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The Green Lane: Fuel Efficiency Standards

Vehicle fuel standards are becoming widespread

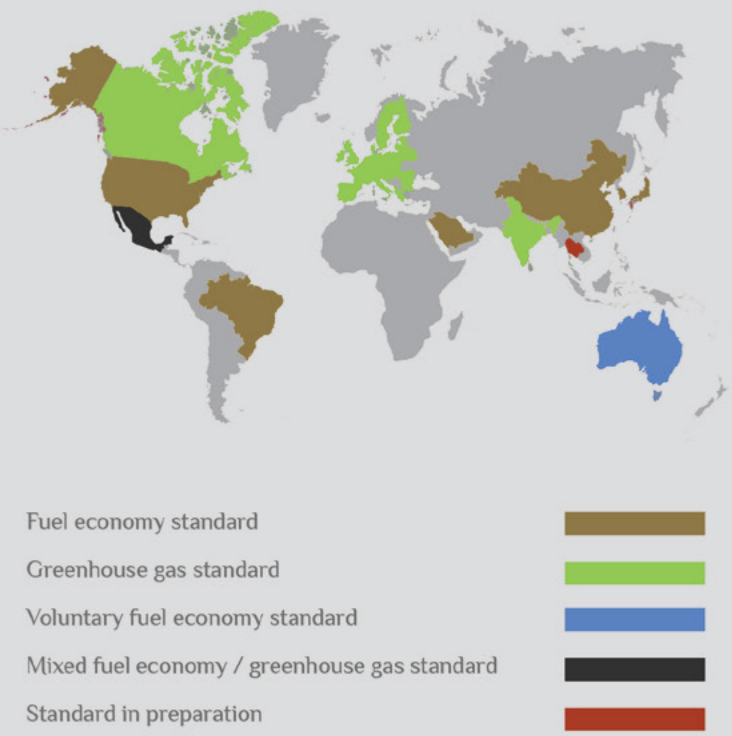
Since the 1970s oil crises, governments have sought to reduce oil consumption to make their countries more resilient to supply disruptions and price spikes. More recently, environmental goals, particularly the reduction of greenhouse gas emissions, have grown in importance.
Governments have adopted three main sets of policies to improve vehicle fuel efficiency. The first, dominant in countries such as Europe, Turkey and Japan, has been high fuel taxation. The second is differential vehicle taxation based on efficiency or a related parameter such as weight or engine size. The third, pioneered in the US in 1975, is the subject of this study - fuel consumption standards imposed on manufacturers.
Twelve countries and regions with more than 75% of global light vehicle fuel consumption, have voluntary or mandatory identified fuel standards .

Labelling schemes are in place, or standards under discussion, in other countries such as Vietnam, Indonesia, the UAE and Chile. Some countries, including Norway, Iceland and Mauritius, have vehicle taxation policies or 'feebate' schemes that reward lower-consuming vehicles at the expense of higher-consuming ones. Surprisingly, eco-conscious New Zealand does not have vehicle fuel efficiency standards while Australia has only a voluntary code.

However, even countries that do not adopt standards will be affected by them, particularly in the case of small vehicle markets without a car industry of their own, adjacent to a large bloc, as in the case of Norway or non-EU south-eastern Europe. Turkey is a large vehicle manufacturer without mandatory standards, but its new cars are similar in emission to Europe's.

On the other hand, policies to accelerate the retirement of inefficient vehicles, such as high differentiated road taxes, can lead to the export of such vehicles to markets without standards. This has been the experience of Uganda, where vehicle fuel efficiency has actually been falling.

FIGURE 01: COUNTRIES WITH FUEL STANDARDS



Equivalently referred to as fuel efficiency or fuel economy standards.
US, Canada, Mexico, Brazil, EU, Saudi Arabia, India, China, Japan, Taiwan, South Korea, Australia (Thailand in preparation)

Standards are still mostly a matter for light, not heavy vehicles

The US, Canada, China and Japan have efficiency standards for heavy-duty vehicles (trucks mostly used for road haulage). The EU began this year to record and certificate HDV emissions, but it will take several years to convert this to mandatory standards. India is in the process of creating such standards.

Global fuel consumption by trucks and buses is about half that of light passenger vehicles, but growing more quickly. The commercial imperatives on haulage businesses mean they are already focussed on fuel savings, and so standards at the manufacturer level may be less important than for individual motorists. Nevertheless, the IEA sees fuel economy for trucks in the US improving more quickly than in the EU up to 2035, because of standards.

The details of standards matter

There are two broad metrics for standards: fuel efficiency (often measured in litres per 100 km driven), and greenhouse gas emissions (grams of CO2 equivalent per km). The main difference between the two is in the fuel type, diesel being more CO2-intensive (though usually more efficient) than gasoline (petrol). Some countries, such as South Korea and Mexico, as well as, the new rules in the US, use a hybrid of the two. Vehicles can be assessed on their weight (as in the EU, India, Brazil and South Korea) footprint (as in North America), or a combination (as in China), with the footprint method having the advantage of encouraging "light-weighting" of vehicles.

And the efficiency can be assessed across a manufacturer's entire fleet, as in the US and EU, or per model as in Japan. The US's Corporate Average Fuel Economy (CAFE) allows manufacturers to bank credits if they exceed standards in a given year, to be used later, trade credits between vehicle classes or firms, acquire additional credits for selling flex-fuel (ethanol-powered) vehicles, or pay a fine if they are unable to comply.

Manufacturers have responded to tightening fuel efficiency standards by improving aerodynamics; reducing weight (for instance through replacing steel with aluminium, plastic and carbon composites); downsizing the engine; improving engine efficiency by methods such as turbo engines with direct fuel injection; reducing rolling resistance; improving electric components and auxiliaries such as air-conditioning and headlights; and injection; reducing rolling resistance; improving electric components and auxiliaries such as air-conditioning and headlights; and introducing automatic engine shut-off when the vehicle is stopped. These techniques have yielded new-car fuel consumption improvements of 1.2% or more annually. Some options such as better tyres and low-friction lubricating oils are not included in standard tests.

On a fleet basis, high-margin high-performance cars can be used to subsidise the cost of smaller, more fuel-efficient vehicles. Dieselisation has been favoured in Europe by fuel taxation policies, but concerns over growing local air pollution and the Volkswagen emissions cheating scandal are likely to reverse this.

Harmonisation of standards and testing regimes across major markets can lower compliance costs. There are three major test cycles: New European Driving Cycle (NEDC) (Europe), CAFE and Japan Cycle (JC08).

The UN has introduced the Worldwide harmonised Light Vehicle Test Cycle (WLTC) which more closely reflects real-world driving and should help to reconcile the differing standards. The EU is expected to shift to this in the next two years.

More dramatic improvements, necessary to meet much tighter US and EU future standards, will probably require the wider introduction of hybrid and electric vehicles. Research for the IEA, MIT and UK government suggests new-car efficiency could improve by 30% by 2020 (over 2005 levels) and 50% by 2050, but the 50% gain

Worldwide standards are continuing to tighten – but with significant gaps between countries

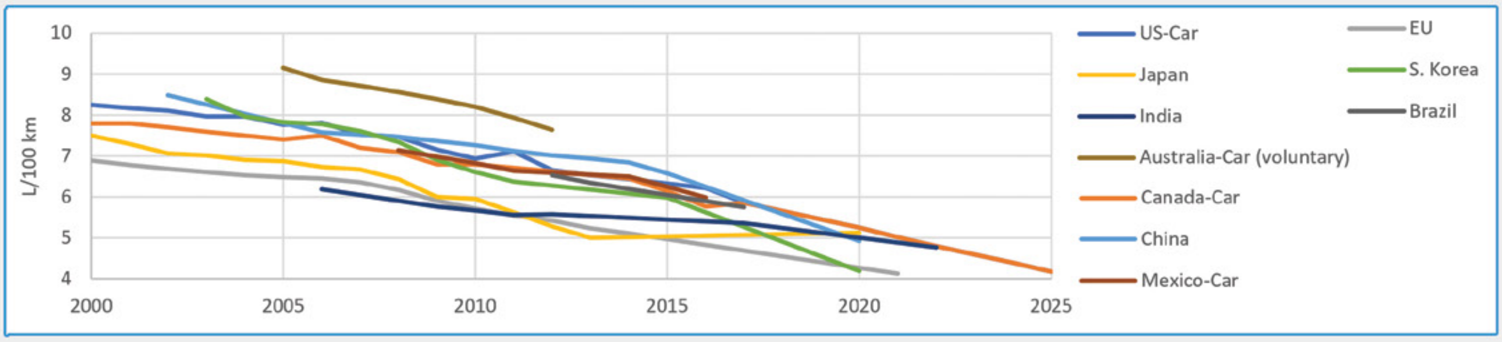
Countries with fuel standards have generally continued to tighten them, although the clarity of guidance on future standards varies. The current EU cycle runs to 2021 and the US and Canada to 2025. Oddly, for cars Japan has already attained its target so future standards are weaker. US standards will see a 4.6% annual reduction in greenhouse gas emissions from 2016 to 2025. The mandated rate of improvement is similar for other countries, though much faster in South Korea.

Standards also vary widely between countries: as Figure 2 shows, the 2021 target for US cars is more than 20% higher than the EU's. China's initially weaker standards tightened rapidly, surpassing the US around 2016. Saudi standards (not shown here) tighten from 7.0 l/100 km in 2016 to 5.9 l/100 km in 2020. Although a substantial improvement, this is still by some way the weakest mandatory standard of those analysed.

The US, EU, Canada, Mexico, China and other countries have separate standards for light-duty vehicles (delivery vans), while the US, Canada, Mexico, Japan and South Korea distinguished light trucks (including SUVs) from cars. This can encourage the migration of drivers from cars to SUVs, having the perverse effect of pushing up overall fuel consumption. The change in CAFE rules introduced by the US in 2011 instead shifted to using a measure of vehicle footprint.

In 2011, the Obama administration boosted CAFE targets from the equivalent of 6.9 l/100 km in 2010 to 6.2 l/100 km in 2016 for cars, with parallel targets for other vehicle types. The Trump administration in the US announced in July that it was considering weakening these standards. One option would be to freeze standards at the 2021 level, 5.0 l/100 km for cars. This, though, would make US-standard vehicles increasingly unsellable in the rest of the world.

FIGURE 02: EFFICIENCY STANDARDS, CARS (NORMALISED TO CAFE)



Standards have a significant effect on future oil consumption

The US Energy Information Administration predicts relatively modest rates of growth in worldwide transport oil consumption. Light passenger vehicle oil use is forecast to grow 1.0% percent annually during 2012 to 2040, buses by 2.1%, two- and three-wheelers (motorcycles and the like) by 1.4%, and heavy goods vehicles by 1.5% per year.

But because of transportation's dominant share of oil use, these growth rates still amount to large absolute increases in oil use.

Total transportation oil demand of about 52.0 Mbpd in 2012 is forecast to increase to 67.8 Mbpd by 2040. Light vehicle demand grows from 23.7 to 31.4 Mbpd, buses from 2.0 to 3.7 Mbpd and trucks from 11.1 Mbpd to 17.0 Mbpd. Total growth in these three sectors of 15.3 Mbpd is almost half the 31 Mbpd total growth in world oil demand foreseen by the EIA in this period.

Tightening fuel efficiency standards, along with other factors, are expected to hold oil demand for transportation in the OECD almost flat to 2040. Though nearly all demand growth is forecast in non-OECD, such standards also reduce consumption growth in countries such as Brazil. If efficiency requirements were tightened in other major non-OECD markets, transportation oil demand could be substantially lower than these projections.

The most important countries for gasoline consumption currently not covered by standards are Russia (834 kbpd in 2013), Indonesia (534 kbpd), Iran (404 kbpd), Malaysia (282 kbpd), Venezuela (238 kbpd), South Africa (208 kbpd), Nigeria (167 kbpd), Iraq (134 kbpd) and the UAE (134 kbpd). Turkey is also a leading vehicle manufacturer and market although its passenger cars run on LPG and diesel more than gasoline. A total of almost 3 million bpd of gasoline use between these ten, larger than any single country other than the US, is 13% of global demand. Theyare priority countries to watch, as the introduction of fuel standards here could have most impact on future global consumption.

Worldwide targets to improve efficiency by 50% by 2050 have to be adjusted by some rebound effects (as described below), and by shifts in the vehicle fleet. Existing projections for oil use also include some allowance for efficiency standards. If achieved, the Global Fuel Efficiency Initiative projects savings of 8.2 million barrels per day by 2050, 24% of the EIA's forecast global light vehicle oil demand in that year. This would reduce global oil demand growth between 2012-50 by about a quarter.

TABLE 01: FUEL EFFICIENCY STANDARDS, SELECTED COUNTRIES

Country	Standard Type	Current/Previous Standard Period and Target	Future Standard Period and Target	Form of Target Curve	Test Cycle
Saudi Arabia	Fuel economy	-	For 2020: 17km/L	Footprint-based corporate average	U.S. combined
China	Fuel consumption	2012-2015 For 2015: 6.9 L/100km	2016-2020 For 2020: 5L/100km	Weight-class based corporate average	NEDC
USA	Fuel economy and GHG emission	2012-2016 For 2016: 36.2 mpg and 225 gCO_2 /mi	2017-2025 For 2025: 55.2 mpg and 147 gCO_2 /mi	Footprint-based corporate average	U.S. combined
EU	CO_2 emission	2012- 2015 For 2015: 130 gCO_2/km	2021 For 2021: 95 gCO_2 /km	Weight-based corporate average	NEDC
India	CO_2 emission	2017 For 2017: 130 gCO_2/km	2022 For 2022: 113 gCO_2/km	Weight-based corporate average	NEDC for low powered vehicle
Canada	GHG emission	2011-2016 For 2016: 217 gCO_2 /mi[1]	2017- 2025 For 2025: N/A	Footprint-based corporate average	U.S. combined
Japan	Fuel economy	2015 For 2015: 16.8 km/L	2020 For 2020: 20.3 km/L	Weight-class based corporate average	JC08

The cumulative impact is important – but there are question-marks

To some extent, fuel efficiency standards and taxation work against each other. Better mileage reduces the cost of driving and so encourages more frequent use of personal vehicles and longer journeys. The 'rebound effect' for individual drivers has been estimated at 10-30% in the long run, so that (for example) a 20% improvement in fuel efficiency leads to 2-6% more driving.With an average vehicle lifespan of about 15 years in the EU and US, improvements in new-car efficiency filter through only slowly to the entire fleet.

Better reliability, and the higher price of new more efficient models, is encouraging motorists to keep their cars on the road for longer, with the US fleet now 11.5 years old on average, further slowing the penetration of improved vehicles. This effect reduces the impact of fuel standards by about 15%.

Efficiency standards can also be criticised for economic inefficiency – especially in the US where fuel taxation is minimal. They impose a cost on manufacturers (ultimately nearly all paid by the consumer) but do not seek out the best or cheapest way of cutting fuel consumption – which can include taking public transport, cycling, walking, moving house to be closer to work, cutting out unnecessary trips, driving more carefully, keeping tyres properly inflated and other behavioural measures that are not incentivised by a vehicle's theoretically better consumption, but which would be encouraged by higher fuel prices.

Unlike fuel taxation, standards also do not raise revenue for the government. However, if motorists do not take fuel costs fully into account when buying a vehicle, standards have a complementary role with taxation. Studies, such as those of the Global Fuel Economy Initiative (GFEI), indicate that a mix of economy standards and vehicle taxation differentiated by emissions levels has led to the highest efficiency gains.

The testing of fuel economy standards has come under criticism for being unrepresentative of real driving conditions, particularly in the wake of the Volkswagen scandal of 2015. More realistic conditions, and more use of on-road assessment, will be required to ensure that fuel standards represent real improvements and not simply gaming of the tests.

At a global level, improving fuel efficiency will lower demand and hence prices, leading to some "rebound" of oil demand. The overall impact of tighter standards cannot simply be assessed, therefore, by applying lower estimates of fuel use per km driven.

Allowing for these factors, fuel efficiency standards may cost the consumer 2-10 times more per litre of fuel (or tonne of carbon dioxide) saved than the use of fuel taxes.

But fuel taxes are already high in Europe and Japan, and face political opposition, while increasing US gasoline taxes has long been seen as political suicide.

An intelligent mix of fuel taxes and economy standards may therefore be the best choice.

Feebate schemes – where a tax on high-consuming vehicles subsidises the purchase of highly-efficient (for instance electric or hybrid) ones can also be used to help offset the higher cost of efficient models.

Private Return on Fuel Standards

The cost of complying with standards has been estimated by the Global Fuel Economy Initiative as $500-2500 per vehicle (average $1500) for an efficiency increase of 15%. For an average EU fuel price around $1.60 per litre (as of August 2017) and a typical efficiency of 5.1 litres/100 km, that implies the additional cost to the motorist would pay back after 122550 km driven, which with average annual European mileage is equivalent to about 10 years. The typical European car has a lifetime of 13.9 years, giving an implied rate of return for the investment of about 7% (assuming no impact on other factors, such as insurance, maintenance or scrappage value).

This is attractive on a societal basis (assuming that the fuel price inclusive of taxation is a fair estimate of its market value plus externalities), but not likely to be compelling for most individual drivers, especially given a lack of visibility on fuel savings. This explains why more fuel-efficient vehicles may not be readily taken up by private motorists.

In countries with lower fuel taxation or (as in Saudi Arabia) subsidised fuel, the payback time would of course be greater. Conversely, the investment would have been more attractive before the fall in oil prices from mid-2014.

Conclusions

Fuel efficiency standards are well-established as an energy policy tool through most of the major oil-consuming markets, representing more than three-quarters of light vehicle fuel consumption. They are present in two of the largest growth markets, China and India, and will likely spread to other emerging non-OECD economies in the years to come. They are designed to reduce macroeconomic and security vulnerability to oil shocks, and, more recently, to reduce greenhouse gas emissions from the rather intractable ground transport sector.

These regulations are being met by technical improvements in engine and vehicle design in internal combustion engine-powered vehicles, and by changes in fleet composition. However, the more aggressive future targets will require an increasing move to hybrid, electric or other alternative (e.g. fuel cell) vehicles. Heavy-duty vehicles are also likely to be drawn more into the ambit of regulations, although the overall impact will be less given the existing commercial incentive for haulage companies to save fuel.

Such standards have theoretical and practical problems, and the implied rates of return (or cost of greenhouse gas emissions avoided) often appear relatively unattractive compared to other measures. The practical problems are being addressed by improvements in standards design and testing procedure.

Fuel taxes are a theoretically preferable way of incentivising efficiency. However, given that vehicle innovation occurs mostly at the level of the manufacturer, that motorists may not fully value long-term savings versus a higher up-front cost, and that high fuel taxes are politically unappealing in many countries, efficiency standards are a valid tool as part of policy. Up-front purchase or registration taxes on inefficient vehicles, possibly combined with rebates for more efficient ones, are also widely used.

Fuel saving potential is significant, with standards set to improve 4.6% per year in the US. They have a significant role in keeping OECD fuel demand essentially flat to 2050, in EIA projections. If widely adopted and tightened in non-OECD, light-vehicle standards would also cut the projected future growth in that market, and reduce global oil demand in 2050 by an estimated 8.2 million barrels per day, reducing overall demand growth by a quarter.

Fuel efficiency savings are partly offset by 'rebound' effects. In a world of much greater efficiency gains, the consequent fall in oil demand and prices would be likely to spur other consumption, both inside and outside the transportation sector. However, instead of a simple linear extrapolation of the impact, if standards spur the adoption of electric vehicles to the point of widespread competitiveness, a major segment of the oil market would dry up.