Working Paper No. **HDH-09-12**
(9th HDH meeting, 21 to 23 March 2012)

Japanese position to the proposals from TU-G and TU Wien

9th HDH Informal meeting, 21-23 March, 2012

JASIC

Japanese position to the proposals by TU Wien and TU Graz

◆The proposal "Extended HILS" by TU Wien regarding the measures for COLD TEST

We do not think the proposal is appropriate for certification because of the expected huge investment for the facilities, complexity of the system and such. It is possible to modify the conventional Japanese HILS to include the water temperature table into the model in order to adjust to COLD TEST.

◆The proposal by TU Graz "WHDHC" method

The proposal is based on the idea of WHTC cycle for conventional vehicles and partly reasonable, however, it does not require the concept of vehicle-base, so it does not properly reflect the difference of specification of each vehicle.
Furthermore, the emission results of this method do not align with those of WHTC, the test method for conventional vehicles.

◆Considering the above-mentioned issues, the Japanese proposal are based on these concepts;

1. Consideration for the COLD START
2. Equivalent to WHTC while the motor is not operating
3. The influence due to the difference of HEV system is properly reflected.
4. Based on the Japanese Open Source Model

--Outline of Japanese Proposal--

WHVC is the basic cycle. Based on the Japanese open source model, obtain the operating ratio of engine to the system in chronological order by HILS simulation. Then the ratio is multiplied to the WHTC base load factor to normalize the pattern, and use the normalized pattern to develop the engine driving pattern converted to WHTC. The emission is measured on HEV engine as unit.

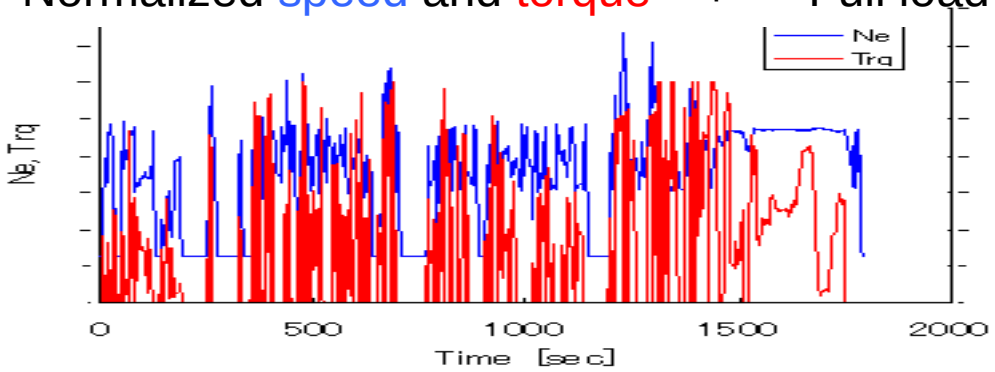
Comparison of WHTC, Japanese HILS and proposals

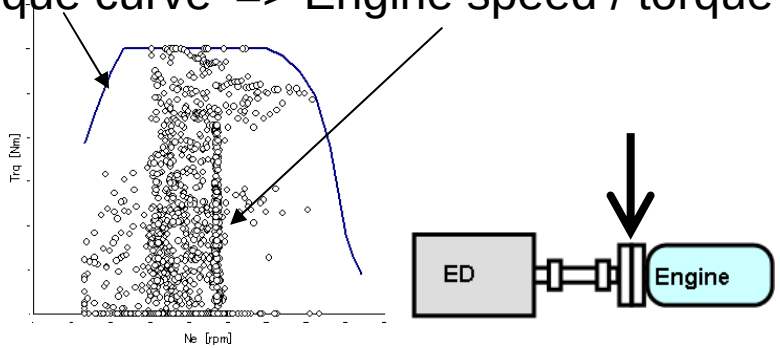
	WHTC (for Conv. Diesel)	Current Japanese HILS	Japanese Proposal （HEV ratio）	TU GRAZ Proposal （WHDHC）	TU Wien Proposal （Extended HILS）
Outline	Emission test is done by the RPM/torque pattern, distinctly obtained by the engine	HEV engine RPM/torque pattern is obtained by cycle (defined only by vehicle speed) simulated by HILS.	First obtain the HEV ratio by HILS using the vehicle speed of WHVC, then multiply the ratio and WHTC torque to obtain modified engine RPM/torque pattern.	Obtain HEV engine RPM/torque pattern by HILS simulation using the cycle developed from combination of WHTC power rate and WHVC vehicle speed.	The current Japanese HILS engine model is replaced to the actual engine. Method to measure the actual emission while simulating.
Necessity of concept of vehicle	NO	YES	YES	NO	YES
Provisions for negative torque	NO	Possible to reflect the effect of HEV system	<=	Defined distinctly (impossible to reflect the effect by differences of vehicle specification)	Possible to reflect the effect of HEV system
Cold test	Possible with real engine condition	Possible with real engine condition. Include the water temperature table into the model to solve the effect of HEV control	<=	<=	Possible with real engine condition
E/D	Current facilities are sufficient	<=	<=	<=	Need to modify the facility
Alignment with WHTC	－	NO: simulation on WHTC is impossible	YES: WHTC test as HEV engine is possible	NO: the test points are different from those of WHTC	NO: Simulation on WHTC is impossible
Concerns	－	Impossible to align with WHTC	WHVC load rate is not considered, but possible to modify by adding gradient condition.	Impossible to reflect the effect of HEV system b/c concept of vehicle is not considered. Impossible to align with WHTC.	Huge investments required for facilities Impossible to align with WHTC

Reference

WHTC

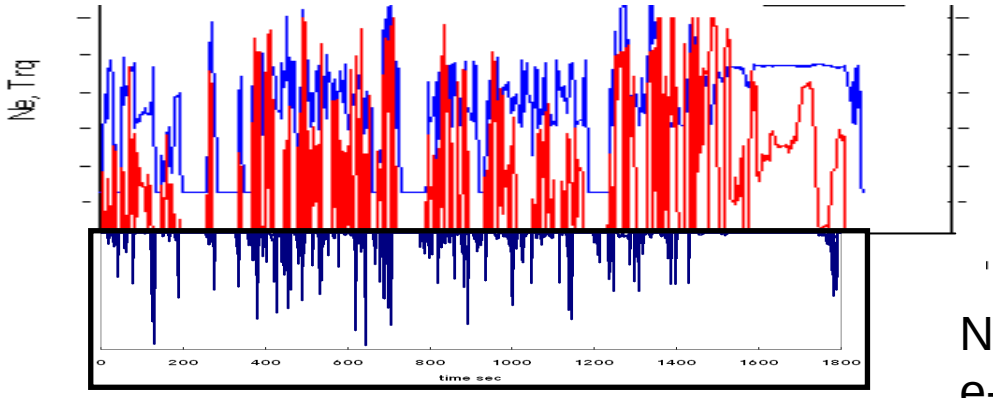
Normalized speed and torque + Full load torque curve => Engine speed / torque





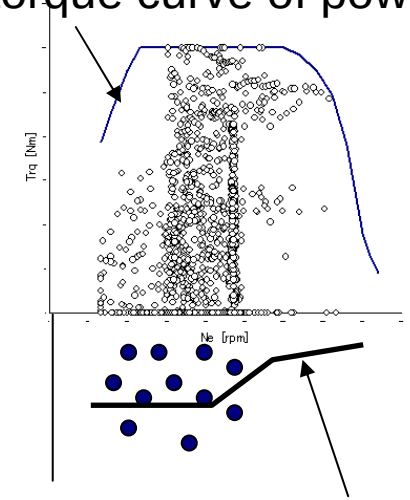
Theoretical WHTC for HEV

Normalized speed, positive torque and negative torque

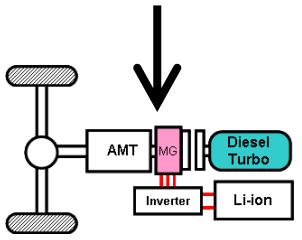


Negative torque profile

Full load torque curve of power pack



Pre-transmission



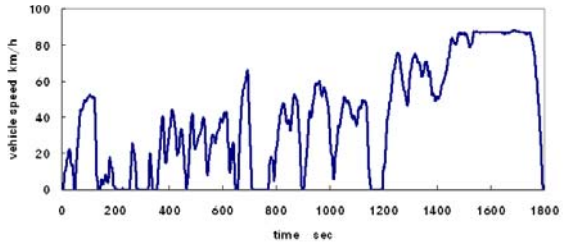
Negative maximum torque curve of e-motor

Reference

Japan HILS (vehicle based approach)

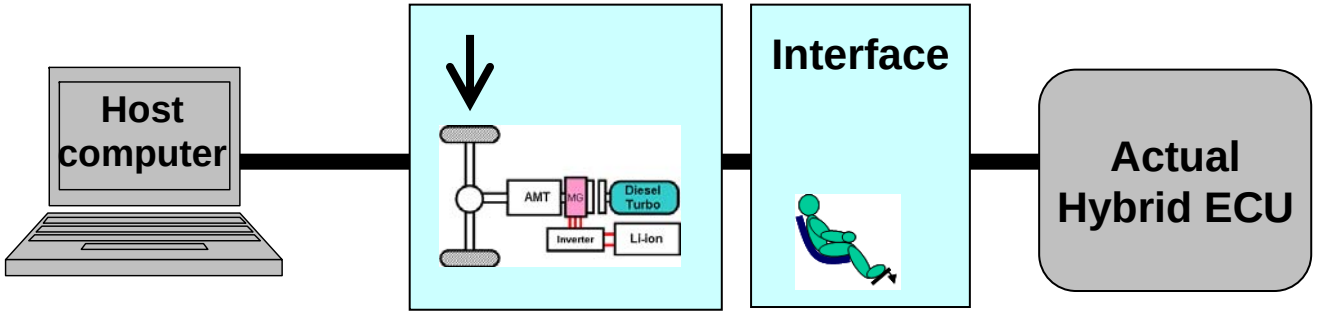
Harmonized vehicle specification +

Vehicle speed pattern (WHVC) with appropriate gradient (WHVC)



=> Engine speed/torque by HILS

HILS system



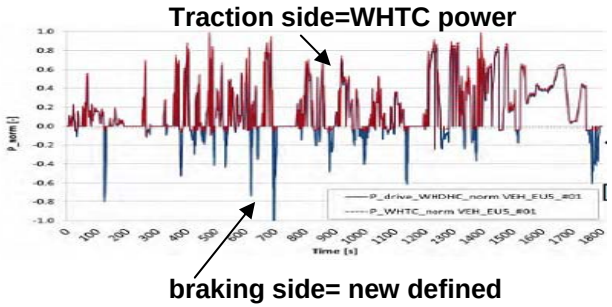
It is possible to reflect WHVC speed/power profile(as gradient) for each harmonized vehicle.

However it is independent of WHTC.

Reference

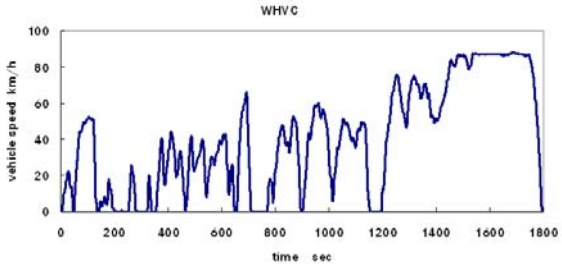
Japan understanding of WHDHC

WHDHC normalized power pattern



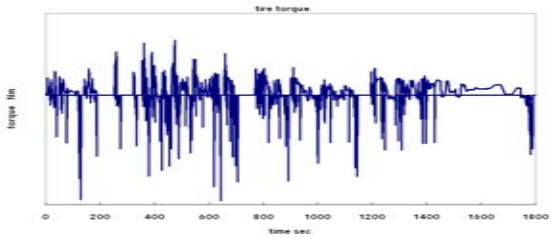
=>

Vehicle speed pattern (WHVC) km/h



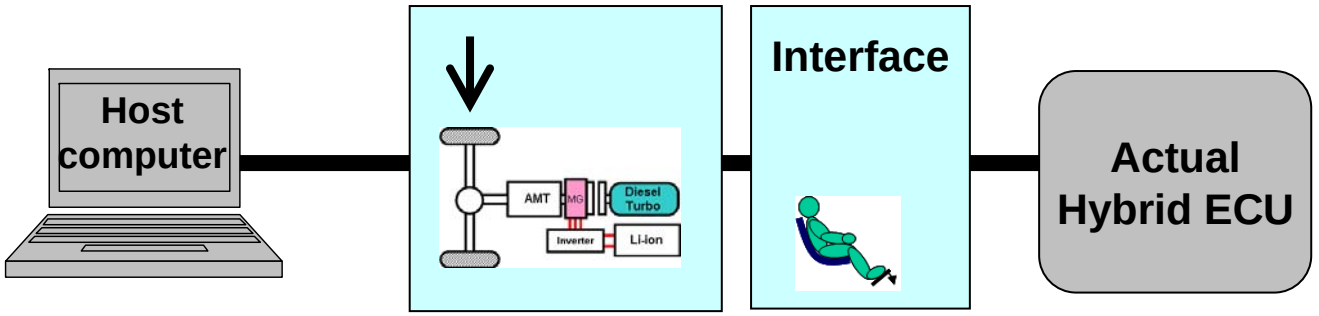
+

Vehicle tire torque pattern (as gradient) with considering friction of TM



=> Engine speed/torque by HILS

HILS system



It is possible to reflect WHTC power profile.

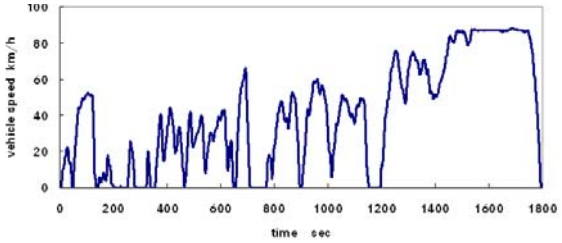
However it is independent of WHTC speed/torque.

Reference

Japan proposal: vehicle based simulation for modified WHTC

Vehicle speed pattern (WHVC)

Harmonized vehicle specification +



=> Engine speed/torque and e-motor speed/torque by HILS

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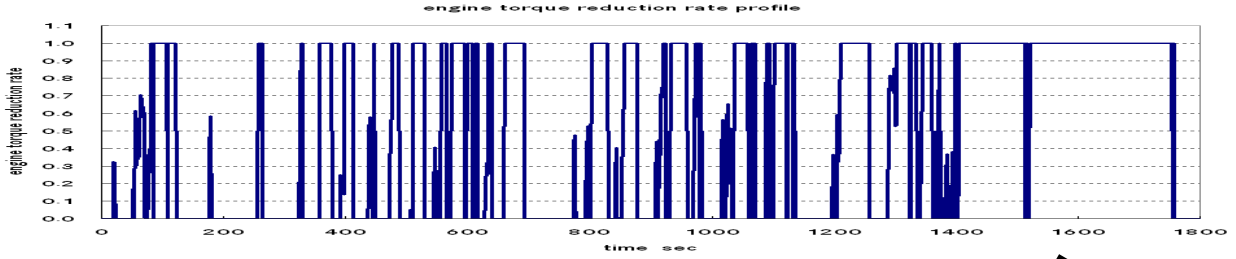
Engine torque reduction ratio profile = engine power/(engine power + e-motor power)



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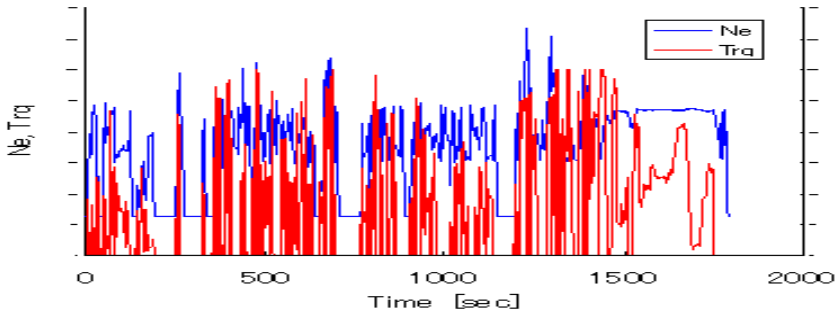
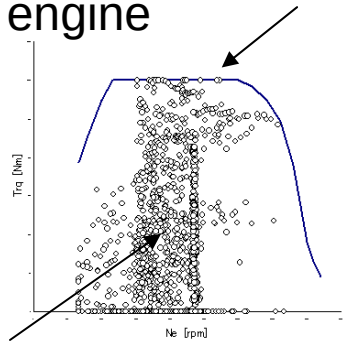
WHTC for combustion engine

Normalized speed and torque +



Full load torque curve of engine



Conventional engine speed / torque

HDH engine reduced torque/speed(same to WHTC)

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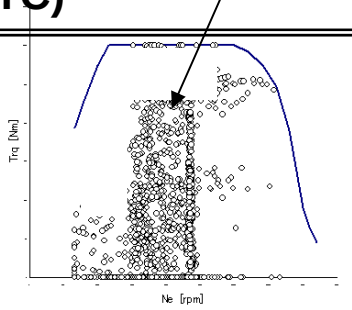
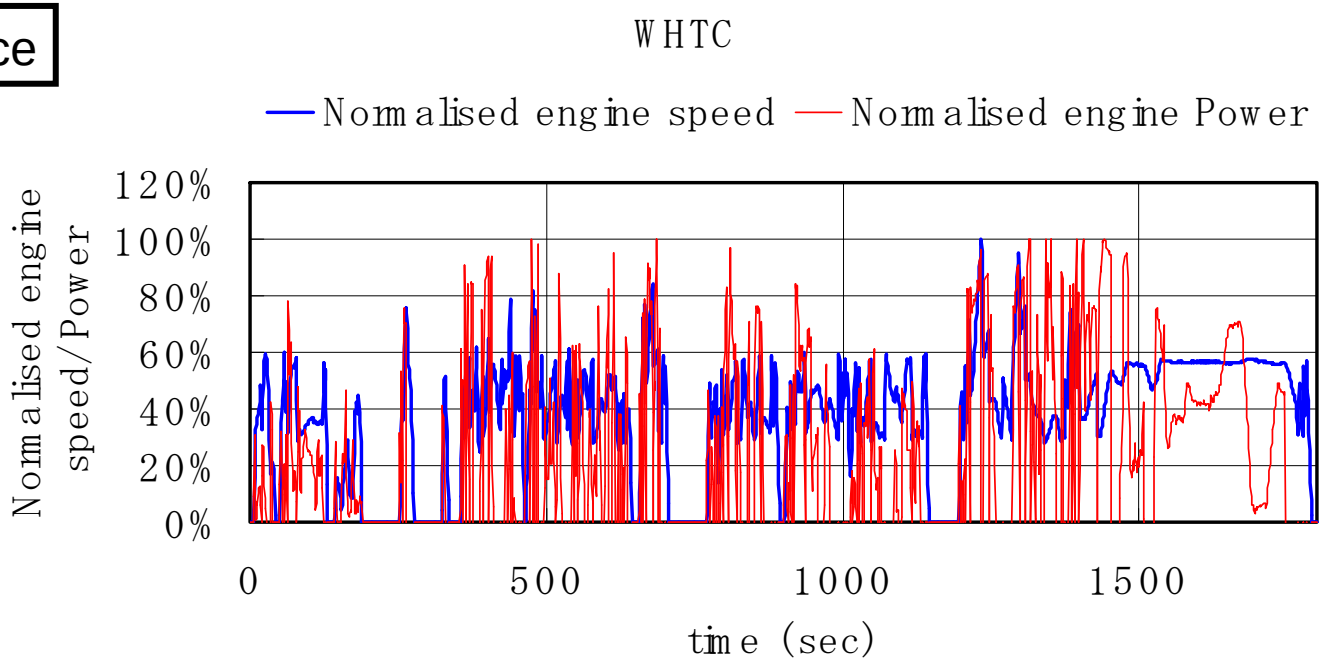
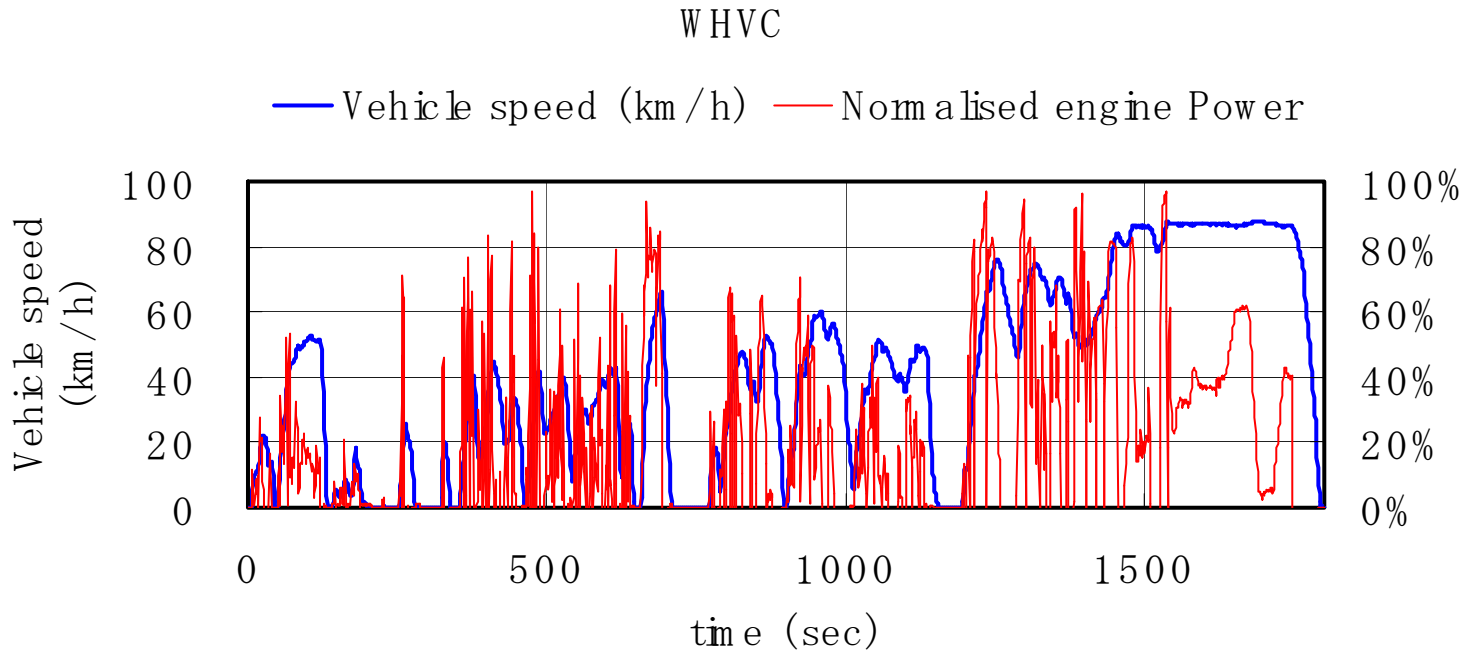


Reference


WHTC
Normalised engine speed
Normalised engine Power
Normalised engine speed/Power
120%
100%
80%
60%
40%
20%
0%
0
500
1000
1500
time (sec)


WHVC
Vehicle speed (km/h)
Normalised engine Power
Vehicle speed (km/h)
100
80
60
40
20
0
100%
80%
60%
40%
20%
0%
0
500
1000
1500
time (sec)