

Energy Efficiency Series

International Energy Agency

TRANSPORT ENERGY EFFICIENCY

Implementation of IEA Recommendations since 2009 and next steps

INFORMATION PAPER

Kazunori Kojima and Lisa Ryan

2010 September

INTERNATIONAL ENERGY AGENCY

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This information paper was prepared for the Energy Efficiency Working Party in September 2010. It was drafted by Kazunori Kojima and Lisa Ryan, Energy Efficiency Unit, IEA. This paper reflects the views of the International Energy Agency (IEA) Secretariat, but does not necessarily reflect those of individual IEA member countries. For further information, please contact Kazunori Kojima in the Energy Efficiency Unit at: kazunori.kojima@iea.org

2010 September

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Executive summary

Transport is the sector with the highest final energy consumption and, without any significant policy changes, is forecast to remain so (IEA, 2009a). In 2008, the IEA published 25 energy efficiency recommendations for seven sectors: industry; transport; utilities; buildings; lighting; appliances; and cross-sectoral. Its four recommendations for the transport sector focus on road transport and include policies on improving tyre energy efficiency, fuel economy standards for both light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs), and eco-driving.

The IEA report, *Implementing Energy Efficiency Policies: Are IEA member countries on track?* (hereafter referred to as the *Tracking Progress* report) describes the level of implementation of the energy efficiency recommendations by IEA countries. It found that there was poor implementation of the transport recommendations up to March 2009 (IEA, 2009b). For this reason, and the fact that transport is such an important user of energy, it was decided to examine the extent of implementation of the transport recommendations in IEA countries.

Though the IEA transport energy efficiency recommendations represent a significant step in addressing the continued high use of energy by the transport sector, it is important to continue to review the recommendations and consider whether their scope or focus should be changed. So this report has two purposes: firstly, to examine in more detail the fuel efficiency policies that have been implemented in IEA countries since March 2009 and update the *Tracking Progress* report; and secondly, to consider the four IEA transport energy efficiency recommendations and discuss whether complementary measures could extend their scope.

This report concludes that during 2009 some progress was made in the implementation of the existing IEA transport energy efficiency recommendations and notes the following developments in implementation of each of the transport recommendations.

Recommendation 5.1. Tyres

The United States has mandated tyre pressure monitoring systems (TPMS) on all passenger cars, multipurpose vehicles, trucks and buses since 2007. The European Union also took significant steps in 2009 as part of the European Union's integrated approach to reduce CO_2 emissions from light-duty vehicles (EU, 2009). This integrated approach will be enforced from 2012 and includes measures such as the mandatory fitting of TPMS, and requirements for rolling resistance and other essential tyre performances. In Japan, a voluntary tyre-labelling scheme with information on fuel efficiency and wet grip performance was implemented in January 2010.

Therefore the three main vehicle manufacturing regions have either implemented or plan to implement some or all of the IEA recommendations on tyres and fuel efficiency. It is also encouraging to note that all three regions are using the same ISO (International Standards Organization) test procedures to measure tyre rolling resistance. Although the technical requirements for TPMS currently differ between regions, the United Nations for Economic Commission for Europe (UNECE) is developing harmonised technical requirements for TPMS that the European Union has committed to employ upon publication.

Recommendation 5.2. Fuel economy standards: light-duty vehicles

The United States has regulated fuel economy in cars the longest with the Corporate Average Fuel Economy (CAFE) standard, which was introduced in 1975. The CAFE system was updated, or "reformed", and enhanced in 2009 so that it will become a function of vehicle size or "footprint" from 2011. Most recently in 2010, the standards were tightened again so that the

fleet average fuel economy rises to 35.5mpg[1] in 2016, which will represent a 30% reduction in fuel consumption compared with 2005. Labelling of vehicle fuel economy and associated costs has also been a requirement in the United States for more than 30 years. Canada has recently switched from a voluntary to mandatory fuel economy system and these standards are aligned with the United States' revised CAFE standards.

Following insufficient progress in a voluntary agreement on passenger car CO_2 emissions in Europe, in 2009 the European Union adopted CO_2 emissions regulations for passenger cars with implementation to be phased in over 2012-15. The standard is based on vehicle mass and means that the passenger car fleet on average will emit 130 g CO_2/km by 2015 (compared with 161 g CO_2/km in 2005). Another 10 g CO_2/km is expected to be reduced through complementary measures such as tyre efficiency, gear shift indicators, air conditioners and greater use of low-carbon biofuels. Vehicle CO_2 emissions and fuel economy labelling has existed in the European Union since 2001, but the format of labelling differs across member states. The EU labelling directive is currently under revision.

In Japan, the Top Runner programme sets standards in energy efficiency across a wide range of equipment, including passenger cars. There are currently two sets of targets: the incumbent 2010 standards and the new 2015 standards. These standards are based on the "best in class" technology and are a function of vehicle weight. Positive labelling is used in Japan where vehicles are rated by how much they exceed their target.

It is difficult to compare the fuel economy standards between regions due to the difference in test measurement cycles, which means that each standard is based on different parameters such as vehicle speed, acceleration, load, etc. However, it is interesting to see the recent developments in most IEA countries, which have tightened fuel economy and CO_2 emissions standards for passenger cars, which in turn will reduce fuel consumption by 20% to 30% over the ten-year period 2005 to 2015/16. Therefore, although different regions have different starting points in terms of current fleet average fuel economy, all regions are tightening standards by relatively similar amounts.

Recommendation 5.3. Fuel economy: heavy-duty vehicles

Japan was the first country to introduce fuel economy standards for heavy-duty vehicles in 2006. The standards are similar to that for passenger cars in Japan and are based on vehicle weight, in this case gross vehicle weight, and the best in class principle of the "Top Runner" programme. Fuel economy levels are mandated to improve 12% from 2002 to 2015. The problem of emissions' testing for multiple variations of chassis/engine combinations has been solved by measuring engine emissions in the laboratory and simulating full vehicle emissions electronically. There has been no change to this policy over the period reviewed.

The European Union is discussing methods and standards for CO_2 emissions from HDVs but there has been no legislation to date. In April 2009 in the United States, the Environmental Protection Agency initiated rulemaking procedures on greenhouse gas (GHG) emissions from heavy-duty vehicles and the Obama administration has declared that a national policy on heavy-duty fuel efficiency and GHG emissions be formulated for vehicles beginning with model year 2014. However, to date Japan remains the only country worldwide with fuel economy standards for HDVs.

The implementation of fuel economy standards for heavy-duty vehicles in most countries is still lacking. It is difficult to test HDVs due to the wide range of chassis/engine variations, but the

[1] Combined fuel economy standard (34.1mpg) and new EPA standards for air conditioners = 35.5mpg (equivalent to 156 grams CO_2/km).

Japanese have overcome these challenges with simulation methods. It has long been argued that heavy-duty vehicles do not need fuel economy measures since commercial operators are already guided by costs and therefore any possible efficiency improvements would have already been made. However, the Japanese experience shows that only efficiency measures with a payback period of less than or equal to three to four years will be made by commercial operators. Policy measures are needed if efficiency improvements with a longer payback period are considered necessary. Alternative measures to the regulation of heavy-duty vehicle fuel economy have been implemented in many countries with varying rates of success and some of these complementary measures are discussed in the next subsection.

Recommendation 5.4. Eco-driving

Eco-driving has been shown to reduce fuel consumption and CO_2 emissions by up to 20% for some drivers and by 10% for all drivers long term. Most countries now have programmes of eco-driving, either at national or sub-national level, with varying levels of success. Programmes can be supported with technical aids such as in-car feedback instruments. The European Union has mandated the fitting of Gear Shift Indicators (GSI) in all new cars from 2012. Eco-driving is implemented at member state level and countries have different programmes. In Japan, eco-driving is promoted through campaigns orchestrated by several ministries and manufacturers generally offer feedback instruments even though they are not required to do so. In 2009 more than 70% of new cars contained such instruments. In the United States, there are several programmes at state level that are supported by the auto industry association.[2]

Eco-driving is gaining widespread recognition as a low cost method of reducing vehicle fuel consumption without the need for vehicle technology improvements. A significant advantage is that it can be implemented with drivers of both new and old passenger cars, as well as those of all sizes of commercial vehicles. However, regular updates through information campaigns and driver training are needed in order to ensure long-term savings. In-car feedback instruments would support this.

Implementation of transport policy recommendations

For each of these four recommendations since March 2009, many IEA countries have made progress in their implementation, moving from “planning to implement” to “implementation underway” (Figure ES1). None of the four energy efficiency recommendations for the transport sector have been fully implemented by all countries. In light of this, the IEA calls for full and immediate implementation of the transport energy efficiency recommendations in member countries.

Owing to their complexity, there are no simple policy measures to resolve the challenges associated with energy use in the transport sector. The IEA four transport recommendations mainly focus on vehicle and tyre efficiency and do not address driver behaviour (aside from the recommendations on eco-driving) or travel demand. There are a host of complementary policy measures such as fiscal measures, vehicle labelling, and modal shift that could both support a more efficient implementation of the existing recommendations and address other new elements of the transport challenge. These measures will be considered for inclusion in the transport sector recommendations in the ongoing review of the IEA 25 energy efficiency recommendations.

[2] More information available at: www.ecodrivingusa.com,

Figure ES1: Progress of IEA transport recommendations across IEA member countries

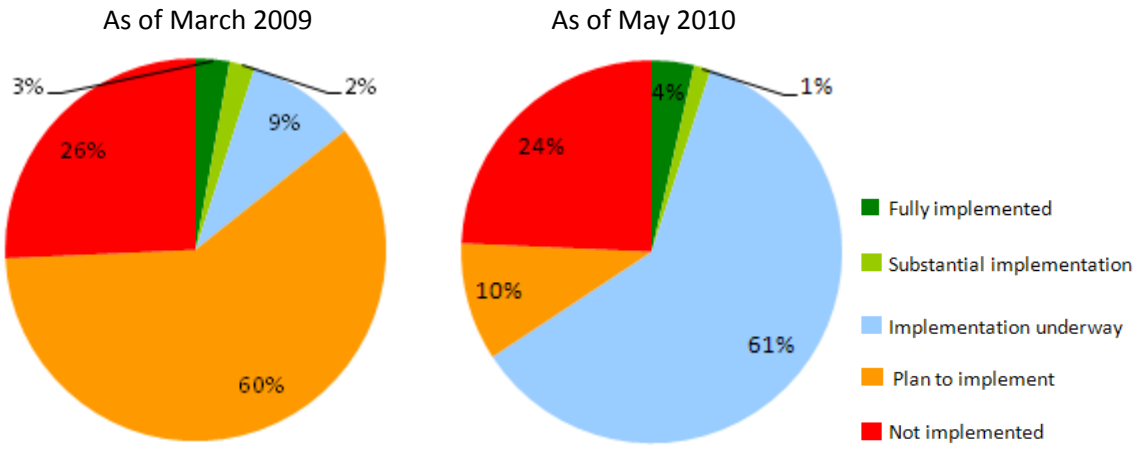


Table ES1: Progress in implementation of transport energy efficiency recommendations

Status/ Recommendation	Fully implemented	Implementation underway	Planning to Implement	Not implemented	Estimated energy saving
Fuel-efficient tyres		European Union, Canada, United States	Japan, Korea	Australia, New Zealand, Turkey	4-5%
Fuel efficiency standards: LDV	Japan, United States	Canada, European Union, Korea		New Zealand, Turkey Australia	20-30% reduction over the period 2005-2015/16
Fuel efficiency standards: HDV	Japan		European Union, United States	Australia, Canada, Korea, New Zealand, Turkey	12% reduction over the period 2006–2015 at Japanese target
Eco-driving programmes		Australia, Canada, European Union, Japan, Korea, New Zealand, United States		Turkey	5%-20% short term, circa 5-10% medium term

Source: Updated from IEA (2009b)

Chapter 1. Introduction

The implementation of energy efficiency measures remains a priority for all countries. Recent meetings of the IEA Governing Board at Ministerial level (May 2007 and October 2009) and the G8 Leaders' meetings (at Gleneagles in 2005; in St Petersburg in 2006; in Heiligendamm in 2007; and in Hokkaido-Toyako in 2008) reaffirmed the critical role that improved energy efficiency will play in both achieving energy security, and meeting environmental and economic objectives.

Without new energy policies, energy demand and consequent CO_2 emissions are projected to increase. Global primary energy demand by industry is projected to rise by 40% by 2030 from 2007 levels. This would put global energy-related CO_2 emissions at 40.2 gigatonnes (Gt) in 2030, with an annual growth rate of 1.5% (IEA, 2009a). Such a trajectory puts the world on track for a long-term concentration of greenhouse gases in the atmosphere of over 1000 ppm of CO_2 equivalent and a longer-term average temperature increase of 6 °C. This is clearly unsustainable, environmentally, socially and economically. Co-ordinated action will be needed in all energy sectors, particularly in the transport sector.

The transport sector is a huge consumer of energy (accounting for 19% of global final energy consumption in 2007) and will account for 97% of the increase in world primary oil use between 2007 and 2030. The consequent energy security and greenhouse gas emission implications of oil-dominated road transportation mean that reducing the fuel used in this sector is one of the highest priorities for all countries.

In view of this, it is important to note the relevance of the road transport energy paradigm, which can be split into three main parameters:

$E_{\text{road transport}}$ = (vehicle fuel efficiency) x (vehicle travel) x (the vehicle population)

where the vehicle fuel efficiency is determined by the technical energy efficiency; vehicle travel denotes the type of travel/driving and the number of miles driven; and the vehicle population is the number of vehicles on the road.

However, IEA estimates that there is a potential for cost-effective technical improvement in new vehicle fuel economy of 50% by 2030 (IEA, 2009c). This would result in a reduction of close to 500 000 tonnes of oil equivalent (toe) fuel use and almost 1 Gt of annual reduction in CO_2 emissions. Achieving this target will be challenging yet possible, but will require strong policies that maximise technology uptake and minimise fuel economy losses due to increases in vehicle size, weight and power. Policies that help to improve vehicle fuel economy are one of the most cost effective measures for achieving an overall CO_2 reduction target of 50% below 2005 levels by 2050 across the transport sector.

All transport modes are expected to show substantial increases in activity and fuel use in the future. Road transport (passenger cars and freight trucks), in particular, will continue to dominate overall transport energy and oil use, accounting for nearly 80% of demand in 2050. Air travel and shipping will account for the remainder, and are expected to grow substantially. Efforts to curb energy use and CO_2 emissions from all these modes will be needed.

The IEA estimates that if its energy efficiency policy recommendations for transport are implemented globally without delay, there could be a saving of around 1.4 Gt of CO_2 per year across the transport sector by 2030. One of the key findings of the *Tracking Progress* report was that in most IEA countries, many of the recommended actions were still only planned, or, at best, partially implemented. Even the best performing countries had implemented less than

60% of the recommendations across all sectors. In particular, transport was highlighted as the one sector having received the least energy efficiency policy action across all countries. However, since the report's writing in mid-2009, there have been several implementations of the transport recommendations and these are outlined in the next chapters.

While the four transport recommendations included in the original IEA energy efficiency recommendations represent an important first step in transport energy efficiency policy, however they do not resolve all the barriers to improving energy efficiency in transport. There has been much analysis of policies for sustainable transportation in governments and research institutions globally. It is clear that no one measure will provide the solution and that action is needed simultaneously on the following criteria:

I. improving vehicle technology leading to increased vehicle energy efficiency;
II. changing driver behaviour to use less fuel per mile driven;
III. reducing the distances travelled per vehicle; and
IV. shifting travel to the most sustainable modes of transport.

The IEA transport energy efficiency recommendations focus mainly on the first two items in this list. Policy packages adapted to country requirements are needed that incorporate elements of technology, purchasing decisions, driving behaviour and related issues such as public transport and land use planning. The IEA considers it timely to revisit the IEA energy efficiency recommendations and to review their scope. It is hoped that the following report will assist countries to further expand their transport energy efficiency policy portfolios in order to achieve the ambitious energy efficiency targets needed for a sustainable energy future.

Chapter 2. Fuel-efficient tyres

IEA Energy Efficiency Recommendation 5.1. Fuel-efficient Tyres

Governments should:

- Adopt new international test procedures for measuring the rolling resistance of tyres, with a view to establishing labelling, and possibly maximum rolling resistance limits where appropriate, for road-vehicle tyres; and
- Adopt measures to promote proper inflation levels of tyres. This should include governments, acting in co-operation with international organisations including UNECE, making the fitting of tyre-pressure monitoring systems on new road vehicles mandatory.

General description

Roughly 20% of a motor vehicle's fuel consumption is used to overcome rolling resistance of the tyres (IEA, 2005). The amount of rolling resistance is a function of the level of inflation of the tyres and the technical rolling resistance of the tyre material.

Additional fuel is required when tyres are underinflated. In most real-world driving conditions, tyres are underinflated compared to their optimum performance level. Data presented at the IEA Tyre Workshop in 2005 showed that in the European Union, the tyres in service were underinflated by 0.2 to 0.4 bar on average for passenger cars and 0.5 bar for trucks. It is generally understood that these numbers correspond to an increase in energy consumption and CO2 emissions of roughly 1% to 2.5% for passenger cars, and 1% for trucks. Tyre pressure monitoring systems are a valuable tool for both car safety and fuel economy purposes. Information is sent to drivers when their tyres need inflation, which encourages better vehicle fuel efficiency. Installing tyre pressure monitoring systems could be expected to improve tyre maintenance and lead to an improvement in the range of 1% to 2% in overall non-powertrain vehicle efficiency.

Concerning the technical rolling resistance of tyres, tyres with low rolling resistance are already available on the market. In the European Union, some modern tyres have a rolling resistance of up to 30% lower than the best tyres produced in the early 1980s, while the worst tyres on the market have twice the rolling resistance of the best. Auto manufacturers already carefully minimise rolling resistance of tyres fitted to new cars because this is an effective way to comply with fuel economy standards. However, the rolling resistance of tyres in the replacement market could be higher than those offered on new cars, so the fuel savings from the low rolling resistance tyres could be lost after the original tyres wear out. Consumers may not always purchase low rolling resistance tyres as replacement tyres due to their high initial cost, the lack of clear information provided, and limited market availability (IEA, 2009c).

The fitting of the best replacement tyres and the more effective maintenance of tyre pressures could save about 3% of the fuel used in LDVs (equivalent to around 70 Mtoe and 190 Mt CO_2 in the medium term worldwide). In the absence of policy intervention, there would be very weak incentives for both manufacturers and consumers, because tyre inflation pressure in the real world and rolling resistance of replacement tyres are not subjected to current fuel economy standards. Therefore, efficiency measures for tyres and proper maintenance of tyre inflation pressure represent important complementary measures to fuel economy standards. There are

some international initiatives underway, which target the harmonisation of tyre pressure test procedures and regulations.

International Standards Organization (ISO)

The ISO published test procedures for measuring tyre rolling resistance (ISO 28580) in July 2009. These test procedures have been adopted by the European Union, Japan and the United States. Given that tyres are globally traded, this internationally harmonised test procedure will benefit both consumers and industry.

UNECE/WP.29

The World Forum for harmonisation of vehicle regulations (UNECE/WP.29) is a forum established in the UN framework to address global issues regarding vehicle energy as well as safety, environmental pollution and anti-theft with participation of governments and industries from around the world. UNECE/WP.29 has been working on internationally harmonised regulations for tyres such as TPMS, rolling resistance and wet grip. These regulations could also be the basis for harmonised measures for tyres.

Policy updates in IEA member countries

The United States

Tyre pressure monitoring systems (TPMS): The United States was the first country to introduce mandatory fitting of TPMS for all light vehicles, with a phase-in from 2005, and full compliance from 2007. It is now mandatory for all passenger cars, multipurpose passenger vehicles, trucks and buses. The primary target of this measure is vehicle safety, but by maintaining an appropriate tyre inflation pressure, fuel efficiency also improves. There have been no developments in this area in the United States since March 2009.

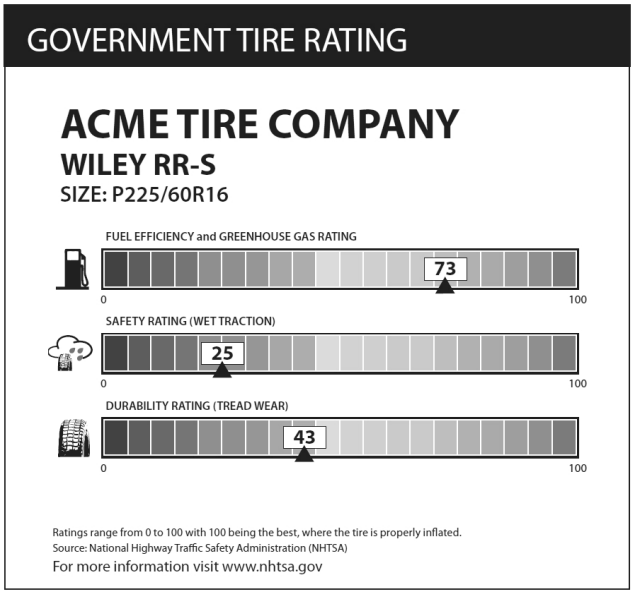
Low rolling resistance tyres and labelling: The United States has also made progress on tyre labelling after the IEA's *Tracking Progress* report in 2009. The Energy Independence and Security Act of 2007 (EISA, 2007) directed National Highway Traffic Safety Administration (NHTSA) to create a national consumer education programme on tyre energy efficiency.

In this context, the US Department of Transportation proposed in July 2009 a "tire efficiency consumer information program". This programme proposed a label for replacement tyres, which would provide information about the tyre's impact on fuel economy and CO_2 emission reductions and is illustrated below (Figure 1). The rolling resistance of the tyre, which has a direct impact on fuel economy and CO_2 emission, would be measured using the ISO 28580 test procedure. This label would also provide consumers with two other key pieces of tyre performance information *i.e* wet weather traction for safety and tread wear for durability. All three ratings are prominently displayed on a removable label attached to the replacement tyre at the point of sale and online.

Some more approaches are being discussed at the state level. For example, in October 2003, the California state legislature adopted Assembly Bill No. 844 (AB 844), which required the California Energy Commission (CEC) to develop a comprehensive fuel-efficient tyre programme. It requires tyre manufacturers of light-duty tyres sold in the state to report fuel economy

information. It also mandates a rating system and minimum efficiency standards. Under this law, the CEC proposed a staff draft regulation for fuel-efficient tire programme in June 2009. This programme would define fuel efficient tyres as those with declared fuel efficiency rating value[3] no higher than 1.15 times the lowest declared fuel efficiency rating value for all tyres in its combined tyre size designation and load index. Tyres would be defined as not fuel efficient tyres when the declared fuel efficiency rating value is higher than 1.15 times the lowest declared fuel efficiency rating value for all tyres in its combined tyre size designation and load index (CEC 2009).

Figure 1: Proposed label by NHTSA



Source: NHTSA (2009a)

The European Union

The European Union has made major steps forward on tyre-related measures in 2009. In July 2009, the European Union adopted the regulation "concerning type-approval requirements for the general safety of motor vehicles, their trailers and systems, components and separate technical units intended therefore" (EC 661/2009) as a part of European strategy to reduce CO_2 emissions from road vehicles. Another corresponding regulation to reduce CO_2 emissions from new passenger cars initially proposed an emissions' target of 120 g CO_2/km; however it faced strong opposition from industry so an "integrated approach" (EC 443/2009) was added to soften the targets. This entailed an average target of 130 g CO_2/km emissions for a fleet. Complementary measures are required to contribute a further emissions cut of up to 10 g CO_2/km, thus reducing overall emissions to 120 g CO_2/km. These complementary measures include efficiency improvements for car components with the highest impact on fuel consumption, such as tyres and air conditioning systems, and a gradual reduction in the carbon content of road fuels, notably through greater use of biofuels. Efficiency requirements for these components are being discussed and will be introduced for these car components.

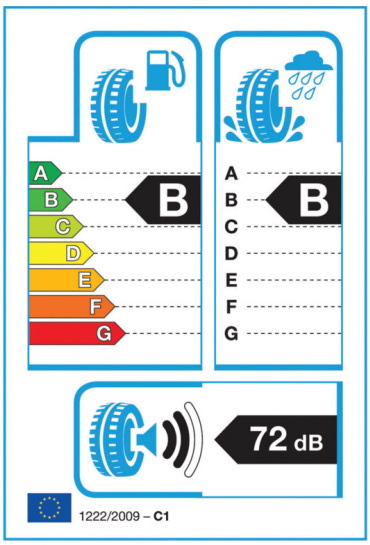
[3] Fuel efficiency rating is defined as the ranking of the particular tyre in a distribution of rolling resistance values among the same tyre size and load index category.

TPMS: The above regulation on the type approval of vehicles and their components contains several measures for tyres including mandatory fitting of tyre pressure monitoring systems and limit of tyre rolling resistance as parts of general vehicle safety measures. Mandatory fitting of TPMS will be required by November 2012 for new passenger cars and by November 2014 for all newly-registered passenger cars. Technical requirements for TPMS will be defined by UNECE regulation 64, as performance-based requirements.

Low rolling resistance tyres: In addition, other measures on the characteristics of the tyre itself, such as the introduction of wet grip requirements and limit values on rolling resistance and tightening noise limits, are also included in the regulation EC 661/2009. Wet grip requirements will be applied to tyres for passenger cars. Limit values on rolling resistance and tightening noise limits will be applied to tyres for passenger cars, light commercial vehicles and heavy-duty vehicles. The rolling resistance of tyres will be measured in accordance with ISO 28580, the same for those in the United States. These measures will be applied to original tyres installed on new vehicles as well as replacement tyres, from 2012-2016, depending on tyre categories. The European Commission will develop implementing measures by the end of 2010.

Tyre labelling: Furthermore, the European Union also adopted a separate regulation on "the labelling of tyres with respect to fuel efficiency and other essential parameters" (EC 1222/2009) in November 2009. Fuel efficiency, wet grip and external rolling noise of tyres will be indicated in the label (Figure 2). Similar to measures for tyre rolling resistance and noise limits, this regulation will cover almost all tyres used on public roads, such as tyres for passenger cars, light commercial vehicles and heavy-duty vehicles. Tyre labels will be displayed at the point of sale and in technical promotional literature, including websites, by November 2012. This label will allow consumers to make more informed choices and should result in fuel cost savings, as well as a reduction of CO_2 emissions, from vehicles.

Figure 2: Adopted label for tyres



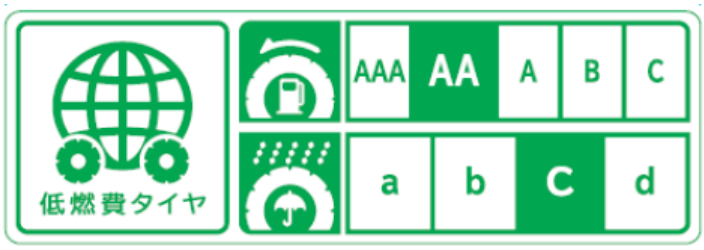
Source: European Union (2009b)

As stated above, once these comprehensive regulations are implemented, they will incorporate IEA recommendations on tyres.

Japan

In December 2008, the Japanese government established a committee to promote fuel-efficient tyres (its title translated as the "Committee for promoting deployment of fuel-efficient tyres and other related things"). This committee published a final report recommending measures for tyre rolling resistance test procedures and a labelling scheme in July 2009. The test procedures for tyre rolling resistance refer to the ISO 28580 test method. The label has information on both fuel efficiency performance and wet grip performance of tyres (Figure 3). The labelling scheme, which is applied to replacement tyres for passenger cars, has been implemented on a voluntary basis since January 2010 and is planned to remain voluntary. Introduction of TPMS is currently under discussion.

Figure 3: Adopted label for tyres



Source: Japan Automobile Tyre Manufacturers Association

Korea

In April 2010, the Korean government announced a master plan to introduce tyre fuel efficiency standards and labelling for passenger cars. It will be implemented on a voluntary basis from the second half of 2011 and on a mandatory basis from the second half of 2012. By the end of June 2011, related regulations will be revised and the details of the labelling scheme and test procedures will also be decided. The label will provide the rolling resistance coefficient and wet grip of tyres. The government is also considering the insertion of external noise and tread wear on the label. Mandatory fitting of TPMS is currently under discussion.

Discussion

Several countries have updated their policies relating to tyres since March 2009. Progress of policy recommendation on tyre labelling on rolling resistance is evident (Figure 4) and there has also been progress in the implementation status of TPMS between March 2009 and May 2010 (Figure 5).

The majority of IEA member countries have moved from the "Plan to implement" to "Implementation underway" category with respect to policies in both tyre labelling and TPMS.

This chapter has described significant developments in policy for fuel-efficient tyres in the United States, the European Union and Japan over the last year. Technology improvements on both TPMS and low rolling resistance tyres mean that these tools are ready for mass production and deployment.

Figure 4: Progress of policy recommendation on tyre labelling of rolling resistance

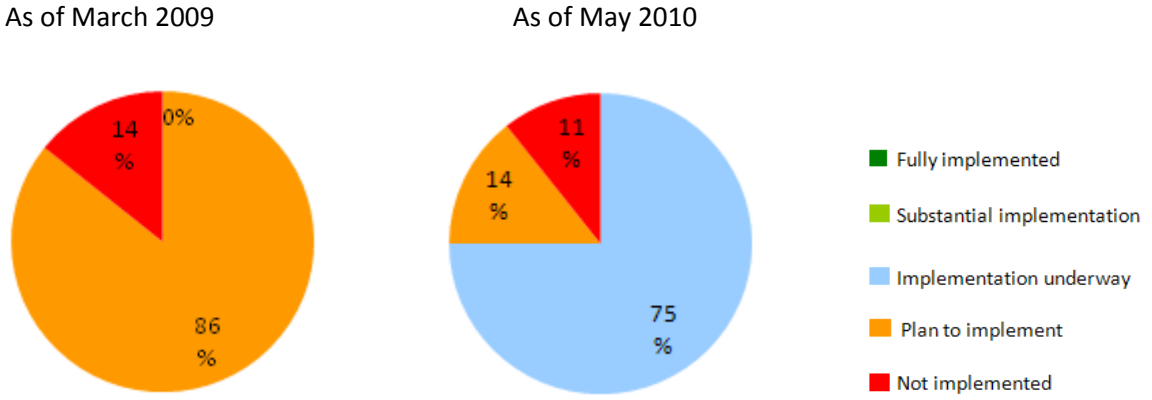
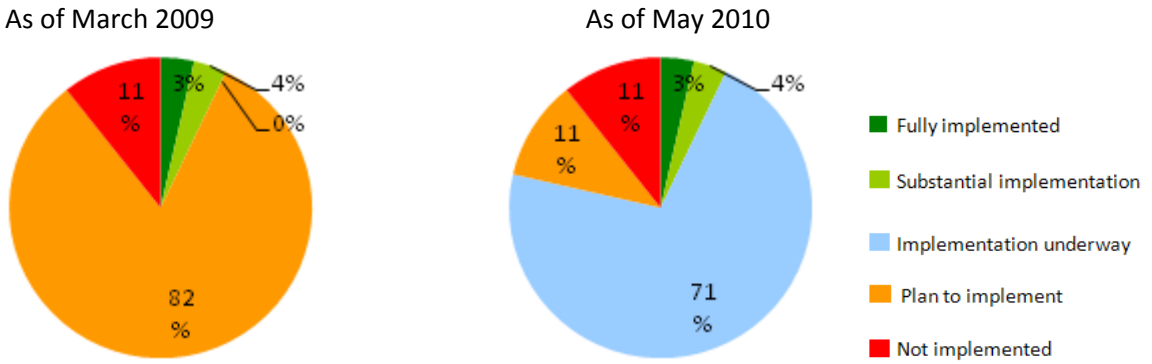


Figure 5: Progress of policy recommendation on tyre pressure monitoring systems



The United States has mandated TPMS for all LDVs since 2007; and Japan and the European Union are also in the process of doing so. Some more work is needed on harmonising the methods used to detect tyre under-inflation. The threshold defining under-inflation should be common across countries to enable cross-comparison of vehicle fuel economy. Previous IEA work estimates that 10% under-inflation causes an increase in tyre rolling resistance of 4%.

In the case of low rolling resistance tyres, there is a trade-off between reducing rolling resistance and wet weather traction performance. Recent technology improvements have enabled a balance between both tyre characteristics. There is increasing consensus on the methodology used to define tyre rolling resistance and the limit values for energy efficiency. Many countries are using the ISO 28580 method.

Governments can mandate that new vehicles are sold with low rolling resistance tyres. However, it is also important that policies are in place to ensure that replacement tyres also have low rolling resistance. Only the European Union is planning mandatory low rolling

resistance replacement tyres from 2012. Similar measures are needed in other countries to improve the efficiency of cars already on the road.

All three vehicle-manufacturing regions have introduced tyre labels documenting the rolling resistance and wet weather traction: the United States immediately, the European Union from 2012, and Japan from 2012 on a voluntary basis. These will help inform customers on the fuel efficiency impacts of their choice of tyres. To date, there are no fiscal incentives to complement the labelling schemes and incentivise the purchase of fuel-efficient tyres, which would improve market uptake. Finally, no progress has been made on tyre efficiency in Australia, New Zealand, and Turkey.

Chapter 3. Fuel economy of light-duty vehicles

IEA Energy Efficiency Recommendation 5.2. Mandatory fuel efficiency standards for light-duty vehicles

Governments should:

- introduce new mandatory fuel efficiency standards for light-duty vehicles if they do not already exist, or, where they do exist, make those standards more stringent;
- announce the more stringent content of the proposed standards as soon as possible; and
- harmonise, where appropriate, as many aspects of the future standards as possible.

General description

Governments have introduced a wide variety of policies such as voluntary targets and regulatory standard programmes to accelerate the deployment of more fuel-efficient vehicle technologies. Some IEA countries have over 30 years of experience with policies to improve vehicle fuel efficiency. The scope of policies is vast, ranging from a hands-off approach to voluntary programmes to strict mandatory regulations.

A significant finding of the 2008 IEA study, *Review of International Policies for Vehicle Fuel Efficiency* (IEA, 2008), was that voluntary fuel economy measures have generally fallen short of their targets. In light of this, Korea, Japan, the European Union and Canada have all moved from voluntary to regulatory regimes in recent years. The study, and the subsequent IEA energy efficiency recommendations, called for the introduction of regulatory fuel economy standards, which are as stringent as possible, appropriate to each country. It was noted that the design of fuel economy standards determines the outcome of the policy and its effectiveness and efficiency. Several issues, such as the scope, test procedures required, flexibility, and administrative cost, are also important.

The IEA recommended the introduction of fuel efficiency standards for LDVs and HDVs in the 25 energy efficiency recommendations. It recommends that countries without fuel efficiency standards should introduce them without delay and those with existing standards assess whether the level of the standards should be more stringent. Any new standards should be announced as soon as possible to allow industry time to adapt product development. Finally, governments are strongly recommended to harmonise as many aspects of fuel efficiency standards as possible across countries. This will enable comparison of targets between countries, reduce industry costs, and remove barriers to trade. Although vehicle labelling was not listed separately as a recommendation in the measures, it is an important complementary measure to fuel economy standards.

The IEA *Progress Report* highlighted the fuel efficiency standard regimes that were in place in IEA countries up to March 2009. The next sections will outline some developments since then and draw some conclusions regarding the trends in this area.

Box 1: UNECE/WP. 29

WP.29 has been developing vehicle regulations and test procedures for fuel economy standards similar to tyres, as described in chapter 1. The regulations developed by WP.29 are widely adopted by WP.29 member countries, but also referred to by non-WP.29 member countries.

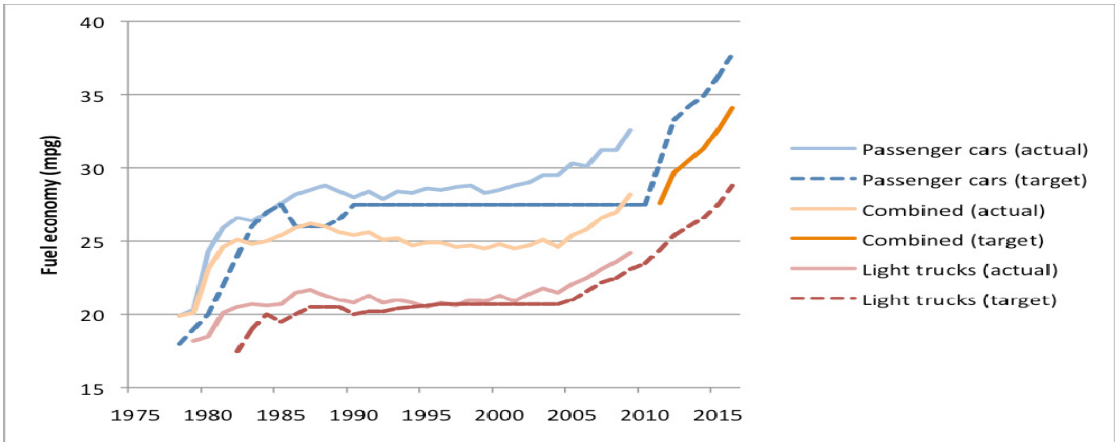
In November 2007, WP.29 agreed to set up an informal group on Worldwide Harmonised Light Vehicles Test Procedure (WLTP). WLTP involves a common test procedure, which includes the driving test cycle used for vehicle CO_2 emissions measurement. Test cycles and test procedures are being developed by this informal group, with participation of major WP.29 members, such as China, India, Japan, Korea, the European Union and the United States.

Policy updates in IEA member countries

The United States

In the United States, vehicle fuel economy has been regulated since 1975, when the Corporate Average Fuel Economy (CAFE) programme started. Under CAFE, cars and light trucks up to 8 000 pounds (about 3 600 kg) are required to meet a minimum fuel economy target based on miles per gallon (MPG). Separate standards exist for cars and light trucks. The standards were initially set through the mid-1980s, and have been in force ever since at approximately the same levels, though in recent years the standard for light trucks has been raised. For cars, the standard can only be changed via Congressional legislation but for light trucks, the Department of Transportation (DOT) has the authority to set higher or lower standards. Actual fleet fuel economy to Model Year (MY) 2009 and CAFE standards up to MY 2016 are shown (Figure 6).

Figure 6: NHTSA CAFE standards and actual fleet fuel economy[4]



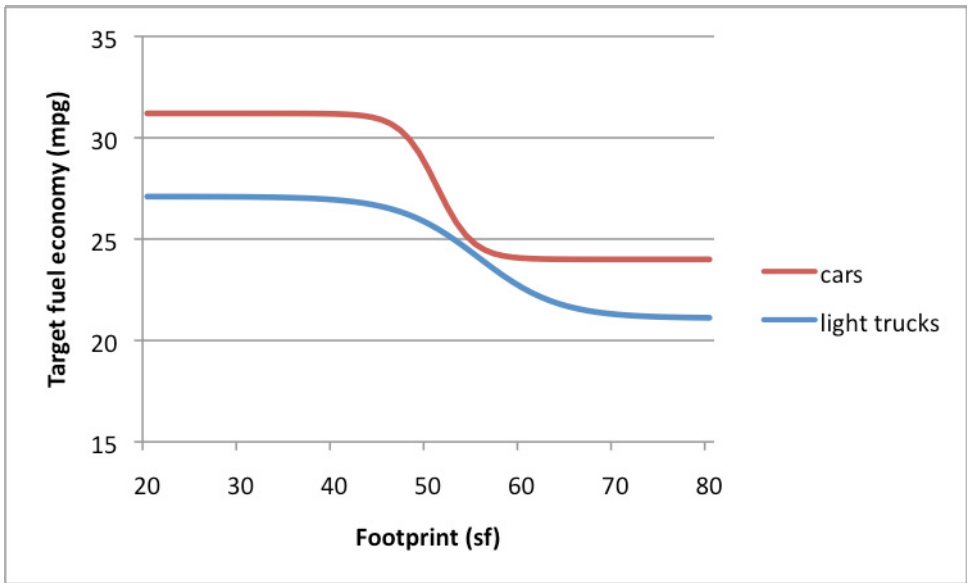
Source: NHTSA and EPA (2010a)

In March 2009, the NHTSA (via the DOT) published the final rule of reformed CAFE programme for passenger cars and light trucks (the Reformed CAFE), as well as standards for model year 2011. Under the Reformed CAFE system, each passenger car and light truck manufacturer

[4] NHTSA's combined target in 2016 is 34.1mpg which is different from that stated on the next page (35.5mpg). This difference results from the treatment of air conditioning improvements (related to CO_2 and HFC [Hydrofluorocarbons] reductions), which affects the relative stringency of the EPA standard and NHTSA standard. The NHTSA standard with credits for air conditioning improvements is equivalent to the EPA standard.

is required to achieve the level of CAFE, which is based on each vehicle's target level and set according to vehicle size. The targets are assigned according to the vehicle's "footprint" (the product of the average track width multiplied by the wheelbase). Each vehicle is assigned to a target specific to the footprint value (Figure 7). Passenger vehicles and light trucks are still regulated separately but adhere to the same compliance methodology.

Figure 7: The Reformed CAFE targets for MY 2011



Source: NHTSA (2009b)

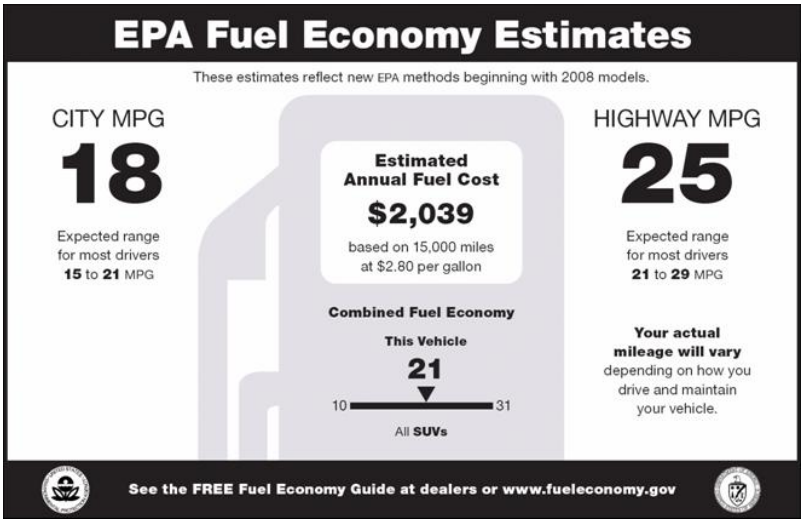
In April 2010, DOT and the Environmental Protection Agency (EPA) further revised the CAFE standards, which will improve the United States' fuel economy to 35.5mpg by 2016.[5] This is equivalent to 6.6 L/100km and represents a 30% reduction in fuel use compared to the new light-duty vehicles in the United States in 2005. Although this represents a significant reduction in fuel economy over the period, it should also be stated that fleet fuel economy is much higher than in most other developed countries and will remain so even with a substantial reduction such as that planned.

Labelling

In the United States, fuel economy estimates have been provided for more than 30 years to consumers as a tool to help consumers compare different vehicles. The labelling includes information comparing the fuel efficiency of different vehicles, expected on-road fuel efficiency and estimated annual fuel cost. The revised fuel economy label that appears on vehicle window stickers since 2008 models is much more informative (Figure 8).

[5] DOT/NHTSA is primarily responsible for CAFE standards while the EPA is responsible for GHG standards, such as HC and NOx. In the United States, CO_2 is also considered as a harmful emission, therefore EPA is regulating. The 2016 CAFE standards are harmonised with the GHG standards.

Figure 8: U.S. passenger car fuel economy label



Source: EPA (2006)

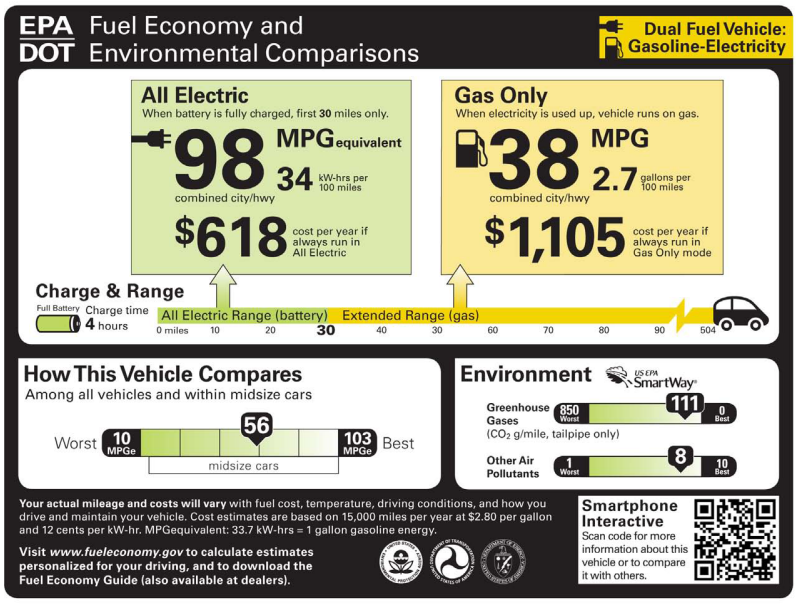
In August 2010, DOT and EPA jointly proposed new label designs for a range of vehicle technologies, including electric vehicles and plug-in hybrid electric vehicles, as well as conventional gasoline and diesel vehicles. The proposal has two options (Figure 9). One of these options, or its modified version, will be applied to MY 2012 cars and trucks. It is expected that the redesigned label will provide comprehensive information on fuel economy, energy consumption, fuel cost, and environmental impacts to the consumers with straightforward comparisons possible across all vehicle types.

Figure 9: Proposed fuel economy label

Option 1



Option 2



Source: NHTSA and EPA (2010b)

Japan

The Japanese government has twice introduced non-binding fuel efficiency targets for light-duty vehicles. The first target was set in 1978, with the target year of 1985, and the second one in 1990, with the target year of 2002. The latest standards have been set for 2010 and 2015. There are no new updates on fuel economy standards in Japan, however some details on the Japanese vehicle fuel efficiency standards or "Top Runner" programme are provided (Box 2).

Labelling

The Energy Conservation Law also requires manufacturers to provide information on the fuel efficiency of vehicles through labelling. Fuel efficiency values are accompanied by CO_2 emission values converted from the fuel efficiency values, although people are generally more accustomed to fuel efficiency values provided in the unit of kilometre per litre (km/L). There have been no new measures implemented in this area in Japan since 2009.

Box 2: Vehicle labelling and incentives in Japan

In order to stimulate consumer interest in fuel efficiency performance and to encourage the wide deployment of fuel-efficient vehicles, a vehicle fuel efficiency certification programme was implemented in April 2004. Under this programme, vehicles are ranked according to their fuel efficiency performance and certified in four levels (this was expanded from the initial two levels of certification in 2006) – the level meeting the target and the levels exceeding the target by 5%, 10% and 20%. Manufacturers must attach the certification sticker showing the vehicle's fuel efficiency performance level to the rear windows of the vehicles.

Furthermore, in an effort to tackle global and local environmental issues, in 2001 a tax credit for both fuel-efficient and less polluting vehicles and a tax increase for vehicles older than 11 years old were introduced. The thresholds are tightened every two years to accelerate wider deployment of more fuel-efficient and cleaner vehicles. Since Japanese fuel economy standard is weight based, the criteria to receive tax reduction are different by vehicle weight.

Figure 10: Stickers for fuel-efficient cars



Figure 11: Sticker for less polluting cars



Source: MLIT

The European Union

Passenger vehicles

In the European Union, progress has been made since March 2009 in implementing fuel efficiency standards in the form of CO_2 emissions standards.

In December 1995, the European Commission proposed a strategy to reduce CO_2 emissions from passenger cars towards the average fuel-efficiency target of 120 g CO_2/km with a time limit beyond 2005 for this attainment.

In the late 1990s, the European Commission agreed with the European Automobile Manufacturers' Association (ACEA), the Japan Automobile Manufacturers' Association (JAMA) and the Korean Automobile Manufacturers' Association (KAMA) that each association would commit to the same quantified CO_2 emission objective for the average new passenger car sold in the European Union. The content of the commitments was that the members of each of these associations should collectively achieve a CO_2 emission target of 140 g CO_2/km by 2008 (ACEA) or by 2009 (JAMA and KAMA). The problem of sharing the burden of the objective between the different manufacturers was left to each association itself to decide. Although vehicle CO_2 emissions reduced from 172 g/km to 153 g/km (European Commission, 2008) over the period 2000 to 2008, in 2007 the Commission announced that "the strategy had brought only limited progress towards achieving the target of 120 g CO_2/km by 2012" and that "the review of the strategy has concluded that the voluntary commitments has not succeeded and that the 120 g target will not be met on time without further measures" (European Commission, 2007).

As a result, in April 2009 the European Union adopted the regulation "setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles" to reduce CO_2 emission from passenger vehicles (EU, 2009). Average emissions from new passenger vehicles sold in the European Union have to reach the 120 g CO_2/km target by 2015. Improvements in motor technology will reduce average emissions to no more than 130 g CO_2/km, while complementary measures will contribute a further emissions cut of up to 10 g CO_2/km, thus reducing overall emissions to 120 g CO_2/km. These complementary measures include efficiency improvements for car components with the highest impact on fuel consumption, such as tyres and air conditioning systems, and a gradual reduction in the carbon content of road fuels, notably through greater use of biofuels. Efficiency requirements for these components are being discussed and will be introduced for these car components.

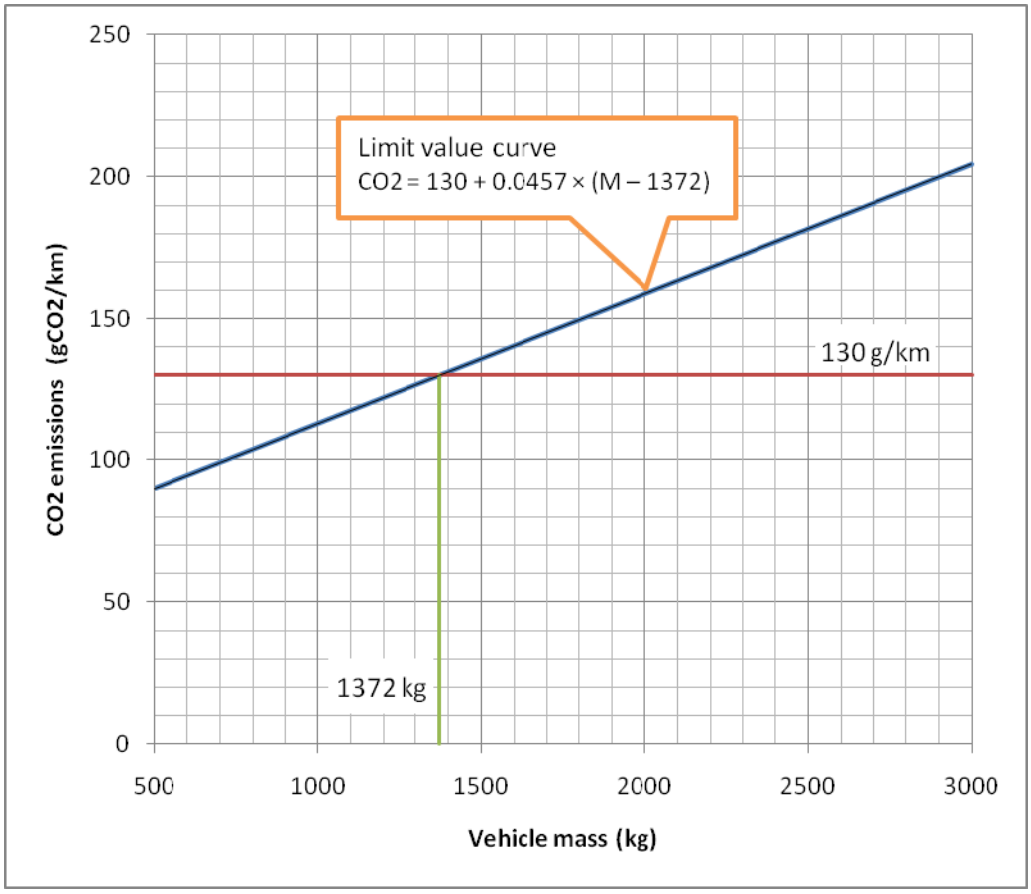
The legislation defines a limit value curve of permitted CO_2 emissions for new vehicles according to the mass of the vehicle. This curve, the so-called 60% limit value curve, is set in such a way that a fleet average for all new cars of 130 g CO_2/km is achieved. From 2012, a manufacturer will be required to ensure that the average emissions of all new vehicles are below the average of the permitted emissions for specific cars given by the curve (Figure 12). In 2012, 65% of each manufacturer's newly registered vehicles must comply on average with the limit value curve set by the legislation. This will rise to 75% in 2013, 80% in 2014, and 100% from 2015 onwards.

The legislation, with its excess emissions premium for average emission levels exceeding the limit value curve, will provide an incentive for the manufacturers to reduce the CO_2 emissions of their vehicles. This premium will be based on the number of grams per kilometre (g/km) that an average vehicle sold by the manufacturer is above the curve, multiplied by the number of vehicles sold by the manufacturer.

The legislation also adopted "super-credits" for extremely low CO_2-emitting vehicles (below 50 g CO_2/km). Those cars will receive extra incentives whereby 1 low-emitting vehicle will be counted as 3.5 cars in 2012 and 2013, as 2.5 cars in 2014, as 1.5 cars in 2015 and as 1 car from 2016. These "super-credits" would support early deployment of the next generation vehicles, such as electric vehicles, plug-in hybrid vehicles and other fuel-efficient vehicles that would be more costly than conventional vehicles.

In addition, CO_2 innovative technologies – mainly non-engine components that are not fully evaluated by CO_2 emission test procedures – will be considered as "Eco innovations". The total CO_2 savings achieved through the use of those technologies is limited to 7 g CO_2/km by the legislation. The European Commission is preparing detailed provisions for a procedure to approve such innovative technologies.

Figure 12: Limit value curve of the passenger car regulation



Source: European Union (2009a)

Light commercial vehicles

Following the CO_2 emissions regulation for passenger vehicles, the European Commission proposed a regulation for reducing CO_2 emissions from light commercial vehicles in October 2009. The proposed regulation targets a CO_2 emission reduction to 175 g CO_2/km by 2016 and indicates 135 g CO_2/km by 2020 as a long-term target. This proposal is similar to the regulation for passenger cars, with features such as weight-based limit value curve, phase-in, period, etc. As this regulation proposal has different CO_2 target values, the slope of the limit value curve and target year differ from those in the regulation for passenger cars. These differences are due to consideration for longer model life and the desire to avoid distortionary incentives that might encourage the use of multiple small commercial vehicles rather than a single larger commercial vehicle, which should be more efficient for carrying the same payload. The European Parliament was discussing this regulation proposal at the time of writing in July 2010.

Labelling

There has been no update since March 2009 on vehicle labelling in the European Union; the European Commission intends to propose an amendment to the European Union labelling directive. Some background information on the existing scheme is provided (Box 3).

Box 3: European Union labelling scheme

The EU directive 1999/94/EC, adopted in 1999, gives European Union countries the authority to require mandatory labels indicating information on the fuel economy and CO_2 emissions of light-duty vehicles to be displayed on LDVs sold within their borders and therefore enables vehicle purchasers to make an informed choice. According to the directive, the information must be provided to consumers in the following ways:

- A fuel economy and CO_2 emissions label for all new cars must be displayed at the point of sale.
- A poster (or a display) showing the official fuel consumption and CO_2 emission data of all new passenger car models must be displayed at the respective point of sale.
- A guide on fuel economy and CO_2 emissions must be produced on at least an annual basis.
- All promotional literature must contain the official fuel consumption and specific CO_2 emission data for the passenger car model to which it refers.

A number of organisations in European Union member states maintain Internet sites, which display the official fuel consumption and CO_2 emissions of new passenger car models offered in their regional markets. In spite of this, there is no harmonised format for labels so that different labels can be seen in different European member states. Furthermore, there are currently no common energy or CO_2 performance thresholds in place across the European Union.

Canada

Canada has had a long history of voluntary fuel efficiency targets for light-duty vehicles since 1976. The targets have generally been achieved, because the levels of the targets have been the same as the United States' CAFE standards.

In January 2008, Transport Canada, the Canadian government agency for transport, announced that the fuel consumption of new cars and light trucks would be regulated from the 2011 model year. Following this announcement, Environment Canada, the Ministry of Environment, proposed the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations in April 2010 (Environment Canada, 2010). The proposed mandatory standards are aligned with the United States' revised CAFE standards, as the Canadian automobile market is closely linked with that of the United States. These proposed regulations should be adopted as official regulations soon.

Australia

Australian automotive industries introduced two sets of voluntary fuel efficiency targets in 1978 and 1987. Both programmes seem to have contributed to fuel efficiency improvement but both missed their targets, partly because of a shift in consumer preference for bigger and more powerful cars. So a third voluntary programme was agreed between government and industry in 2003, with the target of 6.8 L/100km for petrol passenger cars by 2010.

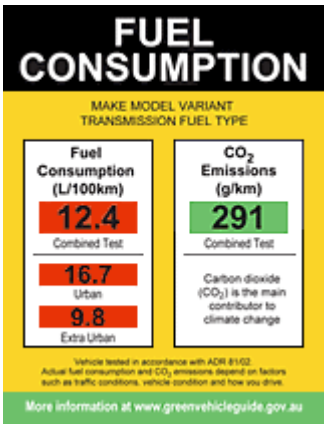
The Australian government is working on fuel efficiency standards and a vehicle fuel efficiency working group was established under the Australian Transport Council and the Environment

Protection and Heritage Council. In March 2009, this working group issued the final working report (Australian Transport Council, 2009). The report considered the case for mandatory sales-weighted average CO_2 emissions standards for new light vehicles, and recommended that the Australian government undertake a detailed regulatory impact statement to assess the costs and benefits of introducing CO_2 emission standards for light vehicles. In July 2009, the Council of the Australian Governments incorporated this recommendation into the National Strategy on Energy Efficiency and a regulatory impact statement will be released in 2010 for public consultation (Council of Australian Governments, 2009).

Labelling

Regarding a labelling scheme, the Australian government has mandated fuel consumption labelling of all new vehicles up to 3.5 tonnes since 2004. In April 2009, the labelling scheme was amended to display the fuel consumption over urban and non-urban test conditions, as well as the combined result, and the label also displays the combined CO_2 emissions result (Figure 13). Car purchasers can consult the web-based "Green Vehicle Guide" to check fuel economy, CO_2 ratings and compare different vehicle models.

Figure 13: Fuel consumption label



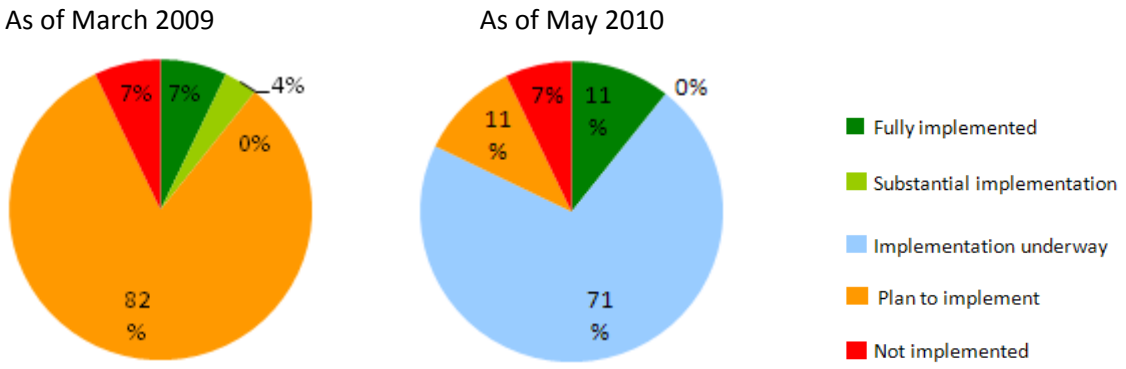
Source: Department of Infrastructure, Transport, Regional development

Korea

In 2006, Korea introduced average fuel economy standards for passenger cars as part of the Energy Utilisation Rationalisation Act and in July 2009, it announced a new fuel economy standard for passenger cars, as part of the national Green Growth strategy. The new standards will be phased in from 2012 and then fully implemented in 2015. Each automobile manufacturer can choose between two corporate average targets, *i.e.* 17 km/L or 140 g CO_2/km. This allows for flexibility in addition to the phase-in approach. Other than phasing-in and corporate average targets, the design of the standard is well aligned with those of the United States and European Union on features such as weight-based target values, and the credit trading/carry over scheme. The Korean government also provides fiscal incentives for cars with extremely low CO_2 emissions.

Discussion

Figure 14: Progress of policy recommendation on fuel economy standards for light-duty vehicles



The preceding sections show that some progress has been made in implementing fuel efficiency standards and tightening existing standards, both in the main vehicle manufacturing regions and other IEA countries (Figure 14). Some regions, such as the European Union, were late starters in implementing fuel efficiency standards, whereas others, such as the United States, introduced standards more than thirty years ago but have only recently tightened them. The majority of IEA member countries have moved from a "Plan to implement" category to that of "Implementation underway". There remain several IEA member countries – Australia, New Zealand, and Turkey – that have yet to introduce mandatory fuel economy standards, although some have voluntary fuel economy programmes, and Australia is currently considering the case for mandatory standards.

Box 4: The Global Fuel Economy Initiative and 50-by-50 campaign

In March 2009, the IEA and three partner agencies – the International Transport Forum; the United Nations Environment Programme (UNEP); and the FIA (*Fédération internationale de l'automobile)* Foundation – launched the Global Fuel Economy Initiative (GFEI). The overall objective of this Initiative is to make all LDVs worldwide 50% more fuel efficient by 2050 compared to average efficiencies in 2005. The Initiative seeks to achieve this primarily by improving international understanding of the potential for greater fuel economy and the cost of achieving it, and by providing guidance and support in the development of policies to promote fuel-efficient vehicles. The Initiative's activities include:

- Developing improved data and analysis on fuel economy around the world; monitoring trends and progress over time; and assessing the potential for improvement.
- Working with governments to develop policies that encourage greater fuel economy in the vehicles produced or sold in their countries; and helping make policies more consistent across countries so as to lower the cost and maximise the benefits of improving vehicle fuel economy.
- Working with stakeholders, including car manufacturers, to better understand the potential for fuel economy improvement and soliciting their input and support in working towards improved fuel economy.
- Supporting regional awareness initiatives to provide consumers and decision makers with the information they need to make informed choices.

Box 5: Design features of fuel economy standards

Voluntary vs. regulatory measures: Voluntary programmes were most popular during the 1980s and 1990s when it was generally thought that less government intervention would be appropriate. Until recently, only the United States and Japan had regulatory fuel economy requirements for LDVs. But in most cases, mandatory targets achieved their goals, although in one case, overall fleet average fuel efficiency deteriorated partly because of perverse effects in the standard design. As a result of the general ineffectiveness of voluntary programmes to constrain vehicle energy efficiency, there is a general trend away from them.

Scope: Both the range of vehicles to which a standard applies in a vehicle category, such as the passenger car category, and the coverage of vehicle categories are closely related to the effectiveness of the standard, and therefore, governments have been working on broadening the scope (*e.g.* covering a greater range of vehicle types). However, broadening the scope of a standard may increase the administrative cost of testing the vehicles. Governments need to find ways to decrease the costs of testing procedures by utilising new methods such as computer simulation.

Testing procedures: To reduce actual fuel consumption, not only improvement in tested fuel efficiency, improvements in on-road fuel consumption are important. For this, test procedures should reflect as many factors affecting the value of the fuel efficiency as possible. These requirements must be balanced against the increased cost of testing.
Since different regions use different emissions testing procedures, it is difficult to compare test results and emissions standards between regions. There have been some efforts to harmonise at least some aspects of testing procedures. This would be an effective way of reducing costs for industry and testing authorities although it would be very difficult to achieve, especially in the short term. In this regard, UNECE WP.29 has started development of the worldwide harmonised test procedure (WLTP), as mentioned before.

Technology neutrality: Fuel efficiency standards are usually set to require the same level of efficiency regardless of the technologies that vehicles adopt. There are, however, cases where requirements are established on the basis of the technology used. In general, setting requirements that favour one kind of energy efficiency technology over another will distort technological development.

Regulatory flexibility: Existing regulatory measures generally try to use a range of mechanisms such as manufacturer fleet averaging, attribute-based targets, weighted average criteria and credit trading systems to increase policy flexibility. In general, high degrees of regulatory flexibility allow more stringent targets to be met at a lower cost (compared to less flexible approaches). Lead time is also an important factor in lowering costs.
Attribute-based standards can bring standards much closer to economic efficiency and may be more likely to ensure greater fairness among all auto manufacturers. Although they do not necessarily ensure an overall improvement in vehicle fuel efficiency, as such standards are subject to weight or size shifts, a standard design in which relatively stringent requirements are imposed on heavier and bigger vehicles could solve at least part of this concern.

Standard stringency: The effectiveness of a vehicle fuel efficiency standard also varies depending on the stringency of the standard. There are several approaches to setting the level of stringency of a policy. This cost effectiveness analysis, which was adopted in the European Union and the United States, depends largely on expectations of existing and emerging technologies (cost and effectiveness), and financial considerations such as discount rates and payback period. An alternative approach is the Japanese Top-Runner programme, in which stringency is based on the performance of the best in each weight class on the market. Under this programme, the value of the mass-produced vehicle with the highest fuel efficiency is used as a base value and factors such as fuel saving potential of future technologies are considered afterwards.

In 2009, the European Union adopted mandatory standards and a law that requires tightening of the CAFE standards was adopted in the United States. When reviewing the fuel economy standards in the European Union, United States and Japan, it is clear that the current goal is to achieve an annual improvement rate of more than 2.5% in terms of fuel efficiency (distance travelled/fuel consumed). This is much higher than past or current improvement rates anywhere. If the standards announced are implemented as planned, then the European Union and Japan will remain the regions with the tightest fuel efficiency standards globally.

Previous IEA research on fuel economy standards has derived some observations on the design of fuel economy standards and these are reported (Box [IEA, 2008]).

Labelling

Governments have been encouraging manufacturers to introduce labelling schemes in the hope that they will lead to fuel savings and several schemes have been introduced. The European Commission (EC and ADAC, 2005) published the results of a study on the effectiveness of the car-labelling directive. These illustrated a disappointing impact of the labelling scheme so far. So improvements were proposed: by eliminating nationally specific schemes and applying a common European Union-wide scheme, which includes extending the scope; introducing energy efficiency classes; and a possible indication of annual running costs. In the United States, comprehensive information has been provided to consumers for many years, yet the average fuel efficiency of LDVs has decreased.

In isolation, fuel economy labels may not lead to significant fuel efficiency improvements. However, fuel efficiency labels do help consumers compare vehicles, and might particularly influence choices between otherwise similar vehicles that have different fuel efficiency ratings. Furthermore, consumers may pay much more attention to fuel economy labels if labelling schemes are linked with vehicle fiscal measures, as in France and Japan.

Chapter 4. Fuel economy of heavy-duty vehicles

IEA Energy Efficiency Recommendation 5.3. Mandatory fuel efficiency standards for heavy-duty vehicles

Governments should:

- Fuel efficiency standards; and
- Related policies including labelling and financial incentives based on the vehicle fuel efficiency.

General description

In 2005, trucks used a total of about 500 Mtoe (21 EJ) of energy worldwide or about 23% of the total energy consumed by the transport sector in that year (IEA Mobility Model database estimates).

There are many engine and non-engine innovations that have the potential to deliver significant fuel efficiency gains. These include aerodynamic improvement, engine downsizing, selective catalytic reduction, hybrid drivetrains, separate auxiliary power unit and telematics. The stringent nitrogen oxides (NOx) and particulate matter (PM) regulations planned in the near future in the European Union, Japan and the United States may reduce fuel efficiency gains. These regulations would require both engine technologies, such as further increase of rate of exhaust gas recirculation (EGR) and after-treatment technologies including a diesel particulate filter and de-NOx catalyst, all of which would generally worsen fuel efficiency.

However, stringent air quality emission regulations in the past have not resulted in reduced fuel efficiency, despite similar fears. Developments in internal engine measures and after-treatment technologies, as well as other non-engine measures, could significantly improve fuel efficiency.

In general, commercial vehicle operators are more conscious of fuel costs than private drivers. Therefore, in theory, policy intervention may not be always needed in this sector, because the market should ensure optimum fuel efficiency. However, market failures, such as the principal agent problem, exist and so policy intervention is needed. Participants of an IEA workshop, Fuel Efficiency for HDVs Standards and Other Policy Instruments, held in June 2007, concluded that potential HDV fuel efficiency improvements were not necessarily being delivered as quickly or as broadly as expected. Most commercial operators expect a three-year payback for fuel economy improvements. Measures that fall within this range are likely to be implemented by industry without any support or regulatory pressure. However, if governments aim to make significant impacts on heavy-duty vehicle energy efficiency beyond what the market can deliver, then the implementation of measures with a payback period of four to six years (*e.g.* multiple turbo chargers) is likely to require some form of government intervention, especially since operators are sensitive to overall operating costs and not just fuel costs (which represent approximately 30% of the total). Measures that deliver fuel economy payback over more than six years would not be commercially viable and would definitely require policy support for their implementation. Given the many technologies available to improve HDV fuel efficiency, and indications that HDV fuel efficiency improvements are not necessarily occurring as quickly or as broadly as possible, a number of governments have introduced, or are considering introducing, policies and measures to promote or require fuel efficiency gains.

Box 6: International Initiatives: UNECE/WP.29

In January 2007, the worldwide harmonised heavy-duty certification (WHDC) test procedures for exhaust emissions and fuel efficiency of HDVs were developed as a global technical regulation (GTR No. 4) by WP.29. Like other UNECE regulations, most countries can use these test procedures.
In March 2010, the development of test procedures for hybrid HDVs was proposed at WP.29, because such a system is not catered for by the existing UNECE test procedure. In future, this development could provide incentives to manufacturers by evaluating the fuel efficiency of the hybrid powertrain.

Policy updates in IEA member countries

Japan

Fuel efficiency standards

There has been no change in Japanese fuel efficiency standards for heavy-duty vehicles since March 2009. However, since Japan is a leader in this area, and indeed the only country to implement heavy-duty fuel efficiency standards, it is worth describing the policies in more detail than given in the *Tracking Progress* report.

Table 1: 2015 HDV fuel economy target values by vehicle category and gross vehicle weight

Target standard values for trucks, except tractors

Class	Gross vehicle weight (tonnes)	Target standard value (km/L)
1	3.5 – 7.5 payload <= 1.5 tonnes	10.83
2	3.5 – 7.5 payload 1.5 - 2 tonnes	10.35
3	3.5 – 7.5 payload 2 - 3 tonnes	9.51
4	3.5 – 7.5 payload > 3 tonnes	8.12
5	7.5 – 8	7.24
6	8 – 10	6.52
7	10 – 12	6.00
8	12 – 14	5.69
9	14 – 16	4.97
10	16 – 20	4.15
11	20 –	4.04

Target standard values for tractors

Class	Gross vehicle weight (tonnes)	Target standard value (km/L)
1	< 20	3.09
2	> 20	2.01

Table 1: 2015 HDV fuel economy target values by vehicle category and gross vehicle weight (*continued*)

Target standard values for city buses

Class	Gross vehicle weight (tonnes)	Target standard value (km/L)
1	6 – 8	6.97
2	8 – 10	6.30
3	10 – 12	5.77
4	12 – 14	5.14
5	> 14	4.23

Target standard values for buses, except city buses

Class	Gross vehicle weight (tonnes)	Target standard value (km/L)
1	3.5 – 6	9.04
2	6 – 8	6.52
3	8 – 10	6.37
4	10 – 12	5.70
5	12 – 14	5.21
6	14 – 16	4.06
7	> 16	3.57

Source: MLIT

Japan was the first country to introduce fuel efficiency standards for HDVs in 2006 as part of its measures to reduce fuel consumption and address global warming. Based on the Top Runner programme for cars (that requires current best-in-class performance to become the average performance level by a target date), manufacturers are required to improve the fuel economy of HDVs until the target year 2015. Compared to passenger cars, there are varied HDVs such as buses, trucks, and tractors. In addition, there are also different body shapes and cargo equipments. The fuel economy of heavy-duty vehicles strongly depends on gross vehicle weight, and so the target standard values are classified into four categories by gross vehicle weight. There are 5 classes for city buses, 7 for buses, 11 for trucks and 2 for tractors, making 28 classes in total (Table 1).

Test procedures

In general, testing the fuel economy of an HDV as a whole vehicle is much more costly than for passenger cars, due to the vehicle size and number of engine/chassis variations. Therefore, fuel economy testing is conducted as an engine test on an engine dynamometer, which evaluates engine fuel efficiency, but not for the whole vehicle.

In Japan, research was conducted into the best and most cost-effective method for measuring fuel economy of HDVs and a simulation method was adopted to measure the fuel efficiency of vehicles with standardised vehicle specifications for each vehicle types. This approach is advantageous in terms of testing facility, testing time, measuring accuracy and evaluation of factors affecting fuel efficiency.

The simulation method uses a computer programme that converts a vehicle-based driving cycle into an engine-based operation cycle using vehicle specification data, and thereby calculates fuel efficiency using the data from engine-based tests.

This test method mainly measures the fuel efficiency of engines, but factors such as aerodynamics and tyre rolling resistance that could have a big impact on on-road fuel efficiency are not estimated. It is hoped that further development of the test method will include as many factors as possible in the near future.

Fiscal incentives

Japan also introduced tax incentives for vehicles that meet both fuel economy and low emission standards. It is possible to have a 1% to 2% reduction in the acquisition tax of new vehicles if the standards have been met.

Figure 15: Stickers for fuel efficient HDVs



Source: MLIT

Since the adoption of the Japanese fuel efficiency standards, together with labelling and tax incentives that were introduced in April 2006, HDV manufacturers have been trying to increase the fuel efficiency of their vehicles while complying with the 2005 stringent local pollutant emission regulations by introducing various fuel efficiency technologies, as mentioned before.

Thanks to these efforts, fuel efficiency increased by a laudable 5.4% by 2007, compared to the 2002 baseline year. As of May 2008, about 20% of vehicle types of new trucks and 35% of new buses already exceeded the 2015 fuel efficiency standards. However, it is possible that the fuel efficiency improvement of future vehicles could slow or temporarily decline due to the stringent Japanese local pollutant emission regulations of 2009.

The European Union

Until recently in Europe, commercial trucks were not seen as offering scope for significant GHG reductions because of the high importance of fuel cost in commercial transport, leading to a perception that most practicable options for fuel consumption reduction were already being used in this sector. However, during the second phase of the European Climate Change Programme (ECCP2) it emerged that there may indeed be scope for further reduction. Since then, the European Commission has been using an open-ended approach in surveying potential measures and instruments. In April 2010, the European Commission started discussions on measuring CO_2 emissions from HDVs as an element for future CO_2 emission standards.

The United States

There has been some progress since March 2009 in the United States in relation to the implementation of fuel efficiency standards for heavy-duty vehicles.

In 2004, the US Environmental Protection Agency (EPA) established a voluntary collaboration programme with the freight industry called the SmartWay Transport Partnership. The goal of this programme is to reduce fuel consumption as well as pollutant air emissions from commercial transportation. By 2012, the programme aims to save between 3.3 and 6.6 billion gallons of diesel fuel per year. In accordance with the "Energy Policy Act of 2005", EPA developed a national loan programme for trucking fleets to enable them to adopt fuel-saving technologies, including idle reduction technologies and low rolling resistance tyres. EPA also conducted tests on several of the most promising emerging technologies, *e.g.* single-wide low rolling resistance tyres. To date, commitments from nearly 500 partners will result in annual fuel savings of over 218 million gallons per year.

In December 2007, the US Congress enacted and the President signed the Energy Independence and Security Act of 2007 (EISA, 2007). The legislation requires DOT to determine, in conjunction with the Department of Energy and EPA, how to implement a fuel efficiency improvement programme for heavy-duty vehicles, which will include test methods, performance metrics, standards, and enforcement protocols.

Previously, in 2006, the state of California passed legislation allowing it to regulate CO_2 and other GHG emissions as pollutants, especially in relation to greenhouse gas emissions from light and heavy-duty vehicles. The state has specifically addressed idling of heavy-duty vehicles as a potentially important source of greenhouse gases' savings and air quality improvements. A state ordinance applicable to heavy-duty vehicles of 14 000 lbs and over requires operators to shut down their engines after five minutes of idling.

In April 2009, the EPA initiated this rule relating to heavy-duty vehicles GHG emissions standards. This action set national emission standards under the Clean Air Act to control greenhouse gas emissions from heavy-duty trucks and buses. This rulemaking would significantly reduce GHG emissions from future heavy-duty vehicles by setting GHG standards that would in turn lead to the introduction of GHG-reducing vehicle and engine technologies. This action follows the United State Supreme Court decision in *Massachusetts vs. EPA* and the latter's formal determination on endangerment for GHG emissions. It also follows the Advance Notice of Proposed Rulemaking, Regulating Greenhouse Gas Emissions under the Clean Air Act of July 2008.

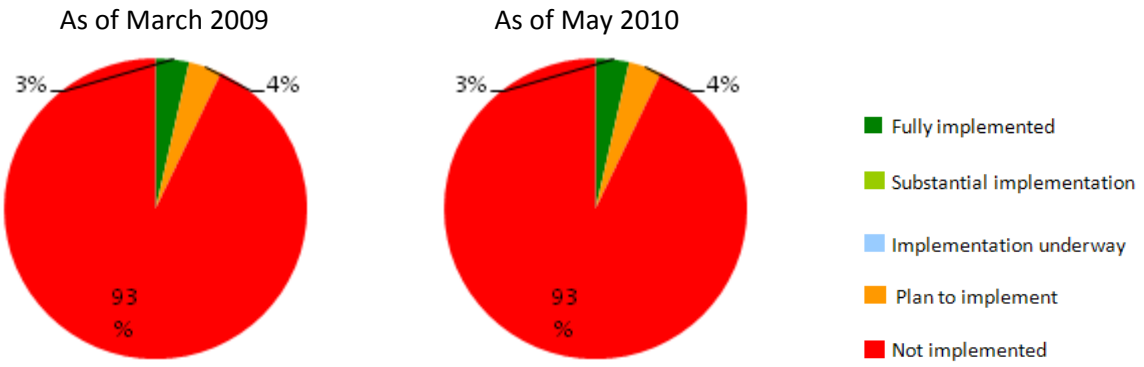
In May 2010, the Obama administration directed the United States EPA and DOT to create a national policy for fuel efficiency and decrease GHG emissions from medium and heavy-duty trucks for model years 2014–18. The NRPM (notice of proposed rulemaking) for heavy-duty vehicles GHG emissions standards is expected soon.

Discussion

There has been no change in the status of implementation of the IEA recommendation on heavy-duty fuel economy standards and therefore no changes since the *Tracking Progress* report last year (Figure 16).

It appears that in Japan, fuel efficiency improvements with a payback period of three to four years have already been, or will be, implemented by commercial operators without any policies. Furthermore, in response to the Japanese standards for 2015, requiring a 12% fuel efficiency improvement from 2002, manufacturers have already introduced some vehicles that meet the new standards. Manufacturers' response to these standards may illustrate the availability of unexploited fuel efficiency technologies.

Figure 16: Progress of policy recommendation on fuel economy standards for heavy-duty vehicles



To date, Japan remains the only country to have introduced heavy-duty vehicle fuel efficiency standards although there are indications that this is likely to change in the next few years in the United States and European Union. There are several reasons for the lack of heavy-duty standards.

Firstly, it is difficult and costly to measure heavy-duty vehicle emissions due to the size of the test equipment required and the number of model variations available on the market for each vehicle type; and secondly, heavy-duty vehicles were until recently considered to be part of commercial operations where the technology had already been optimised for fuel efficiency to reduce operating costs. Both of these issues are now being addressed. The Japanese experience has shown that it is possible to measure heavy-duty emissions through a combination of empirical measurement and computer simulation to reduce costs. Also recent studies have shown that market failure can cause less than optimal fuel efficiency in heavy-duty vehicle technology and subsequent operation.

An additional point is that the cumulative impact of small improvements can deliver significant fuel efficiency gains and so it is important that manufacturers and operators have some method of tracking and aggregating these.

Lastly, care should also be taken to address the role of telematics (*e.g.* navigation systems with real-time traffic information), driver behaviour and logistics. In order to improve fuel efficiency of heavy-duty vehicles, therefore, it is important to involve a broad range of stakeholders.

Chapter 5. Eco-driving

IEA Energy Efficiency Recommendation 5.4. Eco-driving

- Governments should ensure that eco-driving is a central component of government initiatives to improve energy efficiency and reduce CO_2 emissions.
- Government support for eco-driving should include promotion of driver training and deployment of in-car feedback instruments.

General description

Improvements in driving techniques, or eco-driving, can significantly improve on-road fuel efficiency and CO_2 emissions. This can also contribute to better safety, and reduced noise and stress. In some countries, eco-driving training is an important part of road safety programmes.

Eco-driving is the operation of a vehicle in a manner that minimises fuel consumption and emissions. It includes:

- Optimising gear changing.
- Avoiding vehicle idling, *e.g.* by turning the engine off when the vehicle is stationary.
- Avoiding rapid acceleration and deceleration.
- Driving at efficient speeds. The most efficient speed for most cars is between 60 km/h and 90 km/h. Above 120 km/h, fuel efficiency falls significantly in most vehicles.
- Reducing weight by removing unnecessary items from the car, and reducing wind resistance by removing roof attachments such as ski racks.

Used together, these steps could save up to 20% of the fuel used by some drivers and possibly 5% to 10% on average across all drivers on a lasting basis. In November 2007, the IEA, in co-operation with the International Transport Forum, held a workshop to review current experiences around the world in implementing and promoting eco-driving. The workshop reviewed certain initiatives (Table 2).

Presentations at the IEA workshop quantified the impact of individual schemes on both a short-term (less than three years) and medium-term (more than three years) basis. Immediately after eco-driving training, average fuel economy improvements of between 5% and 15% were recorded for cars, buses and trucks. Over the medium term, fuel savings of around 5% were sustained where there was no support beyond the initial training or around 10% where further feedback was available.

Given the potential for very large fuel savings, some eco-driving initiatives are also operating without the help of government measures. Fleet operators are incentivised by cost savings to take action themselves, and eco-driving initiatives can be shown to support wider claims to responsible or sustainable entrepreneurship.

Even though the up-front costs of encouraging and tracking eco-driving schemes tend to be more visible than the long-run savings, there is potential for many more fleet operators and drivers to introduce eco-driving.

Table 2: Eco-driving programmes and targeted improvements in different countries or projects

	Method	Short-term	Mid-term
Netherlands	National programme	10-20%	5-10%
Austria	National programme	10-15%	5-10%
Japan	Smart driving contest	25%	
Japan	Idle stop driving	10%	
Japan	Eco-drive workshop	12%	
Japan	Average mileage workshop	26%	
Sweden	Driver training courses	5-15%	
Austria	ÖBB Post Bus Best Practice training courses, competition, monitoring, feedback	10%	
Austria	Eco-driving competitions for licensed drivers	30-50%	
Austria	Mobility management for company fleets	10-15%	
Deutsche Bahn	Training courses, monitoring, feedback, rewards		3-5%
Shell		5-20%	
Ford	Training courses and trip/driving style analysis	25%	10%
FIA – AASA (South Africa)		15%	
FIA – Plan Azul (Spain)		14%	
FIA – ADAC (Germany)		25%	
FIA – öAMTC (Austria)		6%	
FIA – JAF (Japan)		12-16%	
Nissan		18%	
UK – Lane Group			4%
UK – Walkers			9%

Source: IEA (2007)

Policy updates in IEA member countries

IEA member countries are engaged in many activities, such as information campaigns, driver training by the governments and manufacturers and drivers' associations at both national and regional levels (Table 2). The following section describes some examples of this, especially relating to government initiatives.

The European Union

As with its measures for tyres, in 2009 the European Union adopted the regulation (EC 661/2009), which stipulates the mandatory fitting of a gear shift indicator (GSI) to all new passenger cars with manual transmission, as a part of European strategy on reducing CO_2 emissions from road vehicles. The GSI is an indicator, which displays shifting up or down signs on the instrument panel to ensure optimal gear changing and thereby improve fuel efficiency. It is one of the in-car feedback instruments recommended by the IEA to promote fuel-efficient driving.

Under European Union regulations, it is compulsory to teach eco-driving to novice drivers. The implementation of eco-driving training, as a part of the driving license education and

examination, can improve fuel economy. Many countries have implemented eco-driving through national and regional eco-driving programmes; these will not be described individually here.[6]

Japan

There has been no change in Japanese policy in this area since March 2009, however eco-driving has been in place in Japan since 2003. A liaison committee was established involving the National Police Agency (NPA), the Ministry of Economy, Trade and Industry (METI), the Ministry of Land, Infrastructure and Transport (MLIT) and Ministry of the Environment (MOE), which formulated "10 Eco Drive Tips" and promoted a soft acceleration campaign called "e-start".

In 2005, promotion of Eco-driving Management System (EMS) was initiated with MLIT and METI co-operation. EMS is a combination of on-board and off-board measures, which are especially focused on the fleet operators such as freight trucks, buses and taxis. The on-board instrument records data during driving such as engine speed and vehicle speed, and also alerts the driver to excessive engine speed and unnecessary idling. The off-board instrument, which consists of a personal computer and computer software and is usually located in offices, analyses driving behaviour based on recorded data. These instruments and driver education, through the result of driving behaviour analysis, enabled fleet operators to save an average 8% of fuel compared with normal on-road driving consumption. The government grants subsidies to fleet operators that introduce EMS (MLIT, 2005).

For passenger cars, automobile manufacturers offer in-car feedback instruments for eco-driving on a voluntary basis. In 2009, more than 70% of new cars had such instruments. Although eco-driving remains a voluntary, non-mandatory, measure in Japan, some positive results have been achieved nonetheless.

Korea

Since April 2010, progress has been made in eco-driving in Korea and the government is developing the law and budget for promoting eco-driving guidance equipment. The Ministry of Knowledge Economy has developed a plan to encourage eco-driving equipment, such as onboard indicators of fuel efficiency, and in 2011 will provide fiscal support to target fleet operators, such as bus and taxi companies.

Regarding driver training, Korea will implement various activities to support the proliferation of eco-driving, for example by establishing eco-driving education centres. As part of its policy to improve fuel economy, the Korean government will also broaden the eco-driving content of the driving license examination in 2011.

New Zealand

Some progress has been made on eco-driving in New Zealand since March 2009. The Ministry of Transport announced implementation of the Safe and Fuel Efficient Driving New Zealand (SAFED NZ, 2010) eco-driving programme in July 2010. This programme is primarily directed at commercial fleet drivers to provide benefits such as:

[6] More information can be found at www.ecodriving-online.eu

- increased fuel savings and lower costs for fleet operators;
- reduced reliance on imported fossil fuel;
- improved road safety;
- increased economic productivity;
- improved workforce skills.

Throughout the pilot trial programme, one company made fuel savings of 17.8% and halved the number of safety incidents over a three-year period.

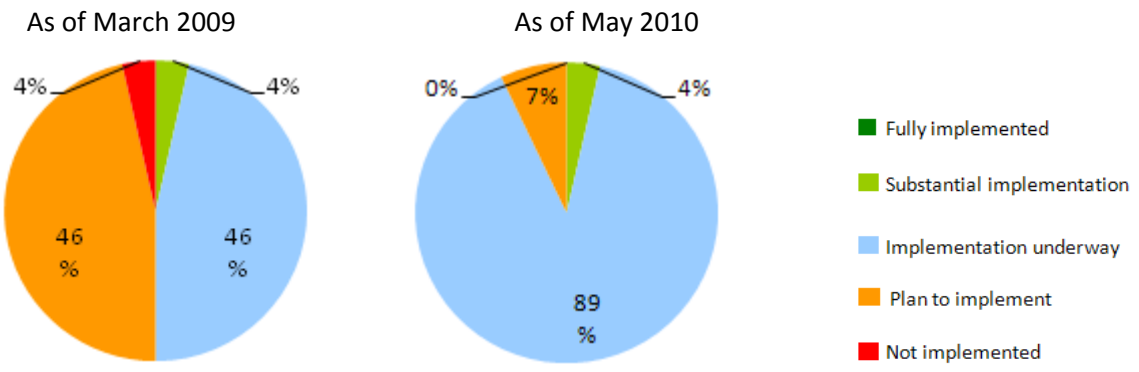
The Ministry of Transport is providing initial funding for the pilot training programme. The senior instructors will train other instructors across the country to ensure skills are shared over the longer term. It is expected that this programme will be expanded to areas other than commercial fleets in the near future.

Discussion

Of the four IEA transport energy efficiency recommendations, eco-driving was the policy measure implemented most widely, by 46% of IEA countries, in 2009. This is not surprising since cost-effectiveness studies of CO_2 emissions abatement repeatedly show eco-driving to have negative costs. In fact, it is only surprising that there is not a 100% implementation of this initiative.

The fact that this policy is not implemented in all countries most likely reflects the public good nature of this activity since the agent paying for the training (normally the government) does not directly recoup the benefits. Another reason is that eco-driving has a smaller profile as a policy initiative compared with say, an announcement of exciting new technologies. However, since March 2009 there has been further progress in introducing eco-driving policies so that 89% of IEA member countries now have eco-driving in the category of ”implementation underway” (Figure 17).

Figure 17: Progress of policy recommendation on eco-driving



Experience of existing eco-driving initiatives gathered at the International Transport Forum (ITF) workshop in 2007 suggests that they are most successful when they incorporate the following elements:

- Information campaigns

Communication campaigns that directly or indirectly publicise practical driving tips have been successful in many countries. Beyond providing information about more fuel-efficient, GHG emissions and accident rates, communication is most effective when eco-driving is promoted with commercial advertising.

The presentation of the message in the advertising must be both teasing and appealing. It must not cast doubt on the driving skills of the target groups. Presentations at the IEA workshop suggested that communication campaigns, supported by information materials, could achieve around 5% fuel savings for individuals who respond to a campaign.

Enlisting the help of other organisations, such as automobile clubs, industry associations and consumer organisations, can also improve the effectiveness of government expenditure.

- Driver training

Driver training is an effective tool, but there is a high cost to covering all drivers. As mentioned in an earlier section, including eco-driving in the driving licence examination would instil the eco-driving message in future licensed drivers.

- In-car equipment

A number of equipment strategies are available to encourage eco-driving. In-car equipment, such as gear shift indicators, cruise controls and onboard fuel economy computers that show real-time and average fuel economy can help improve fuel economy. Instrumentation alone can achieve an estimated 5% savings. In-car equipment creates an incentive for improved performance and so can further improve driver performance after training.

Finally, eco-driving can only succeed with consistent messages to drivers. Consumers should not be encouraged to undertake eco-driving courses while they are regularly offered new models with greater acceleration (which encourages non-eco-driving) than the previous generation of similar vehicles. If this is the case, the success of eco-driving schemes is likely to remain limited, especially in the longer term.

Chapter 6. Topics for future transport energy efficiency policy recommendations

Global energy use in the transport sector is forecast to increase on average by 1.6% annually up to 2030, unless significant policy action is taken (IEA, 2009a). The existing IEA transport energy efficiency recommendations are limited in scope and it is therefore necessary to consider other policies that will halt the trend of increasing energy use by the transport sector.

As a multi-faceted sector with many users and suppliers, transport is also one of the most complex to manage. Policy packages, rather than single measures, are needed that can solve individual challenges and situations.

As described in the first introductory chapter, the road transport energy paradigm can be split into three main parameters:

$E_{\text{road transport}}$ = (vehicle fuel efficiency) x (vehicle travel) x (the vehicle population)

where the vehicle fuel efficiency is determined by the technical energy efficiency; vehicle travel denotes the type of travel/driving and the number of miles driven; and the vehicle population is the number of vehicles on the road.

The four IEA energy efficiency recommendations for transport cover the first two parameters listed above; the energy efficiency of the vehicle as technology performance standards (fuel efficiency standards for light-duty and heavy-duty vehicles, and vehicle accessories performance standards); tyres; and secondly, vehicle use – eco-driving. Additional transport actions are discussed here, which are complementary to the current IEA transport energy efficiency recommendations as they either assist their implementation, and/or consist of additional measures that fill gaps in the current recommendations. This discussion should form the basis for the ongoing review of the energy efficiency recommendations in the transport sector.

Better information through vehicle labelling

Comprehensive, high quality information is a prerequisite for sound decision making. In order for customers to purchase the most efficient vehicles on the market, they must first know about the efficiency levels of the vehicles under consideration. Research shows that many consumers are not aware that their choices can have a significant impact on the environment and that labels significantly influence the choice that consumers make within a vehicle class (Teisl, M. *et al*., 2008). Labels showing fuel economy and CO_2 emissions values and displayed on vehicles are necessary to inform consumers about the fuel efficiency characteristics of the vehicle in question. However, experience in the European Union shows that labels in isolation do not reduce vehicle emissions. A review of EU labelling policy demonstrated that the highest level of success in influencing consumers' vehicle purchasing behaviour occurred when fuel economy and CO_2 emissions labels were combined with fiscal incentives, as was done in the Netherlands and the United Kingdom (EC and ADAC, 2005).

The form of the information is also important because people must be able relate to it. Experience shows that the proportion of consumers willing and able to understand technical information is low (Banerjee and Solomon 2003). Many people may not appreciate the implications of fuel economy or CO_2 emissions from official test procedures. More useful information is often focused on the annual fuel costs. A valuable addition to the vehicle labels is

a guide available in showrooms and on the Internet that provides the fuel economy and CO_2 emissions values of all vehicles on the market. This enables consumers to view the characteristics of other vehicles that they might not have otherwise considered. The IEA recommendations mentioned vehicle fuel economy labelling only in the context of heavy-duty fuel economy standards.

The IEA recommends that the provision of information, such as labelling, should be a part of policy measures that encourage the uptake of energy efficient vehicles.

Fiscal incentives

Fiscal measures can address all three of the elements of the transport paradigm listed above and are not included in the current IEA transport energy efficiency recommendations. In the first instance financial incentives or penalties, in combination with sound information, incentivise the purchase of more energy efficient vehicles and so can accelerate the deployment of energy efficient technologies. The vehicle tax systems of many countries, in Europe particularly, are now based on vehicle CO_2 emissions and research has shown that consumers respond quickly to such financial incentives. For example, in Ireland in the five months after the introduction of the new CO_2 emissions differentiated annual motor and vehicle registration taxes on 30 July 2008, the percentage of passenger cars sold in the lowest emissions bands A to C (under 155 g CO_2/km) soared from 41% to 83% (O'Gallachoir *et al.*, 2009). The European Commission has for many years called for the "inclusion of a CO_2 element in car taxes" Europe-wide; however it has not received approval from the European Council and therefore this element of the European Union strategy remains the responsibility of individual member states. In Japan, a tax credit is available for low-emitting and fuel-efficient vehicles, while in the United States tax credits are provided to purchasers of advanced technology vehicles such as hybrid, plug-in electric, or alternative-fuelled vehicles.

As fuel economy standards in many regions are fleet based, with one target value for the overall fleet, it is necessary for manufacturers to sell a significant number of low-emitting vehicles as part of the strategy. Fiscal incentives play an important role in assisting manufacturers to meet their targets by encouraging consumers to purchase low-emitting vehicles. Care must be taken that fiscal incentives are holistic and do not reduce emissions at the expense of other policy goals. In the aforementioned Irish example, diesel sales rose dramatically as a result of the CO_2-differentiated taxes with the significant adverse effects of increasing NOx emissions.

Fiscal measures can be used to promote fuel-efficient vehicles and address the second and third elements of the transport challenge – namely using the vehicle at optimum efficiency and reducing overall vehicle use. Several studies show that taxing on the basis of vehicle use is a cheaper way to reduce vehicle fuel consumption than fuel economy standards (Van Biesebroeck, 2010). Fiscal measures are most commonly found in the form of fuel taxes and, in a more targeted manner, as congestion charging in cities, road pricing on a larger scale or car park pricing. The impact of fuel prices and taxes on transport demand has been extensively studied and while some researchers argue that demand for travel is inelastic with respect to fuel prices since car use has not declined in the face of rising fuel prices, others feel that lower fuel prices would result in increased travel demand. An example often cited is the higher car use in the United States compared with Japan and Europe where fuel prices are significantly higher (Sterner, 2007).

More targeted fiscal measures include road pricing schemes where charges per kilometre can reflect the external costs to transport users. Road pricing can represent a fair way to apply the

polluter pays principle to transport. Cars that produce high emissions per kilometre and are driven during peak traffic in congested areas are charged more per mile compared with clean, efficient models driving on an empty road. The introduction of a road pricing structure and the abolishment of fixed charges, such as vehicle taxes, so that drivers only pay variable charges would present a strong disincentive for car use. For example, the national road-pricing scheme recently proposed in the Netherlands would set charges according to the pollutant emissions and the fuel efficiency of the car, the time of day and location and would incorporate environmental and congestion externalities in the user price.

There are several congestion pricing schemes in operation in cities around the world where cars are charged to drive in a particular zone within a city. Experiences in cities such as London, Stockholm and Singapore show that congestion charging can be quite successful in reducing vehicle trips within a targeted area. The London and Stockholm schemes reduced travel within the zone by between 15-19% and improved travel times by between 18-50% (Eliasson *et al.*, 2008, Transport for London 2009). The main goal of fiscal measures in transport is to disincentivise the use of the vehicle rather than its purchase per se. High fixed charges, such as vehicle taxes and insurance, can actually encourage vehicle use as once the charges have been paid the driver generally feels that he/she should "get use" out of the vehicle. The main challenge associated with transport fiscal measures is that they are generally unpopular with the public and so require political courage to implement.

The IEA recommends that governments ensure their fiscal systems reward the purchase of the most sustainable vehicle technology (considering CO_2 emissions, energy use and air quality) and incentivise the most efficient use of the vehicles.

Modal shift

An important policy goal in transport energy efficiency is to shift passengers and freight from roads to more sustainable modes of transport such as bicycles, efficient public transport, shipping, and rail (called modal shift). It is estimated that the benefits significantly outweigh the costs in many cases. For example, a recent study in the United States estimated that "high quality public transit typically requires about USD 268 in additional subsidies and USD 104 in additional fares annually per capita, but provides vehicle, parking and road cost savings averaging USD 1 040 per capita, plus other benefits including congestion reductions, increased traffic safety, pollution reductions, improved mobility for non-drivers, improved fitness and health" (Litman, 2010). Policy intervention is generally needed to encourage modal shift since market failures result in a higher than optimal level of road transport use. Cheaper fuel prices for many years have been partly to blame for the increase in passenger car and road freight transport use. There are also challenges to achieving modal shift caused by unsustainable land use planning, such as urban sprawl and dispersed rural populations with associated car dependency. Additionally, public transport is often perceived as less attractive in terms of the quality and price of services provided. All these issues need to be addressed with policy measures if passenger and freight modal shift is to occur.

Policies for passenger modal shift generally include improving public transport services and infrastructure and increasing its attractiveness to potential passengers through information campaigns and improving practical features, such as integrated ticketing, real time travel information and lower fares. There have been many studies documenting the impact that policies can have on increasing public transport usage (Hensher, 2007; Nurdden, Rahmat and Ismail, 2007; De Witte, Macharis and Mairesse, 2008). It is often argued in transport strategy

consultations that transport policy measures, such as fiscal measures *e.g.* penalising car travel, should not be implemented unless there are other available modes of transport. Therefore good infrastructure in modes other than road transport is needed if other transport policies are to be implemented.

The IEA recommends that governments develop sustainable transport infrastructure in tandem with other transport and land use planning policies.

Box 7: Policy design

Previous analysis at the IEA and elsewhere has shown that the selection of the right policies is important in achieving maximum energy efficiency potential and the design of the policy and its framework can be equally, or even more, important than the choice of the policy itself.
The following items are of particular importance in transport policy:

- Data collection and assessment

Collection of current status and proper assessment of potential improvements are essential in the first stages of designing a standard. Since each country/region's status varies from others, such as cost effectiveness of technologies, consumer preferences, driving conditions and climate, it is not viable to adopt one target for all. Policies should be ambitious, but need to take account of such differences so as to set the most suitable targets for a specific country.

- Test procedures and technical standards

Fuel efficiency policies need methods to evaluate the performance of vehicles, or components such as test procedures for fuel economy and tyre rolling resistance. Some policies also need technical requirements for vehicle components, such as TPMS and GSI. Certain IEA member countries have established viable test procedures and technical standards. Since vehicles and their components are globally traded, their harmonisation would be important not only for manufacturers but also for governments establishing and/or implementing policies. As discussed in earlier chapters, UNECE/WP.29 and ISO have been playing an important role in this regard.

- Effective enforcement schemes

To ensure effective enforcement of policies, several elements could be considered.
1. Scope of the policy – policy should cover as broad a range of vehicles as possible and not contain loopholes. 2. Regulatory flexibility – a phasing-in approach, attribute-based standards and corporate average scheme, especially for fuel economy standards such as have been adopted in the European Union and United States, could be considered. 3. Technological neutrality – standards should be set according to the performance requirement and not focus on a specific technology.

Freight transport

Shifting freight from energy intensive modes such as road and air to rail and shipping should be a priority for many countries. Freight road transport has significant external costs, even compared with light-duty road transport, particularly in peak hours, and is the source of substantial physical damage to road infrastructure. The policies to shift freight off of roads focus mainly on three areas: (i) improving logistics through the establishment of freight distribution centres and intelligent transport systems; (ii) investing in freight transport infrastructure; and (iii) road pricing and tolls.

The IEA calls for governments to focus on improving the sustainability of freight transport. This will require the provision of infrastructure to assist with improved freight logistics and encourage modal shift.

Summary

In developing further the IEA 25 energy efficiency recommendations for the transport sector, consideration should be given to packages of measures including elements that address all three elements of the aforementioned transport paradigm. These should comprise elements of the policy measures already included in the IEA recommendations and some of those described in this chapter. In particular, policies should incorporate the following actions:

I. the purchase and deployment of the most efficient technologies through minimum technical efficiency standards for the vehicle (fuel economy standards) and related equipment, such as performance standards for tyres and air conditioning systems, combined with good information and fiscal incentives favouring the most efficient technologies;

II. the most sustainable use of vehicles through the substitution of transport fixed charges, such as vehicle taxes, for variable charges in the form of road user pricing and/or fuel taxes; and the promotion of more sustainable energy sources such as renewable fuels and electricity;

III. modal shift to more sustainable modes of passenger and freight transport through investment in public transport and freight distribution infrastructure; improvements in public transport quality and attractiveness; planning land use and construction in conjunction with sustainable transport infrastructure, and public assistance with logistics and intelligent transport systems for freight transport especially.

The particular mix of these policy measures should depend on each individual country's circumstances. For example, countries with smaller vehicle markets and/or no native vehicle manufacturers are technology takers and therefore less able to promulgate advanced fuel efficiency standards, as they do not have the leverage on the global automobile market. In this situation it is likely to be more productive for these countries to focus on how vehicles are utilised and modal shift, as well as ensuring that a minimum energy performance standard is achieved.

Chapter 7. Conclusions

The IEA *Tracking Progress* report, which was published in 2009, on the implementation of the IEA 25 energy efficiency recommendations highlighted the fact that many of the transport energy efficiency policies in IEA member countries had not yet been implemented. Most countries' policies relating to tyres and energy efficiency standards in light-duty vehicles were in the "plan to implement" category, for example. Though the policy of eco-driving was already underway in many countries, heavy-duty vehicle fuel economy standards had yet to be implemented or even planned in several countries. The report therefore proposed that policies were needed in the transport sector to:

- ensure the implementation of planned policies;
- keep tightening existing fuel efficiency standards for light-duty vehicles; and
- create fuel efficiency standards for heavy-duty vehicles.

This paper has updated on progress that countries have made in implementing policy measures in the four IEA transport energy efficiency recommendations.

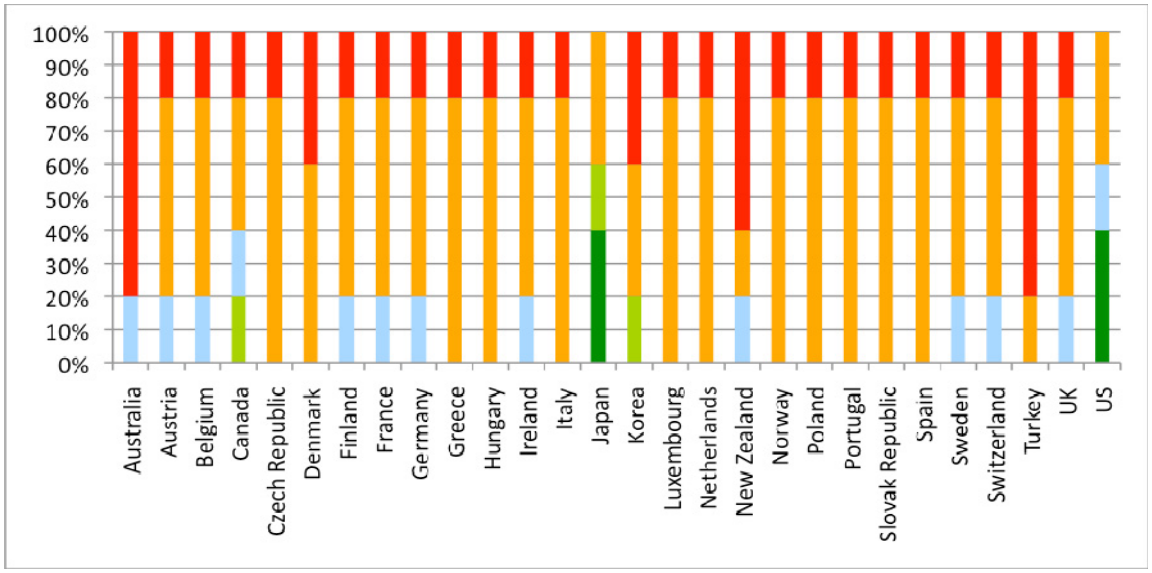
The updated status of implementation of the IEA transport recommendations compared with the progress report in 2009 is illustrated (Figure 18). It is encouraging to see that some progress has been made in implementing the IEA transport sector energy efficiency recommendations since March 2009. The new policy measures that will be, or already are, implemented should result in significant energy savings compared with energy consumption today. In those countries where the policy measures are fully implemented or implementation is underway, energy savings of between 41% to 67% could be realised in specific areas over the ten-year period from 2005/6 to 2015/16. This demonstrates the effectiveness of these policy measures.

The IEA *Tracking Progress* in 2009 showed that 83% of IEA countries were in the "plan to implement" category regarding recommendations for tyres and fuel efficiency. By May 2010, several countries had shifted to the implementation category for one or more of the recommendations and the graph is less red (signifying "not implemented") than in the Progress graph of March 2009.

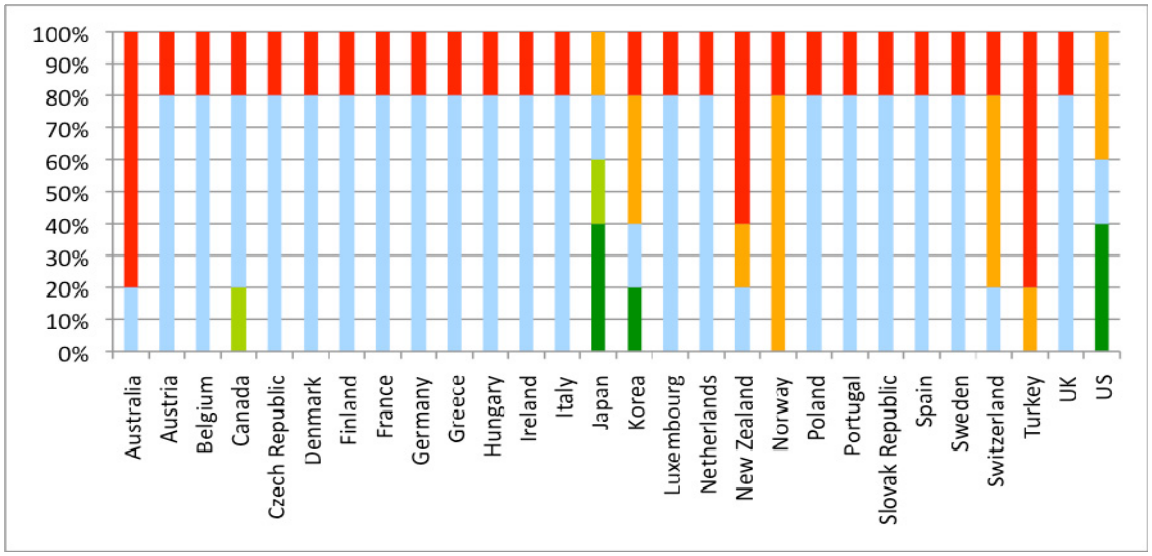
However, there remain several IEA member countries, in particular those outside the main vehicle manufacturing regions, that have implemented very few of the four IEA transport energy efficiency recommendations. The IEA reiterates the call to countries that are not already implementing these energy efficiency recommendations to do so.

Figure 18: Comparison of country progress with implementing applicable transport recommendations

March 2009



May 2010



Fully implemented

Substantial implementation

Implementation underway

Plan to implement

Not implemented

Future work

To date, this work has focused on implementation of the IEA transport energy efficiency recommendations in IEA member countries. Given the importance of the contribution of the transport sector to rising global energy demand and CO_2 emissions, future work could examine the implementation of these recommendations in non-IEA member countries. As transport is a rising challenge to sustainability in many emerging and developing economies, it will be even more important in the future to introduce policies that ensure action on transport energy efficiency outside the IEA.

However, the implementation of policies that are stringent or ambitious is not always a guarantee of success. As noted elsewhere in this paper, the sound design of policies and a comprehensive framework are paramount and should incorporate proper impact assessment, effective enforcement schemes and cost effectiveness, in terms of technology developments, vehicle production and government resources.

Finally, the implementation of the four IEA transport energy efficiency recommendations is a work in progress, as improvements are needed in methods of implementation. It should also be emphasised that even when full implementation of the current IEA transport energy efficiency recommendations has been achieved, there will remain room for improvement.

Fuel efficiency standards can be tightened, tyre programmes can be extended to other auxiliary vehicle components, and eco-driving training can be more frequent and widespread. Monitoring and enforcement of existing policies is crucial to ensure full compliance with the measures. There are also other new policies, not recommended by IEA, which warrant consideration.

This paper raised the idea of using fiscal measures and modal shift as complementary measures. Several countries are already implementing these measures and this idea should be considered further in the review of the IEA energy efficiency recommendations.

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