Promotion of Energy Efficient Vehicles

Annex A of the Handbook 'Navigating Transport NAMAs'

TRANSfer Project – Towards climate-friendly transport technologies and measures

The concept

Fuel economy improvements in vehicles reduce the energy consumption per vehicle kilometre and thus improve the GHG performance of transport vehicles. The fuel efficiency of vehicles is best measured as energy use per vehicle kilometre (MJ/km), which is a fuel neutral measure.

Some instruments to promote energy-efficient vehicles target the existing vehicle fleet, whereas others intend to improve the fuel economy of new vehicles. Thus, the different instruments can complement each other and synergetic effects can be realised. Furthermore, a combination of several instruments can help to reduce rebound effects. For instance, fuel economy improvements can lead to vehicle upsizing, which can be limited by imposing taxes on vehicles according to their absolute CO_2 emissions. Additionally, fuel pricing, road pricing or carbon taxes can reduce rebound effects associated with fuel economy improvements.

Elements of a promotion of energy-efficient vehicles

- Implement vehicle fuel economy standards;
- Tax vehicles according to their CO_2 emissions;
- Incentivise scrappage of inefficient vehicles;
- Introduce vehicle labelling.

For more details on the elements' characteristics see Box 1.

Energy efficiency improvement of vehicles can address bot passenger and freight. For instance, the Japanese government introduced a separate fuel economy standard for heavy-duty vehicles (IEA, 2009).

Table 1: GHG reduction matrix of measures to promote energy-efficient vehicles

	Avoid	Shift	Improve
Direct effects			☑ Enhances the fuel economy of new vehicles ☑ Accelerates the turnover towards more efficient vehicles
Indirect effects			☑ Emission-based vehicle taxation limits increases in vehicle size, weight and power
Rebound effect	☒ Fuel economy improvements lead to reduced cost of vehicle use and can foster an increase in transport activity	☒ Fuel economy improvements lead to reduced cost of vehicle use and thus can foster travel by car	☒ Fleet turnover can lead to vehicle upsizing and the use of energy intensive devices ☒ Scrappage programmes reduce the future fleet turnover
Complementary measures *(to achieve full mitigation potential)*			☑ Decreasing the carbon intensity of fuels (see Factsheet 'Decreasing the Carbon Intensity of Fuels') ☑ Sustainable fuel pricing (see Factsheet 'Sustainable Fuel Pricing')

On behalf of

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

Box 1: Possible elements to promote energy-efficient vehicles

Implement vehicle fuel economy standards

Vehicle fuel economy standards address new vehicles and aim to encourage the automotive industry to invest in technological improvements. Standards have been implemented in several countries (*e.g.* South Korea, China, Japan, United States and the European Union). Some of the standards are mandatory, whereas others are based on voluntary commitment (IEA, 2009). Different design schemes for fuel economy standards are applied. Some standards limit CO_2 emissions per kilometre. However, vehicle manufactures cannot influence upstream emissions of different fuels. Thus, emission-based standards are inadequate. Distance-based targets (*e.g.* km/l or l/km) are best implanted in fuel per specific distance (litre per 100 km) to satisfy the fact that fuel consumption is not a linear function of distance travelled. However, energy intensity (MJ/km) based vehicle standards are better, since they are fuel neutral (Creutzig *et al.,* 2011).

How it works and intended effects:

- Increases the vehicle fuel economy of new vehicles;
- Promotes rapid technology adoption;
- Avoids increases in vehicle size, weight and powerReduces GHG emission per vehicle kilometre of new vehicles.

To be considered for implementation:

- The instrument is cost neutral;
- Vehicle manufacturers need some time to apply new technologies and adapt their vehicle design;
- Timescale for the effect depends on the fleet turnover rate (fleet turnover can be spurred by scrappage programmes).

Responsible actor: Environmental ministries

Tax vehicles according to their CO_2 emissions

Annual vehicle taxes and vehicle registration taxes that are based on CO_2 emissions encourage consumer to purchase more efficient vehicles. Larger, more polluting and fuel consuming vehicles are charged higher tax rates than less polluting vehicles*).

A special form of emission-based taxation is a feebate system, which provides a rebate on the purchase of fuel-efficient, less polluting vehicles funded by a surcharge on the purchase of fuel-inefficient vehicles to modify consumers' preferences in favour of cleaner cars. In 2008, France introduced a feebate system called '*Bonus/Malus*'. The most polluting vehicles were subjected to a taxation of EUR 2 600 (USD 3 400) whereas the cleaner vehicles benefited from a rebate of EUR 1 000 EUR (USD 1 300) (Boutin *et al.,* 2010).

How it works and intended effects:

- Encourages consumers to purchase fuel efficient vehicles;
- Shift in consumer demand that encourages producers to enhance the fuel efficiency of their vehicle models;
  - ➔ Increases the fuel efficiency of new vehicles;
- Increases the turnover rate of the vehicle fleet;
  - ➔ Lowers the GHG emissions of the overall vehicle fleet.

To be considered for implementation:

- The instrument is usually cost neutral;
- First effects can be realised within a short timeframe;
- Effect can be increased if the measure is combined with vehicle fuel economy standards.

Responsible actor: Ministries of finance and taxation

*) For instance, Ireland introduced a carbon based tax system in 2008 that charges EUR 2 000 (≈ USD 2 600) for gas-guzzlers and taxes vehicles below 120 g CO_2/km only EUR 100 (≈ USD 130) (Giblin and McNabola, 2009).

Incentivise scrappage of old vehicles

Old, inefficient vehicles usually have disproportionally higher GHG emissions. Scrappage programmes, under which an incentive is paid to owners who scrap their old car, can speed the fleet turnover towards cleaner vehicles. It is essential that the scheme includes a requirement to replace the vehicle with one that is more fuel efficient and low CO_2 emitting. Furthermore, it would be best if the vehicle exchange is limited to the same or lower weight categories. It has to be noted that fleet renewal is reduced after the phase out of the programme (Nemry *et al.,* 2009).

Instead of rebates on the replacement car also other rewards can be offered such as free public transport passes or rebates on bicycles.

How it works and intended effects:

- Increases the vehicle fleet turnover rate;
  - ➔ The share of fuel efficient vehicles in the national fleet increases more rapidly.

To be considered for implementation:

- Very costly;
- First effects can be realised within a short timeframe;
- To realise considerable GHG reductions the instrument is best combined with fuel-efficiency standards.

Responsible actor: Ministries of finance and taxation

Introduce vehicle labelling

Eco-labelling for vehicles based on fuel economy or CO_2 emissions can promote cleaner vehicles. A simple rating system informs consumers about the different vehicles available and encourages them to include efficiency and emission characteristics in their purchase decision. A labelling system alone is unlikely to lead to a considerable increase in the average fuel efficiency**). However, a labelling system can be successful if an efficiency or emission-based vehicle tax (see above) is in place. Then, the difference in annual cost indicated on the label can trigger a positive purchase decision (IEA, 2009).

How it works and intended effects:

- Influences the vehicle purchase decision;
- Incentivise vehicle manufactures to produce efficient vehicles;
  - ➔ Reduces GHG emissions per vehicle kilometre of new vehicles.

To be considered for implementation:

- Vehicle labelling schemes can be applied on the level of vehicle manufactures or traders;
- Costs arise for the design of the labelling scheme and the vehicle evaluation.
- The reduction potential is low if the instrument is not combined with other measures.

Responsible actor: Environmental ministries

**) In the US the fuel efficiency worsened in the past 20 years, although a labelling system is in place.

GHG mitigation effect and co-benefits

The GHG mitigation effect of the different instruments to improve the vehicle fleets' fuel economy depends largely on the design of the instrument. Comparing current GHG emissions of passenger vehicles and future standards reveals that there is a huge GHG reduction potential. For instance, in 2002 new passenger vehicles in Japan emitted on average less than 160 g CO_2e/km, as opposed to 260 g CO_2e/km in the US. If Japan's fuel economy standard is met, the country will reduce the average emission of new vehicles to 125 g CO_2e/km in 2015 (An *et al.,* 2007). Europe set an average limit of 130 g CO_2e/km, which has to be met by 2015. Moreover, non-motor technological measures such as efficient tires or gearshift indicators should reduce average emissions by additional 10 g CO_2/km. For 2020 the European Commission sets a target for the average emissions for the new car fleet of 95 g CO_2/km (EC, 2009). Rodt *et al.,* (2010) assume that the European energy efficiency standards for passenger cars would lead to a CO_2 emission abatement of 5.8 million tonnes in 2020 compared to current emission trends in Germany. In 2030, CO_2 emission mitigation is projected to reach 10.8 million tonnes. This equals 6% and 13% less emission from German passenger car traffic compared to the baseline scenario in 2020 and 2030 respectively. Of course, the GHG impact of fuel standards depends on the tightness of the limit and the current fuel economy of new vehicles.

The effect of emission–based taxation depends largely on the level of the financial incentive provided. Studying Ireland's carbon-based vehicle taxation, Giblin and McNabola (2009) found that the scheme could lower CO_2 emissions by 3.8% for petrol vehicles and by 3.6% for diesel vehicles.

The different instruments towards higher fuel economy of the national vehicle fleet can be associated with various co-benefits:

- Decrease in local air pollution;
- Reduction in oil dependency and lower expenses for oil imports;
- Reduced individual expenses for transport fuels;
- National car manufacturers become international pioneers in energy-efficient vehicles.

Towards implementation

Some of the instruments are designed to target individual consumer behaviour and others address vehicle manufacturers and car dealers. Emission-based vehicle taxation, vehicle labelling and scrappage programmes for old and inefficient vehicles, intend to persuade motorists to buy vehicles that have a higher fuel-efficiency. In contrast, vehicle fuel economy standards address vehicle manufactures. They have to comply with the standard and bear the costs of non-compliance.

Key stakeholders

- National environmental ministries:
  Responsible for vehicle labelling and the introduction of vehicle fuel economy standards.
- National ministries of finance and taxation:
  Typically responsible for the design and enforcement of vehicle taxation schemes; has to provide financial resources for vehicle scrappage programmes.
- National ministries of economics and technology:
  Promotes innovations and new technologies for energy-efficient vehicles.

Table 2: Potential barriers to implementation and countermeasures

Barriers	Options to overcome
Strong opposition from the vehicle industry against fuel economy standards	■ Support the vehicle industry in financing R&D projects for fuel efficient vehicles; ■ Show strong political leadership; ■ Use public support[a)] to enforce the instrument;
Strong opposition from the public against emission-based vehicle taxation	■ Combine emission-based taxation with scrappage programmes that offer short term (vehicle purchase) and long term (fuel cost) benefits for participants; ■ Information campaigns that inform about fuel savings from low-emission vehicles;
Difficulties to include alternative fuelled vehicles in the scheme[b)]	■ Avoid vehicle fuel economy standards that are based on litres or gallons of fuels[c)]; ■ Avoid CO_2 based vehicle fuel economy standards, since it neglects the differences in upstream emissions from alternative fuels[d)]; ■ Implement energy-intensity based fuel economy standards (MJ/km), which are fuel neutral;
Lack of financial resources to provide scrappage incentives	■ Cooperation with car producers (*e.g.* in Spain manufactures paid 50 % of the scrappage incentive);

a) Typically, consumers favour fuel economy standard, since they can provide financial benefits due to lower fuel expenditures.

b) Vehicle fuel economy standards and emission-based vehicle taxation are usually designed for gasoline and diesel vehicles assuming a certain carbon content per litre of fuel. Electric and fuel cell vehicles cannot be evaluated in terms of litre of fuel or GHG emissions and thus in the long run such vehicle standard is not adequate.

c) Volume based fuel economy standards neglect alternatives like electric vehicles and fuel cell vehicles and are disadvantages for biofuels that have a lower energy density than diesel and petrol (Creutzig *et al.,* 2011).

d) Emission-based standards that include only the tank to wheel emission cannot cover alternative vehicles such as electric vehicles, since upstream emissions are not covered.

Success factors

- Proper design of the evaluation scheme for vehicle fuel economy;
- Design instruments in a way that they properly include alternative fuels;
- Tax differences between low-emission vehicles and gas guzzlers need to have an appropriate level to induce an effect on the vehicle fleet;
- Scrappage programmes have to include strict regulations for the replacement vehicle (low-emission, high fuel economy, no upsizing)[1];
- Penalties for non-compliance to vehicle fuel economy standards have to be higher than the corresponding compliance cost (Creutzig *et al.,* 2011).

Practical examples: Fuel economy standards in Japan and Hong Kong's FRT

Japan introduced a fuel efficiency standard for light duty vehicles in 1999, which sets targets for distance travelled per unit of fuel (km/l) for petrol and diesel vehicles (IEA, 2009; Creutzig *et al.,* 2011). The standard is differentiated according to vehicle weight classes and the target fuel efficiency level is based on the most fuel-efficient vehicle in the respective class. The most efficient vehicle of one year set the level for the standard of the next year. Vehicle manufactures have to meet the target value by an average of all cars sold within a weight class (IEA, 2009). The Japanese fuel economy standard is one of the tightest standards worldwide (see Figure 1). Manufacturers had more than 10 years to adapt their vehicle fleet to the new standard. Since 2010, penalties are raised for non-compliance. In 2007, the standard was updated and a new target was set, to be met by 2015. A special standard for trucks was introduced in 2006 (to take effect in 2015), so that the system covers nearly all road vehicles. In the past, average annual improvements amounted to a reduction of 1.8 % in g CO_2/km (IEA, 2009).

[1] For instance, Italy designed a scrappage programme, which required the replacement vehicle to emit less than 120 g CO_2e per km. The US scrappage programmes includes a fuel efficiency requirement that demands a fuel economy improvement of 5 to 9 miles per gallon (Allen *et al.,* 2009).

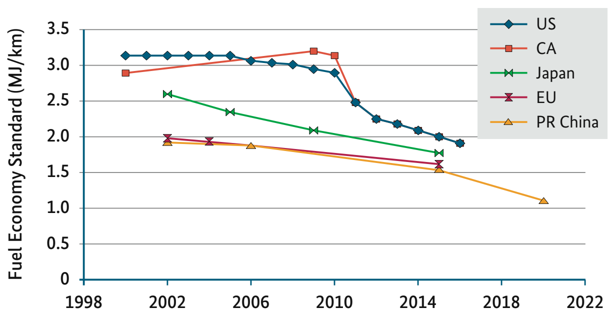

Figure 1

Fuel economy standards in units of energy intensity, extrapolated from current volume and GHG standards. (1 l gasoline= 32 MJ)

Source: Creutzig *et al.*, 2011

Hong Kong implemented a tax incentive scheme for private low-emission petrol cars in 2007. The First Registration Tax (FRT) is reduced by 45 % if the vehicle meets specific emission standards: a) hydrocarbon and nitrogen oxide emissions may not exceed 50 % of the Euro 4 emission standard[2] and b) fuel efficiency has to be at least 40 % better than the average efficiency in the respective vehicle weight class (EPDHK, 2011a). In 2008, the government extended the tax incentive scheme to commercial vehicles including taxis, goods vehicles and buses. Special limits for atmospheric pollutants were introduced for commercial vehicles and FRT rebates were set to 100 % for taxis and buses, and to 50 % for goods vehicles, excepting vans (EPDHK, 2011b). In this way, the government tried to cut roadside air pollution in Hong Kong and to reduce the GHG emissions from transport.

[2] The European emission standard Euro 4 limits emissions of hydrocarbons to 0.10 g/km and emissions of nitrogen oxides to 0.08 g/km for private petrol cars.

IAA Frankfurt – Photo by Jonathan Gómez, 2011

Further reading

- **Allan, A., Carpenter, R. and. Morrison, G.M. (2009)** '*Abating Greenhouse Gas Emissions through Cash-for-Clunker Programs*'. Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-09-26.
- **An, F., Gordon, D., He, H., Kodjak, D., Rutherford, D., (2007)** *Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update*, International Council on Clean Transportation, Washington, DC.
- **Boutin, X., Haultfoeuille, X., and Givord, P. (2010)** '*The Environmental Effect of Green Taxation: The Case of the French Bonus-Malus*', Proceedings of The 11th CEPR Conference on Applied Industrial Organization, Toulouse, France, 29 May 2010.
- **Creutzig, F., McGlynn, Minx, J. and Edenhofer, O. (2011)** '*Climate policies for road transport revisited (I): Evaluation of the current framework*', Energy Policy, vol. 39, pp. 2396–2406.
- **EPDHK – Environmental Protection Department Hong Kong (2011a)** '*Tax incentive for environment-friendly petrol private cars*' http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/environment_friendly_private_cars.html accessed 11 October 2011.
- **EPDHK – Environmental Protection Department Hong Kong (2011b)** '*Tax incentive for environment-friendly commercial vehicles*' http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/environment_friendly_commercial_vehicles.html accessed 11 October 2011.
- **Giblin, S. and McNabola, A. (2009)** '*Modelling the impacts of a carbon emission-differentiated vehicle tax system on CO_2 emissions intensity from new vehicle purchases in Ireland*', Energy Policy, vol. 37, pp. 1404–1411.
- **IEA – International Energy Agency (2009)** *Transport Energy and CO_2 – Moving toward sustainability*, IEA, Paris.
- **Nemry, F., Vanherle, K., Zimmer, W., Uihlein, A., Genty, A., Rueda-Cantuche, J. M., Mongelli, I., Neuwahl, F., Delgado, L., Hacker, F., Seum, S., Buchert, M., Schade, W., (2009)** '*Feebate and Scrappage Policy Instruments*', JRC Scientific and Technical Reports, EUR 23896 EN.
- **Rodt, S., Georgi, B., Huckestein, B., Mönch, L., Herbener, R., Jahn, H., Koppe, K. and Lindmaier, J. ()** '*CO_2-Emissionsminderung in Deutschland – Mögliche Maßnahmen und ihre Minderungspotentiale*' UBA, Dessau-Roßlau.

Contact

E transfer@giz.de
I http://www.TRANSferProject.org

Imprint

Editor:
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

P. O. Box 5180
65726 ESCHBORN / GERMANY
T +49-6196-79-0
F +49-6196-79-801115
E transport@giz.de
I http://www.giz.de