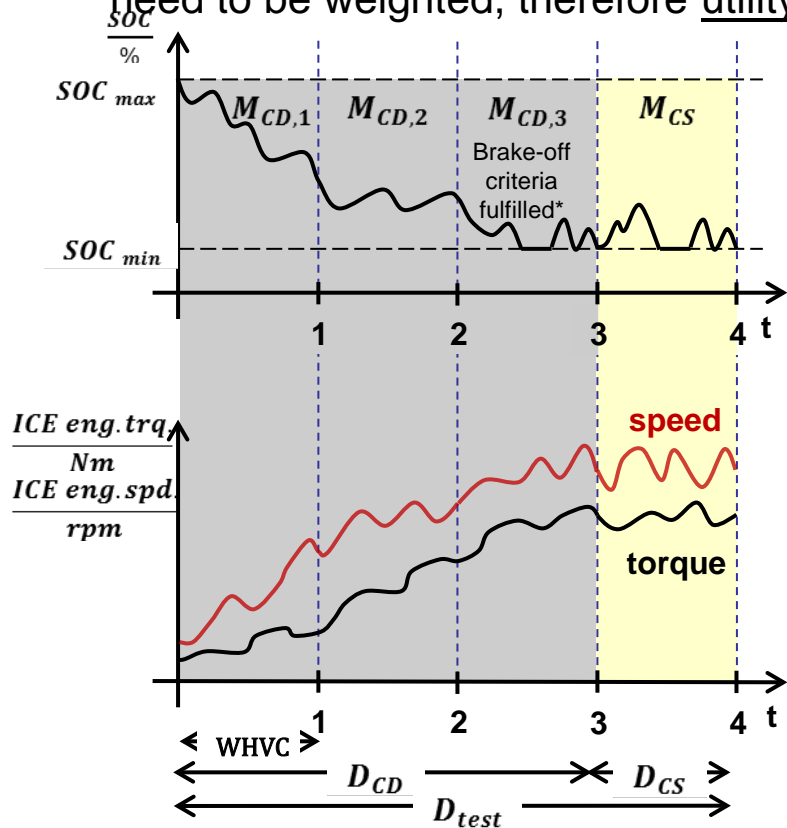


15th Heavy Duty Hybrid (HDH) meeting 24 to 25 October 2013, San Francisco, USA

Proposal for Plug-in Hybrid Certification

Principle of HD Plug-In Certification

- The proposal for certification of HD Plug-in hybrids (PHEV) is based on the concept developed for passenger cars within the WLTP work program
- Exhaust emissions during charge depleting and charge sustaining phase of PHEV need to be weighted, therefore utility factor (UF) is introduced



***Brake-off criteria to be defined**
e.g. according to GRPE-66-02 (ACEA proposal for pass. car certification)

$\frac{\text{electric energy from REESS}}{\text{cycle energy demand per cycle}} \leq 4\%$ (less than 4% of cycle energy demand provided by REESS)

$$M_{weighted} = \sum_{j=1}^k (UF_j * M_{CD,j}) + (1 - \sum_{j=1}^k UF_j) * M_{CS}$$

Where:

M_{CD} are the emissions at charge depleting

M_{CS} are the emissions at charge sustaining

UF_j is the fractional utility factor of the j^{th} phase

j is the index number of the phases up to the end of the transient cycle n

k is the number of phases driven until the end of transient cycle n
in this example: $k = 3$

Boundary conditions:

Measurement starts with cold start

10 min soak between each WHVC cycle

Formula for weighted

emissions based on

SAEJ1711

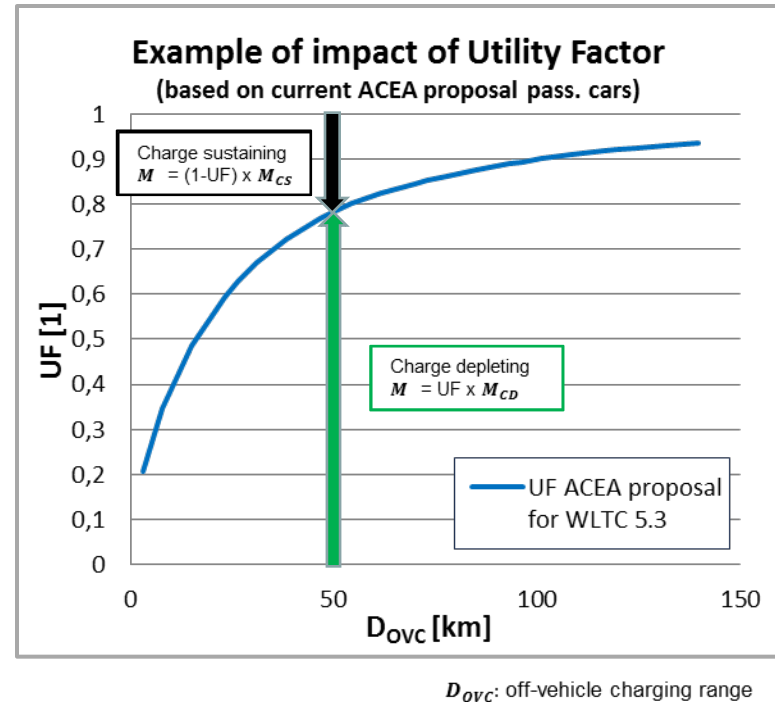
Assessment of the Method

Benefits of proposed method:

- Practical approach (compatible with HILS)
- Reasonable certification effort
- Close to real PHEV operation at customer
- Minimizes potential of misuse
- Similar concept as proposed for passenger cars

Importance of Utility Factor (UF):

- Utility Factor (UF) weights emissions during charge depleting phase and charge sustaining phase
- Definition of UF strongly impacts emissions of future HD PHEVs
- OEM can influence emissions by OEM specific off-vehicle charging range (D_{OVC})
- Vehicle class specific UF basically possible



Further Steps

Upon HDH approval of the proposal, the following steps are necessary:

- Investigation and definition of brake-off criteria for HD PHEV
- Investigation and definition of utility factor for HD PHEV