC members will continue to share their experiences with other stakeholders in order to benchmark policies and identify best practices which contribute to the achievement of sustainable energy future for all.

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The World Energy Council (WEC) is the principal impartial network of leaders and practitioners promoting an affordable, stable and environmentally sensitive energy system for the greatest benefit of all. Formed in 1923, WEC is the UN-accredited global energy body, representing the entire energy spectrum, with more than 3000 member organisations located in over 90 countries and drawn from governments, private and state corporations, academia, NGOs and energy related stakeholders. WEC informs global, regional and national energy strategies by hosting high-level events, publishing authoritative studies, and working through its extensive member network to facilitate the world's energy policy dialogue.

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