To achieve significant reductions in CO2 emissions in global road transport, Japanese, European and US automotive associations advocate the adoption of an integrated approach.
Most regulated countries are tending to >5L/100km in 2020+. 3-6% per /yr reduction needed which is very challenging.
A recent analysis of driving data in EU, there is an increasing discrepancy between Tested FE and Real world FE.
FE performance varies according to: A) operating environment, B) electrical equipment and C) driving behavior for the vehicle.
A) accounts for about 20%, B) 30%, and C) 50% of the FE gap (between “tested” FE and “Real world” FE).
Some of the vehicle fuel is used in operating the electrical equipment like the air conditioner and in maneuvering through jams during road driving, but not during FE testing. Since the amount of this energy unused in FE tests is similar among different vehicles, the ratio of real world FE to tested FE is bound to be smaller for high-FE vehicles.

### Low-FE Vehicle

- **Energy used in road driving (A+B)**
- **Energy unused in FE test (B)**
- **Energy used in FE test (A)**

### High-FE Vehicle

- **Energy used in road driving (A+B)**
- **Energy unused in FE test (B)**
- **Energy used in FE test (A)**

**Ratio to tested FE**

- Low-FE Vehicle: $\frac{80}{80+20} = 0.80$
- High-FE Vehicle: $\frac{40}{40+20} = 0.67$
**FE Gap Factors Investigation: Amb temp, Trip distance**

Data: JAMA

【Ambient temperature】
15°C-20°C is best temperature for FE. The other temperature areas have negative impact shown below.
- Lower temp: Warming up impact
- Higher temp: A/C load impact

【Trip distance】
Short trip driving does not have enough time to finish engine warm up. When engine temperature is cold, several frictions (engine, brake drag, tire rolling resistance, etc.) make negative impact for FE.

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Graphs showing the ratio to tested FE and monthly average temperature with seasonal variation. Another graph illustrates trip distance vs. actual FE in surface road.
5-10% improvement in on-road fuel consumption can be achieved through efforts to promote “eco-driving”. Another 5-10% may be achievable by an “integrated approach” including better traffic management, intelligent transport systems and better vehicle and road maintenance.
Real World FE Improvement by Driving Behavior Change

Honda 2013 US SAE document

Approximately 10% better FE potential by eco-driving behavior

Assumptions
(2) Acceleration energy equivalent
(3) Average travel speeds: +10km/h

*USA Consumers-contracted data
**Improve representativeness of test driving cycle (WLTP)**

- Less accelerations
- Constant cruising speed
- Long idling events

WLTP is developed by worldwide driving behavior. More aggressive accelerations

**Classification of influencing parameters**
- Correction of statistics on LD vehicles use
- Gearshift analysis
- Gearshift prescription

**Determine weighting factor**
- Development of reference database

**Validation, modification and confirmation**
- Development of an initial WLTC
Summary for Tested and Real world FE Gap factors

FE gap factors between Tested and Real world are summarized as below.

1. Vehicle driving style (Acceleration/deceleration, 1trip distance)
2. Accessory device (A/C, electric feature)
3. Environmental condition (Ambient temperature, road condition)

Driving behavior is the most critical factor for the gap. **Eco-driving helps to reduce hard acceleration and improves real world FE.** OEMs will apply several technologies to support Eco driving.

The new type approval test **WLTP** has been developed as “global harmonized” to unify existing test procedures worldwide to the maximum extent, increasing the representativeness of average driving behavior globally. Hence with this process, **it is expected to see the tested FE that is close to the real world.**