## Technology Fact Sheet for Mitigation

### K. Fuel Efficient Gasoline Powered Vehicles [i]

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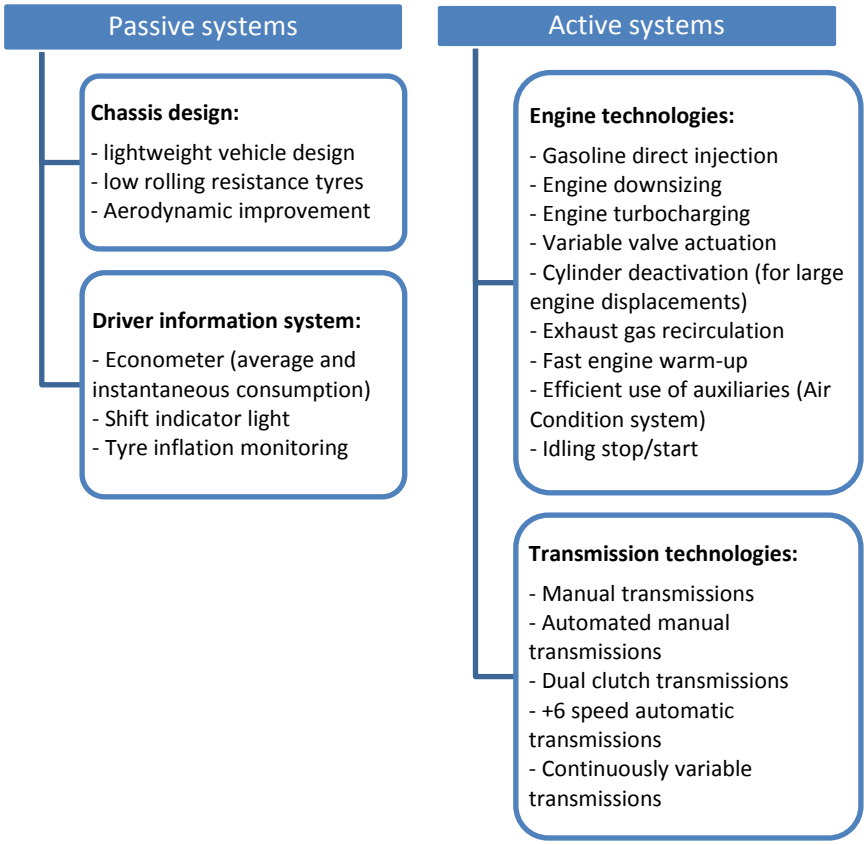
|---|---|
| **Sector : Transport** | |
| **Subsector : Advanced powertrains for passenger cars** | |
| **Technology characteristics** | |
| Introduction | Fuel efficiency terminology means the efficiency of the process within internal combustion engines for converting chemical energy contained in fuel into mechanical energy to drive the vehicle. It is given in km/l or in its reciprocal form in l/100km, known by fuel consumption.<br>Though fuel efficient vehicles are commonly known by vehicles with low consumption (estimated < 6,5 l/100km), fuel efficient vehicles are intended to cover all conventional gasoline vehicles equipped with advanced technologies and presenting advantages of consumption and emissions reduction comparing to similar vehicles within same vehicle class (two-seaters, subcompact, compact, mid-size, full-size, station-wagon).<br>Advanced technologies are classified as passive and active systems (Figure 1). Passive systems have indirect impact on reducing fuel consumption, like reducing the vehicle weight; and active systems have direct impact on consumption reduction like engine idle stop/start systems and automated manual transmissions.<br>  <br><br>Figure 1. Passive and active systems technologies of fuel efficient gasoline powered vehicles. |

<table>
<tr><td>Technology characteristics</td><td>Fuel efficient gasoline powered vehicles offer several advantages:<br>· No major modifications within the power train (similar to conventional vehicles); hence, drivers don't have to adapt their driving techniques to these new technologies.<br>· Technologies can be applied on the basis of modular flexibility where different combination of features (listed in figure 1) can be observed.<br>· With the addition of stop/start systems, combinations of technologies and the use of turbo charging technology to downsize the engine lead to 15-25% improvement compared to today's gasoline engines.<br>· Additional costs are observed according to the added features, but still cheaper than alternative technologies like hybrid vehicles. Including the different available technologies into the gasoline engine results in a cost increase up to 150% of the baseline value.</td></tr>
<tr><td>Operation and maintenance</td><td>Operation and maintenance are similar to conventional gasoline powered vehicles. No exceptional trainings or adaptations are required. However, as for conventional vehicles, regular maintenance for fuel efficient vehicles is required in order to ensure optimal operation.</td></tr>
<tr><td>Endorsement by experts</td><td>Fuel efficient vehicles are endorsed by automotive manufacturers, in order to avoid paying excess emissions penalties.</td></tr>
<tr><td>Disadvantages</td><td>· Additional costs comparing to conventional natural aspirated engines<br>· Sources of energy savings are still not exploited in conventional vehicles (i.e. brake energy losses)<br>· Still depending on fossil fuels<br>· Encourage use of private passenger cars if intelligent taxation policies are not adopted</td></tr>
<tr><td colspan="2">Capital costs</td></tr>
<tr><td>Additional cost to implement mitigation technology, compared to "business as usual"</td><td>It is not simple to gather cost database of technologies used for fuel efficient cars. Table 1 summarizes the additional costs of some of these technologies compared to conventional technologies.<br>Table 1. Costs of technologies used in fuel efficient gasoline vehicles.
<table>
<tr><th>Technology</th><th>Fuel savings</th><th>Additional Cost/car</th></tr>
<tr><td>Continuous Variable Transmission</td><td>7%</td><td>150-200 USD</td></tr>
<tr><td>Dual clutch transmission (DSG)</td><td></td><td>5500 USD</td></tr>
<tr><td>6-Speed Automatic Transmission</td><td>4-5%</td><td>100-500 USD</td></tr>
<tr><td>Gasoline direct injection</td><td>3-4%</td><td>125-175 USD</td></tr>
<tr><td>Lightweight material</td><td>4-8%</td><td>200-500 USD</td></tr>
<tr><td>Engine downsizing + turbo charging</td><td>10-15%</td><td>up to 150% of the baseline gasoline engine</td></tr>
</table></td></tr>
<tr><td colspan="2">Development impacts, direct and indirect benefits</td></tr>
<tr><td>Cost benefits</td><td>Figure 2 illustrates the operating cost savings of different fuel efficient gasoline vehicles, compared to the world average new vehicle fleet operating cost of 2005. With the current fuel price trend (~1.2 USD/liter), over 250 USD could be saved per</td></tr>
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year with mini-, sub-compact and compact cars.

Note that additional savings are achieved by comparing to the average fuel consumption cost of the whole 2005 Lebanese car fleet, since the average consumption far exceeds the world average of 8.07 l/100km.

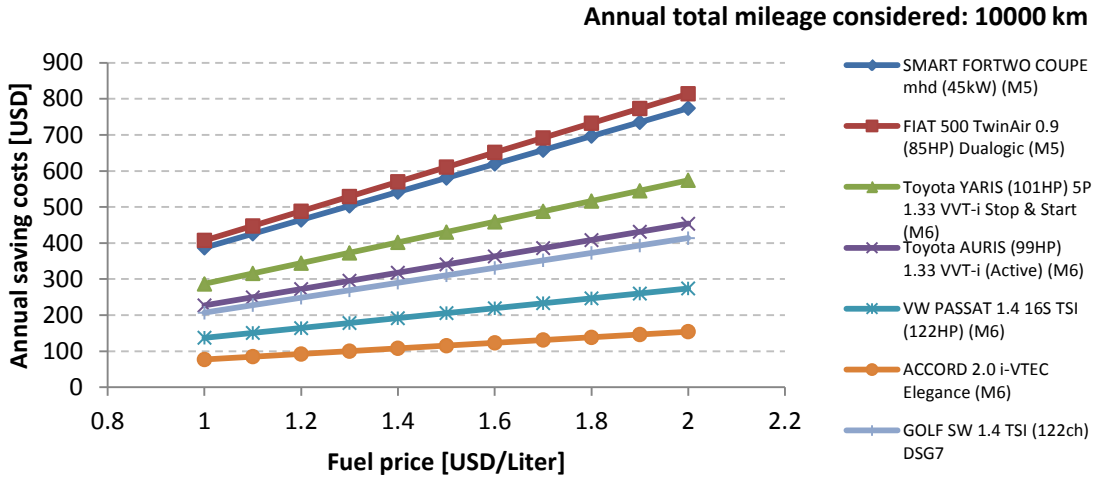


Figure 2. Annual operating saving costs comparing to 2005 new fleet world average, as function of fuel price, with an annual mileage estimated 10000 km.

Environmental benefits

Fuel and CO2 savings range from 5 to 50%, depending on the vehicle segment.

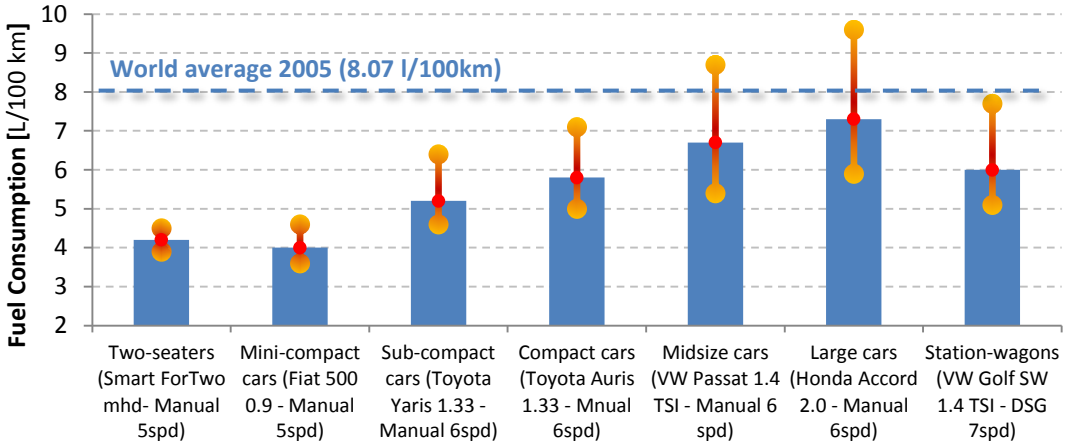


Figure 3. Fuel consumption of fuel efficient gasoline powered vehicles, compared to world average of 2005 new cars fleet. (*blue: FC of combined cycle, lower value: highway cycle, higher value: urban cycle*)

**Local context**

Status

Lebanese passenger cars market is far from exploiting the potential of fuel efficient vehicles.

- The distribution of engine displacement of the Lebanese car fleet of 2007 (table 2) shows that only 8% of car engine displacements are less than 1.4 liters, where this share is 65% in the French car fleet. In addition, 60% of the cars are equipped with oversized engines (>2.0 liters) with a 13 years old average age.

Table 2. Distribution of 60% of the engine displacement of the 2007 Lebanese car fleet.

| | <1.4 | 1.4-2.0 | 2.0-3.0 | >3.0 |
|---|---|---|---|---|

| | |
|---|---|
| | <table><tr><td>**Engine displacement classes distribution**</td><td>8%</td><td>32%</td><td>48%</td><td>12%</td></tr></table><br>·<br>· New car buyers are not informed on vehicle efficiency ratings, fuel economy, emissions ratings, annual operating costs, etc. In addition, though information on power train technologies and transmission technologies are sometimes mentioned, they are not highlighted. Such awareness has direct influence on decision-making while buying a new car; results are observed in the French car fleet where 65% of engines are lower than 1.4 liters.<br>· It is estimated that 50000 of pre-owned cars are imported to Lebanon per year. Recently, most of these cars are imported from the US market, characterized by been heavy/luxury cars with engine displacement above 2.0 liters.<br>· Unfortunately that there are no available information on the passive or active systems of fuel efficient vehicles of the Lebanese car fleet, like the share of manual/automatic transmissions. However, it is noticeable particularly from sale of new vehicles that automatic transmissions share the Lion's part. |
| Timeframe | **Short term implementation**<br>Fuel efficient vehicles' implementation could start immediately. No specific infrastructure is requested. However, adequate taxation policies and car fleet renewal scheme can improve the implementation of these technologies. Many examples can be consulted worldwide, notably the "bonus-malus"/"prime à la casse" French programs, the "*Umweltprämie*" German program and the "US *CARS*" US program. |

[i] **This fact sheet has been extracted from TNA Report – Technology Needs Assessment Reports For Climate Change Mitigation – Lebanon. You can access the complete report from the TNA project website http://tech-action.org/**