9th Heavy Duty Hybrid (HDH) meeting
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Comments to suggested ”Extended” HILS approach (TUV)

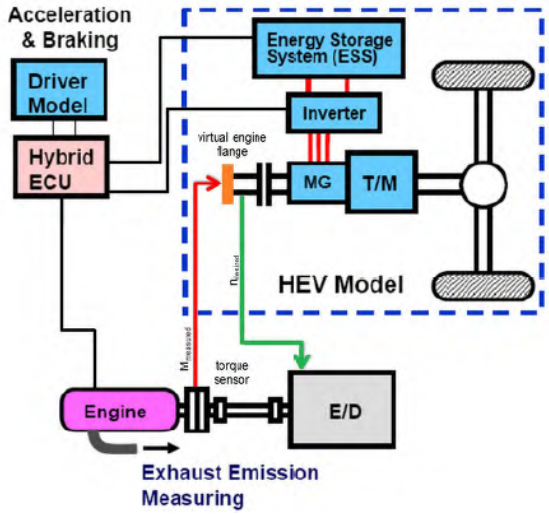
The understanding of the extended HILS method: “*real time HILS simulation” at the engine dyno.*

Consequences: will require (new) equipment connected to engine dyno (for an example dSpace plus computer/model environment).

Benefits: allows Hybrid logics to use real engine outputs → simplify engine model

Proposal of an “extended - HILS-System”

A so called “Engine in the Loop” System is actually used at IFA

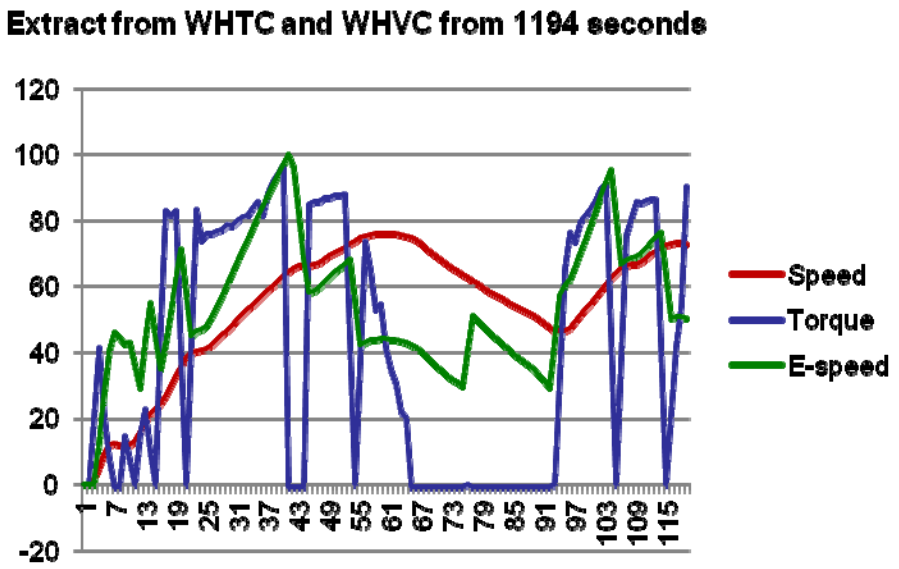


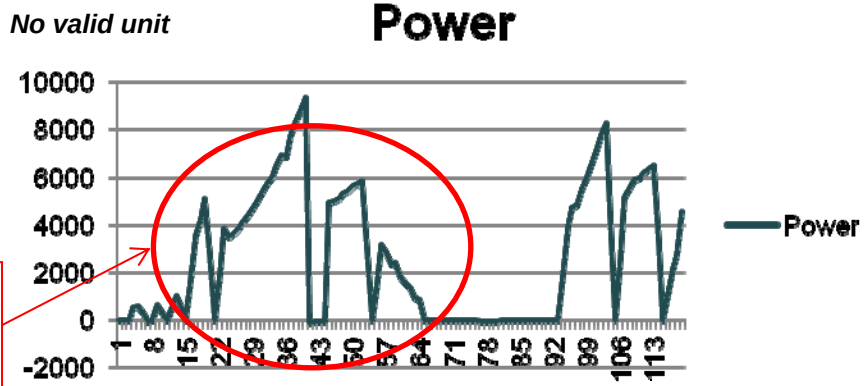
The arrangement will be advanced (equipment not commonly installed and connected to engine dyno).
The benefits will be low. Simple engine and thermal model during nominal conditions should be sufficient.

The preferable way to achieve higher grade of accuracy if necessary would be powerpack testing.

Issues with WHDHC, wheel hub cycle, as reference cycle

- WHDHC is based on WHTC
- WHTC is derived from WHVC based on a vehicle and driveline model with an average conventional gearbox
- By construction WHTC has artifacts, like gear shift torque interrupts, that may not be present in a hybrid vehicle with non-conventional gearbox
- WHTC is based on assumptions that may not be valid in future, for example: a serial hybrid.

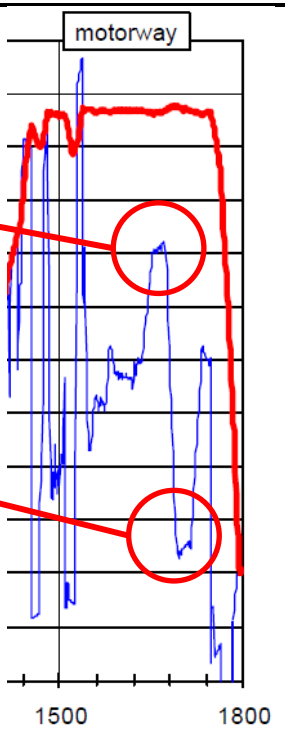




Power transients not representative for typical hybrid vehicle

Issues with WHVC as reference cycle

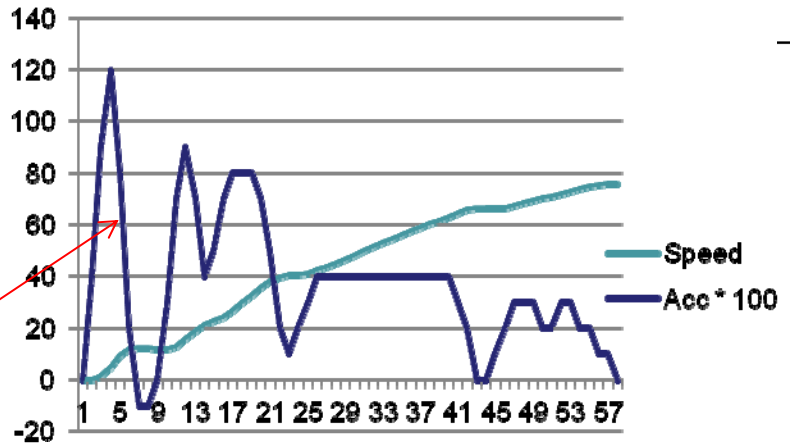
- Generic vehicle models needed for certification of product families
- WHVC defines no slopes (even though the derived WHTC clearly have some slopes in highway part). Without slopes the cycle is less representative for highway applications.
- Artifacts from conventional gearbox shifting visible in speed profile.



Uphill

Downhill

Extract from WHVC



Significant jerk may come from traffic situation but more likely from gear shifts.

Suggested approach to define WHDHC, wheel hub cycle, as reference cycle

Option 1 to investigate:

1. Use WHVC speed profile as a basis
2. Apply some filtering (offline, smoothing) to reduce discontinuous acceleration due to gear shifting
3. Use a standard vehicle model (*) to derive wheel hub power cycle
4. Modify highway part to add the effect of slope as it can be inferred from WHTC.

*) Vehicle manufacturer define reference vehicle (weight, air drag, rolling resistance) representative for engine family , or as an alternative, a few standard vehicle classes may be defined. Calculation formula needs to be standardized as a simple backward calculation from WHVC with the defined vehicle parameters.

N.B. Calculation steps 2 to 4 may be performed offline, prior to HILS simulation.

Suggested approach to define WHDHC, wheel hub cycle, as reference cycle (2)

Option 2 to investigate:

Use WHTC as basis for defining WHDHC (according to TUG proposal) but apply some pre-filtering (smoothing) to remove gear shift transients from the resulting power cycle