Review of in use factors affecting the fuel consumption and CO_2 emissions of passenger cars – On going study

Brussels 9 December 2014

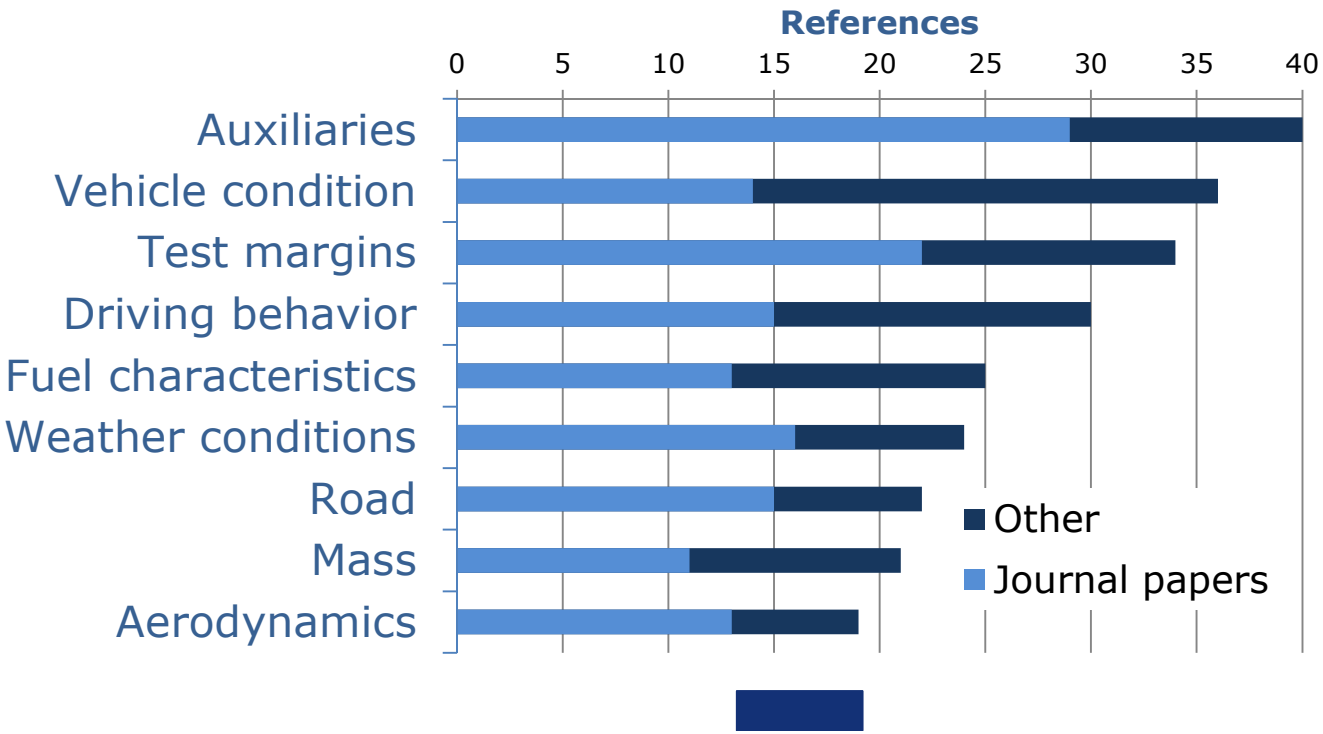
Nikiforos.Zacharof@jrc.ec.europa.eu
Georgios.Fontaras@jrc.ec.europa.eu

Introduction

- *Shortfall in fuel consumption between type approval and real world conditions*
- *Reasons for the shortfall*
- *Many factors are already identified*
- *On going work to better assess impacts*
- *Targeted actions to reduce unnecessary fuel consumption*

Literature review

Approximately 220 references were reviewed consisted of journal papers, scientific, industrial and government publications and magazines

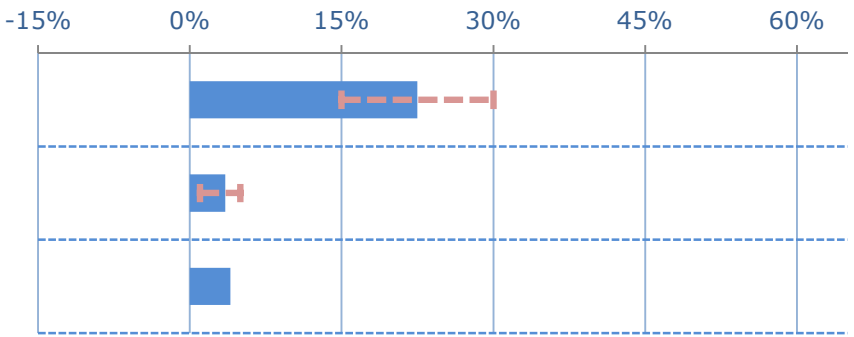


Average year 2009

Certification test margins

- *Smooth driving pattern and increased idling*
- *Auxiliary systems are not used*
- *High test temperature*
- *Other test related margins*

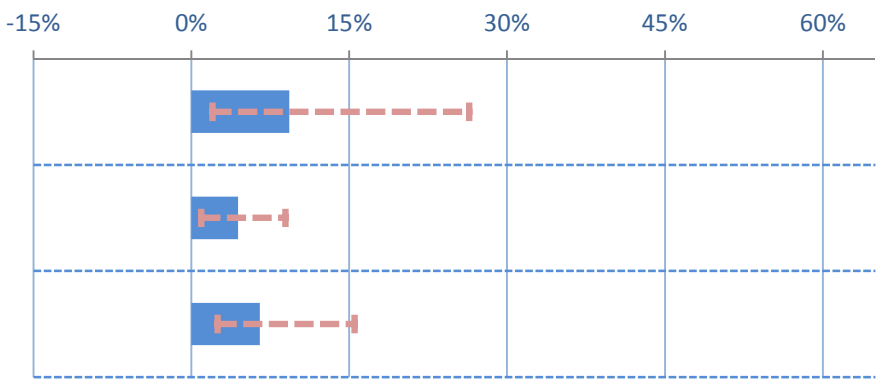
Factors	*Effect on FC*
NEDC design & conditions	*22.5%*
Various factors	*4%*
Lower declared values	*4%*



Auxiliary systems

- *Steering is not included in type approval test*
- *Mandatory use of other auxiliaries (e.g. headlights, wipers)*
- *Energy consumption is variable*

Factors*	***Effect on FC***
Air conditioning	*9.3%*
Steering assist systems ***(HPAS, EHPAS, EPS)***	*4.5%*
Other ***(headlights, wipers, etc.)***	*6.5%*

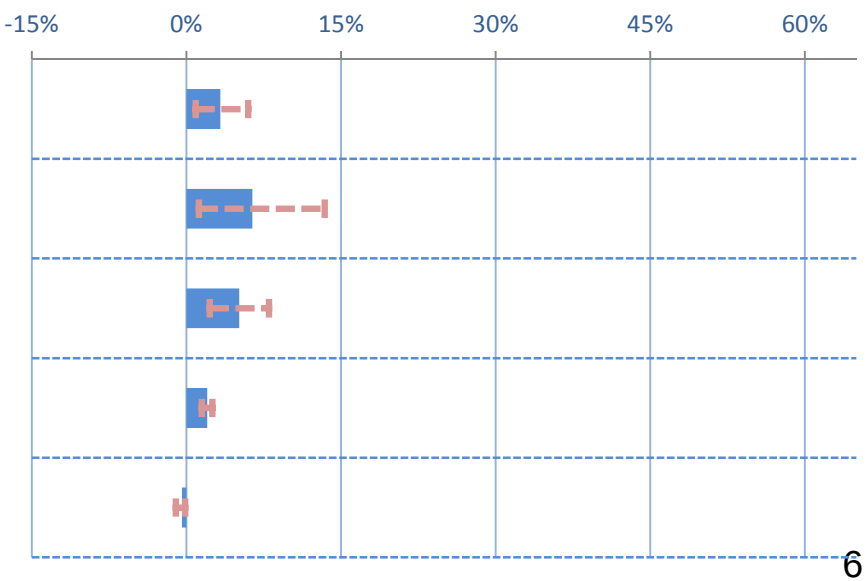


** For continuous usage in reality specific usage factors apply for each individual auxiliary which reduce the effect when considering an average use*

Aerodynamics

- *Vehicle's aerodynamic design*
- *Speed of the vehicle*
- *Speed and angle of the wind*

Factors	*Effect on FC*
Roof add - ons *(various objects)*	*3.3%*
Roof boxes *(unladen)*	*6.4%*
Open windows	*5.1%*
Sidewinds effect *(wind velocity, angle)*	*2.0%*
Improvements *(spoiler, Vortex generators)*	*-0.4%*



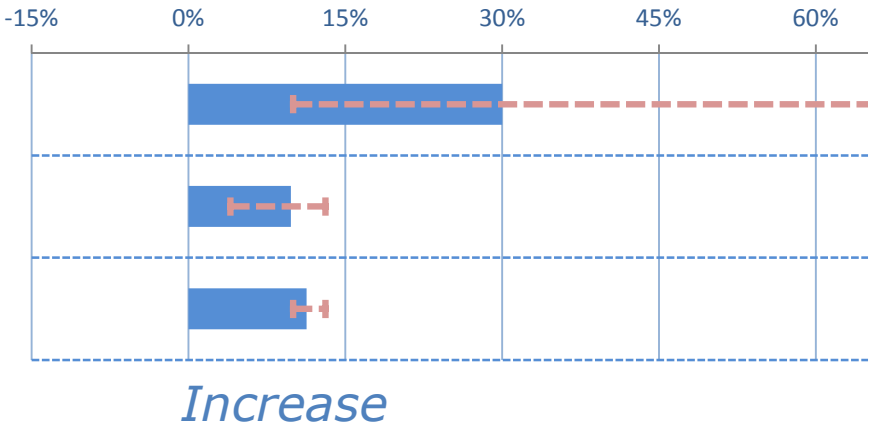
Weather conditions

Temperature affects cold start, cabin heating, lube, tyres, friction

Rain, snow/ice cause:

- *Increased road loads*
- *Grip losses / slip*

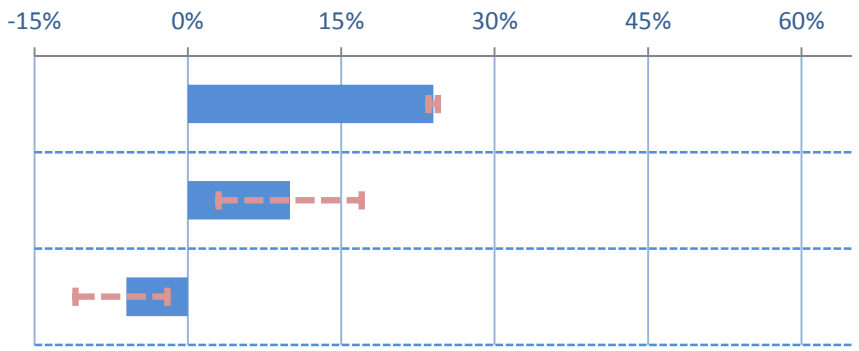
Factors	Effect on FC
Rain *(Depending on conditions)*	*30.0%*
0°C compared to 20°C	*9.8%*
-20°C compared to 0°C	*11.3%*
Snow/Ice	*Qualitative data*



Driving behavior/style

- *Real world driving speed profile*
- *Trip schedule*
- *Drivers style (aggressive, mild)*

Factors	*Effect on FC*
Aggressive driving	*24.0%*
Trip type *(short trips)*	*10.0%*
Eco - driving	*-6.0%*
Built-in driving modes	*Qualitative data*

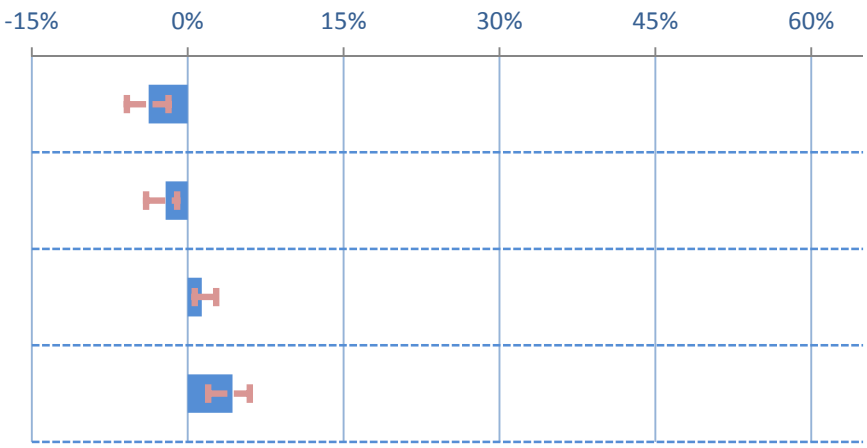


Depending on mode

Vehicle condition

- *Better energy efficient class in tires decreases fuel consumption*
- *Winter – all season tires comparison not possible due to lack of data*
- *LVLs and better maintenance improve consumption*

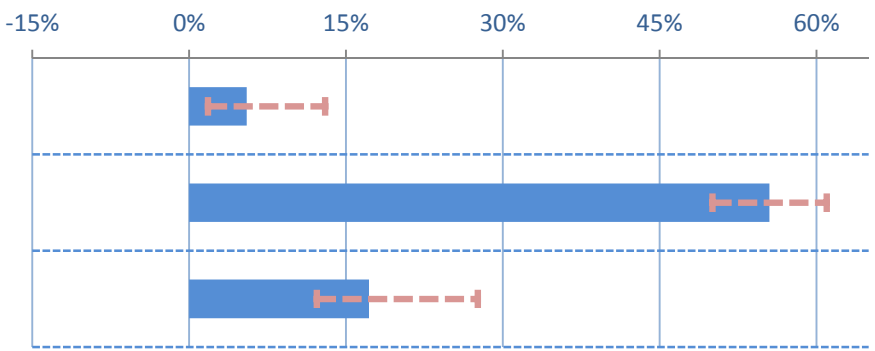
Factors	Effect on FC
Lubrication *(Low viscosity motor oil)*	*-3.8%*
Lower rolling resistance *(By 10 – 20%)*	*-2.1%*
Low tire pressure *(By 0.2 bar)*	*1.4%*
Other *(Poor maintenance, etc.)*	*4.3%*



Operational load (weight)

- *Rolling-resistance*
- *Air drag (in case of roofboxes, treilers, conteiners)*
- *Driving behavior → slower driving compensates increases*

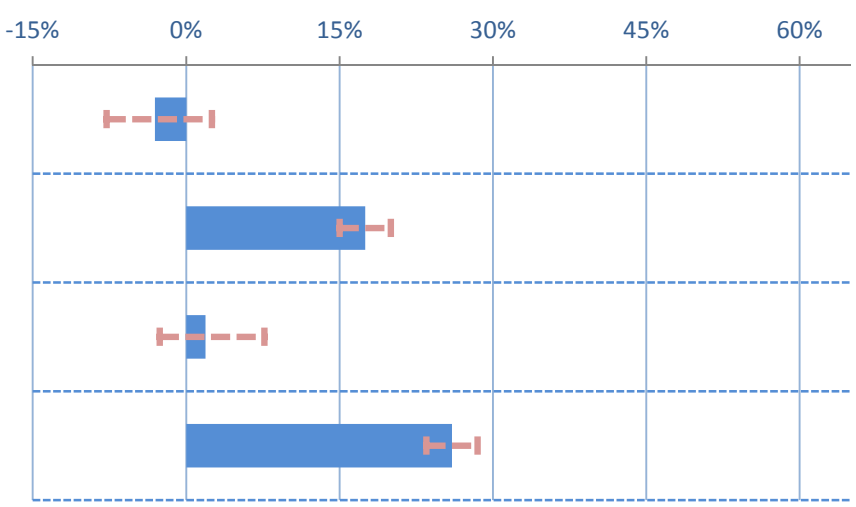
Factors	Effect
Vehicle mass *(100 kg)*	*5.5%*
Trailer towing	*55.5%*
Roof boxes *(mass-aerodynamics incr.)*	*17.2%*



Road conditions - morphology

- *Variations during the trip*
- *Variations according to time*

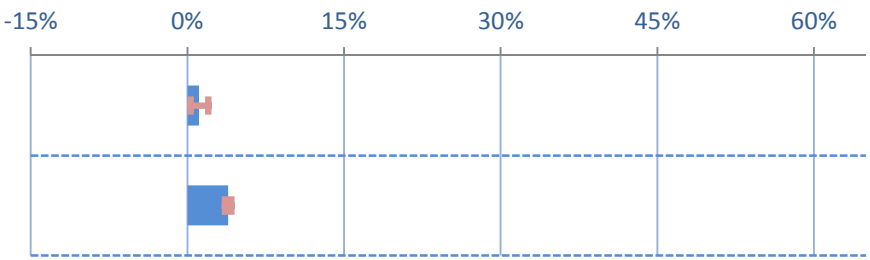
Factors	Effect
Altitude	*-3.1%*
Grade	*17.5%*
Road surface ***(roughness-texture-material)***	*1.9%*
Traffic condition ***(congestion)***	*26.0%*



Fuel characteristics

- *Winter – summer diesel variations, limited sources on effects*
- *Biofuels contain less energy per volume of fuel*

Factors	*Effect on FC*
B10 compared to B0	*1.1%*
E10 compared to E0	*3.9%*



Conclusions

- *A significant number of factors affect fuel consumption*
- *Driving habits and conditions depending on the region*
- *Difficulty in isolating impacts of each individual factor*
- *A combination of factors sum up to the final consumption*

  It is virtually impossible to assign a specific fuel consumption to any given vehicle hence a difference between reported and experienced values will always exist

- *Difficult for any type approval test to assess all the factors – introduction of WLTP is expected to produce more realistic values*
- *Additional actions can help alleviate unnecessary fuel consumption, optimize energy consumption*

Current and future work

- *An analysis on the combined effect of different factors via Vehicle simulation*
- *Examination of the effect of each factor over a base case scenario*
- *Examination of a combination of various factors over different operation scenarios*

Questions?

Suggestions?

Comments?