Working Paper No. **HDH-09-11**
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Proposal of "modified WHTC" for HDH

JAPAN AUTOMOBILE STANDARDS INTERNATIONALIZATION CENTER

Summary

Japan would like to propose new approach of how to connect “vehicle based cycle” with “engine based cycle” for exhaust gas of HDH.

In case of parallel hybrid new approach, “modified WHTC for HDH”, shows

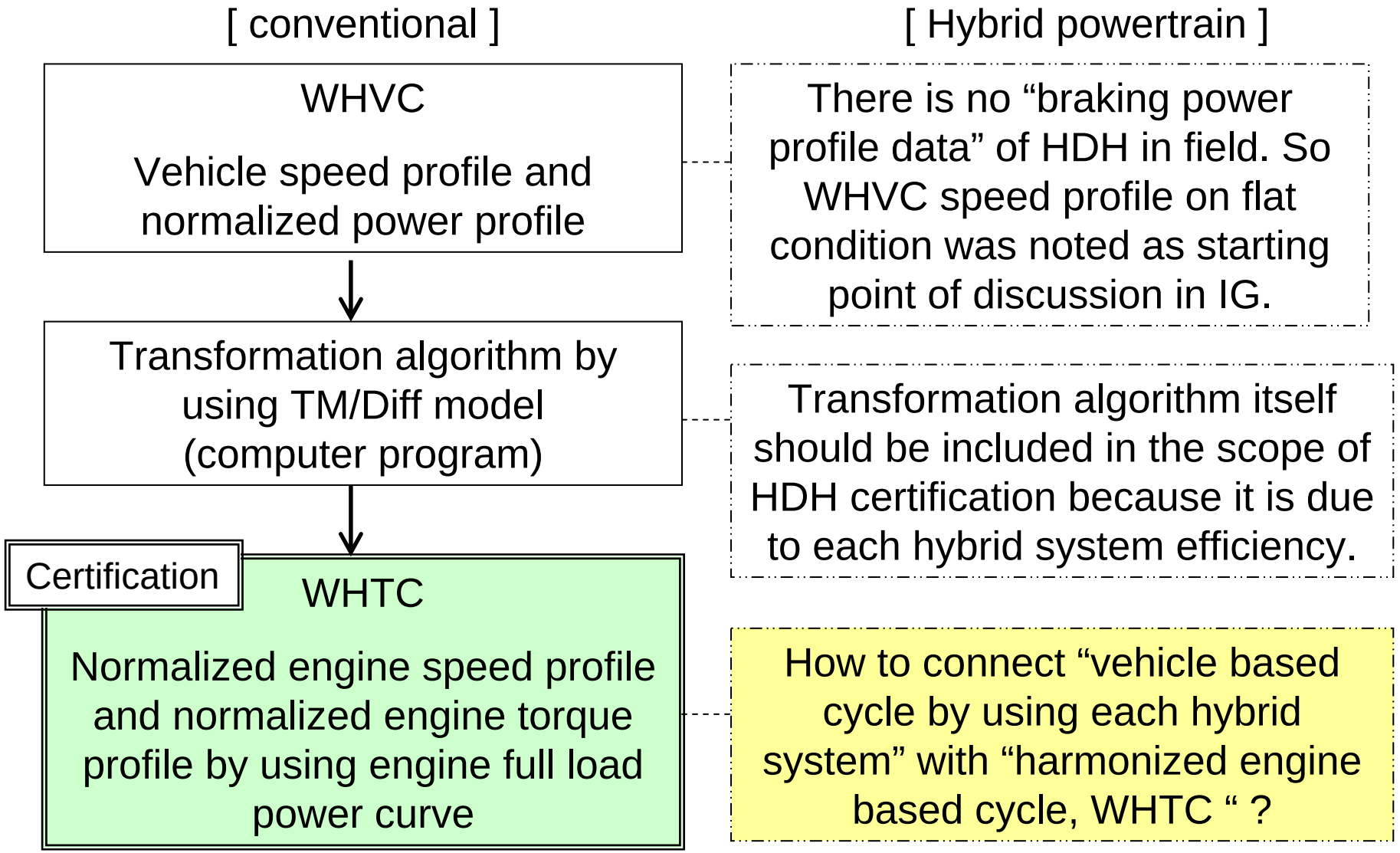
- If hybrid system does not work, i.e. no electric motor work, the engine driving cycle could be perfectly same to “WHTC”.

- Hybrid effect can be reflect to the engine driving cycle according to each hybrid system efficiency.

- It is possible to use “existing Japan certification HILS method” with little modification.

- In addition it is considered how to implement “cold start test”.

Issue of HDH driving cycle



Request for HDH driving cycle

- If hybrid system does not work, i.e. no electric motor work, the engine driving cycle could be perfectly same to “WHTC”.

  => reasonable relationship between HDH powertrain and conventional engine from the view of exhaust gaseous emission in case of parallel hybrid system

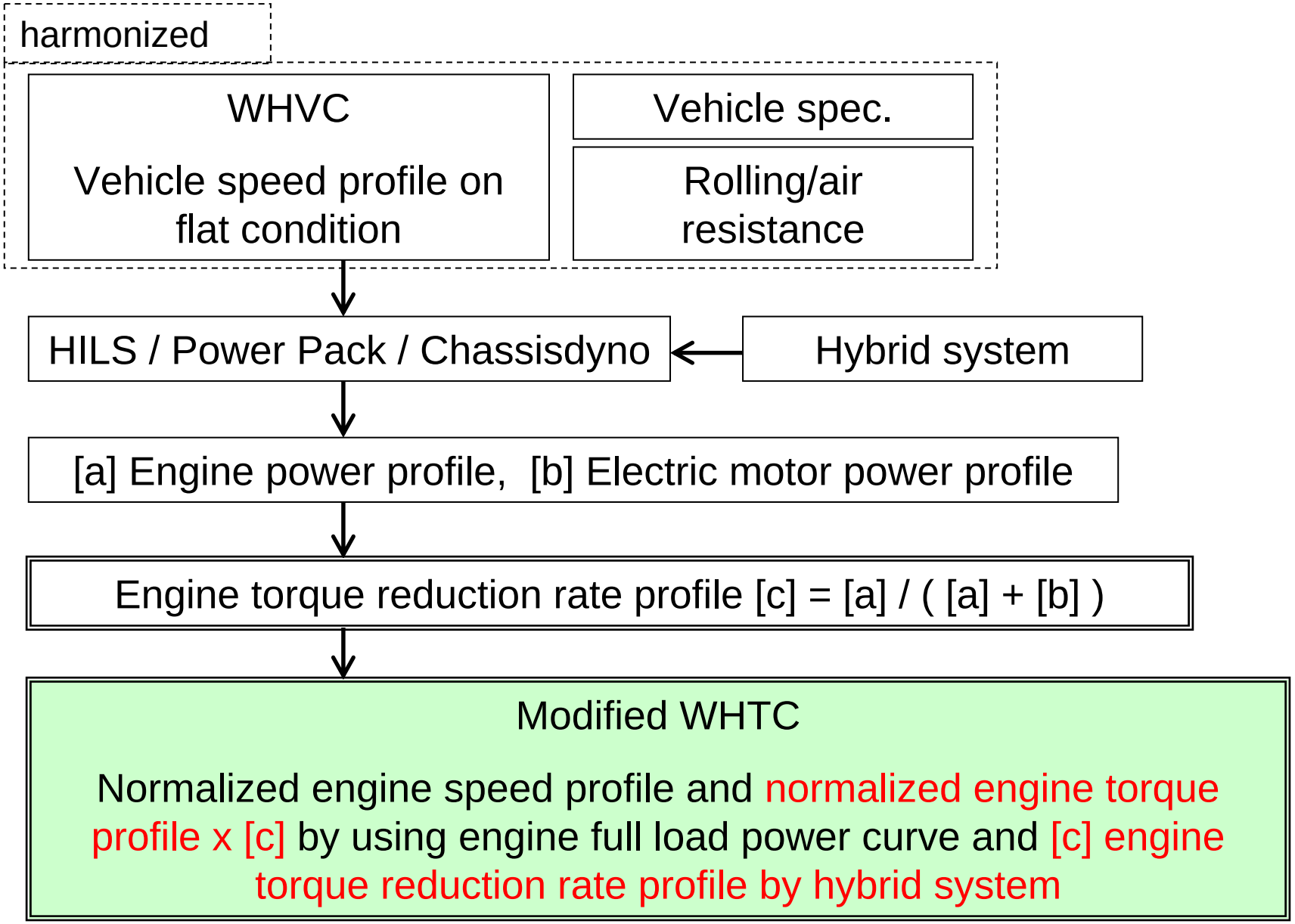
- Hybrid effect can be reflect to the engine driving cycle according to each hybrid system efficiency.

  => “good hybrid technology” can get “good certification result”

- Practical certification method to get the driving cycle

- Possibility of “Cold start” driving cycle

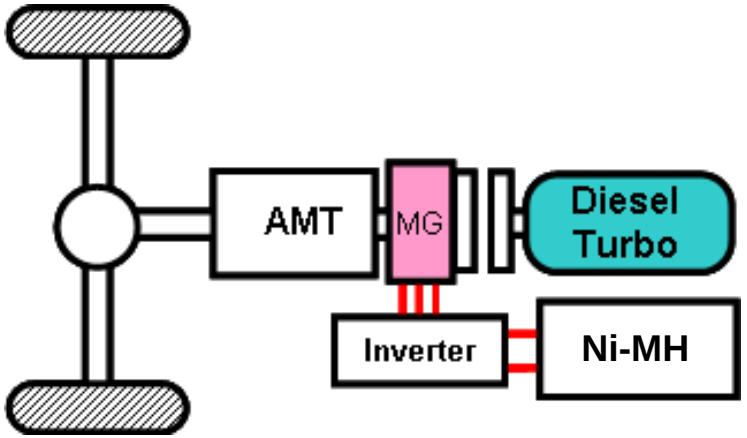
Modified WHTC for HDH (1): concept



Modified WHTC for HDH (2): example

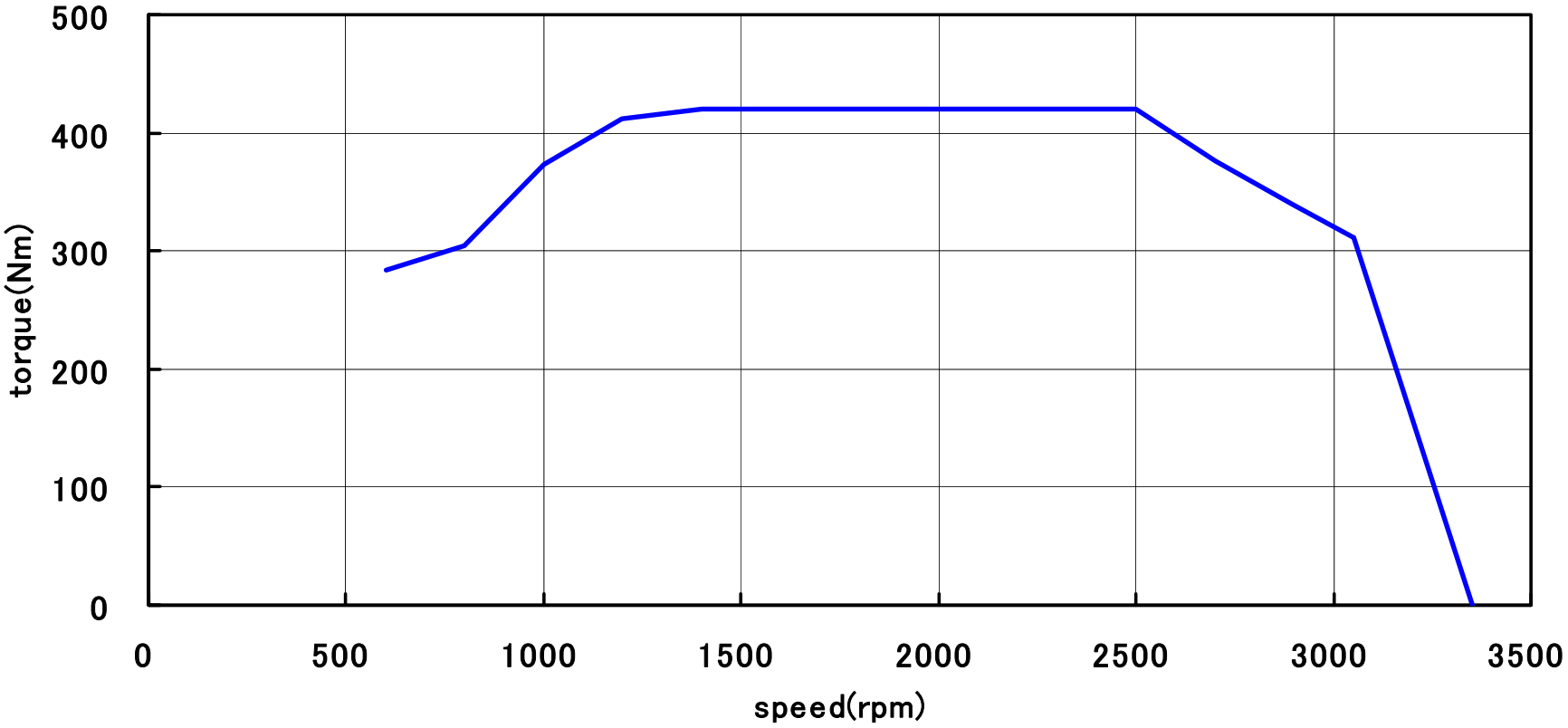
designated Vehicle specification

T2 category	
curb vehicle mass (kg)	3411
tire rolling radius (m)	0.347
rolling resistance	0.01029
guard project area (m^2)	3.675349
air resistance coefficient (N/(m2 km/h)2	0.027105581
Number of gear	5
1st gear ratio	4.981
2nd gear ratio	2.911
3rd gear ratio	1.556
4th gear ratio	1.000
5th gear ratio	0.738
final gear ratio	3.900
idling engine speed (rpm)	600
rated engine speed (rpm)	3050
govemed engine speed (rpm)	3350



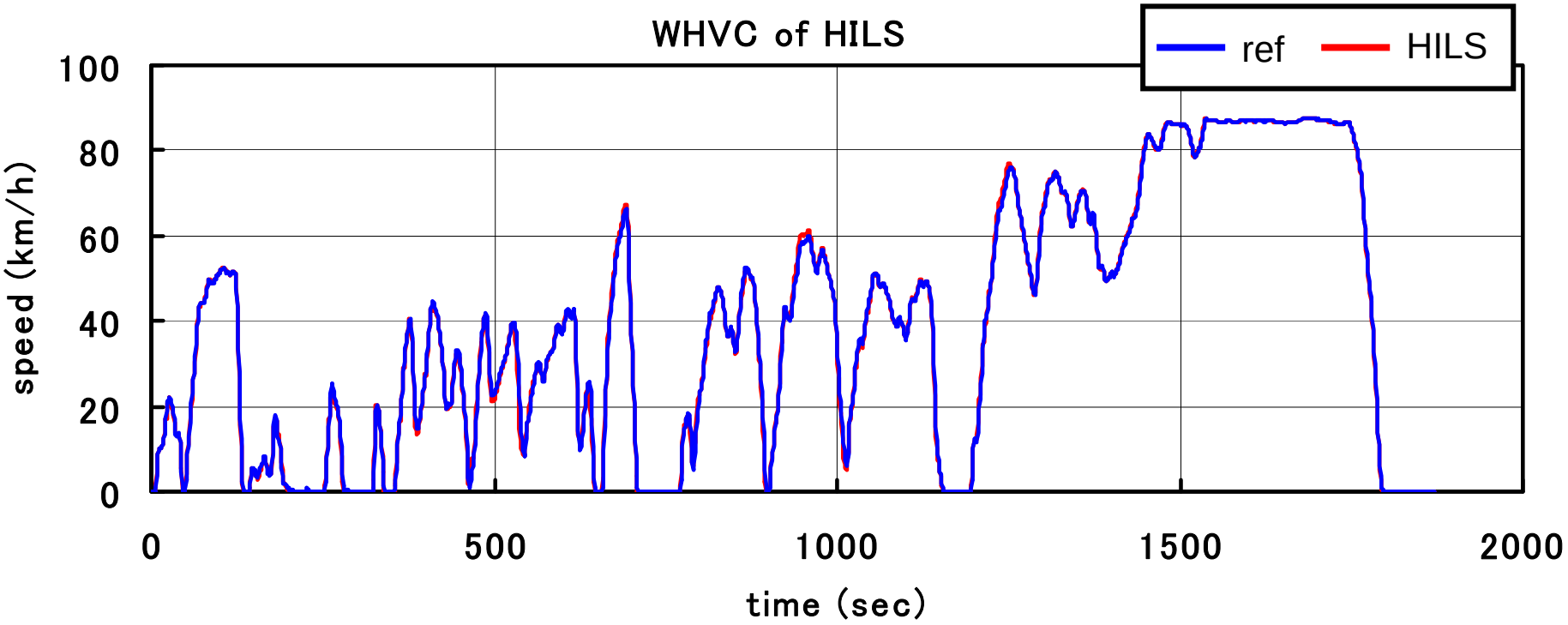
Modified WHTC for HDH (3): example

designated maximum torque curve of hybrid system



Modified WHTC for HDH (4): example

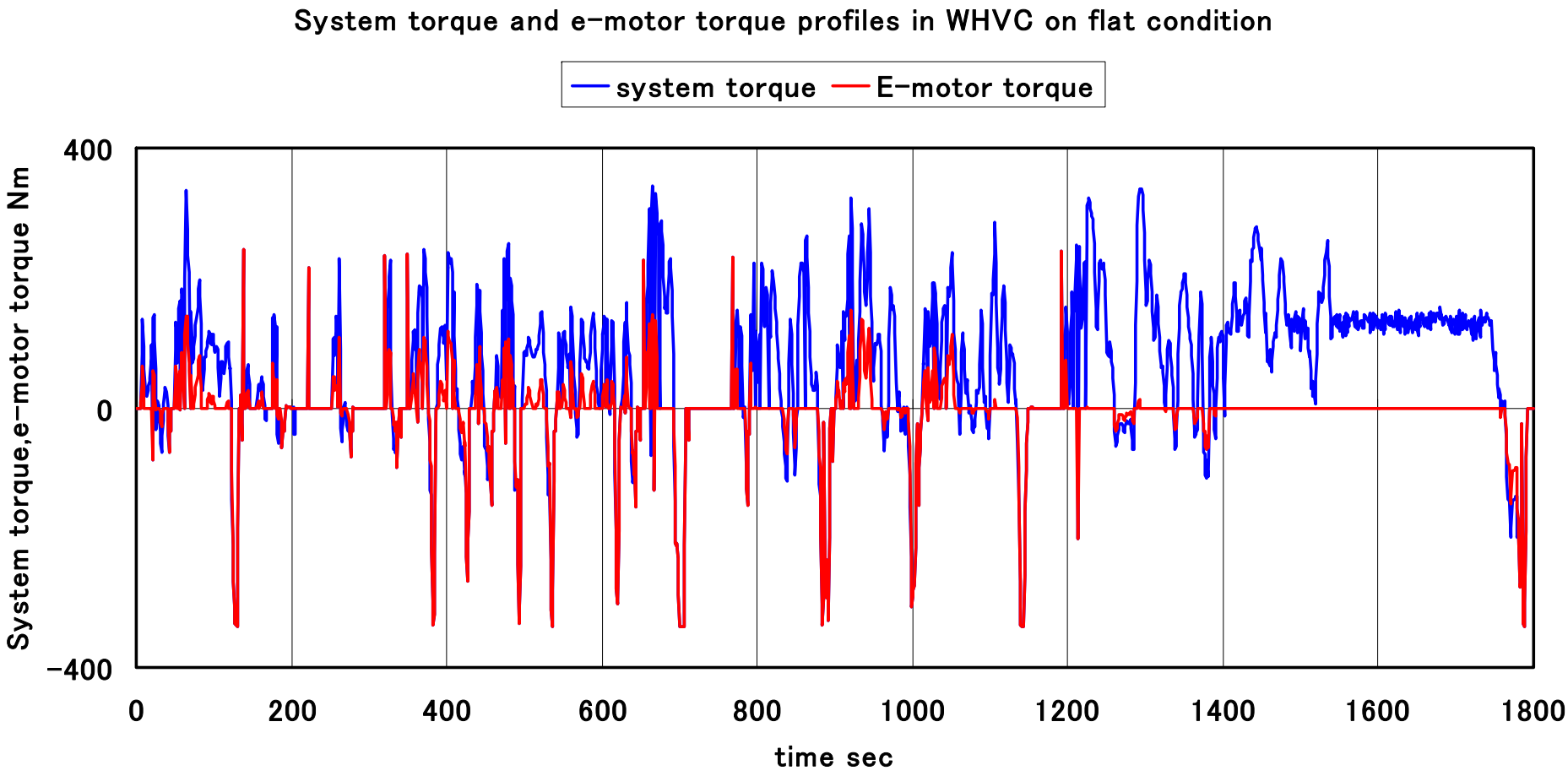
WHVC HILS results



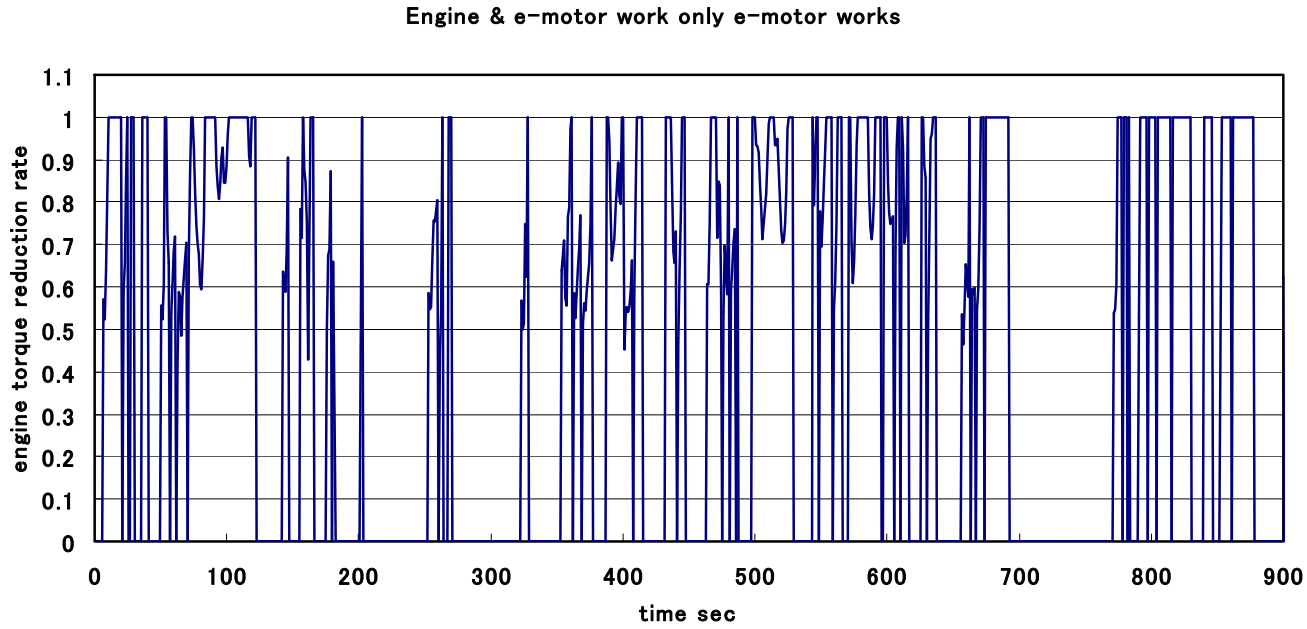
$|\Delta E/C| = 0.00167$

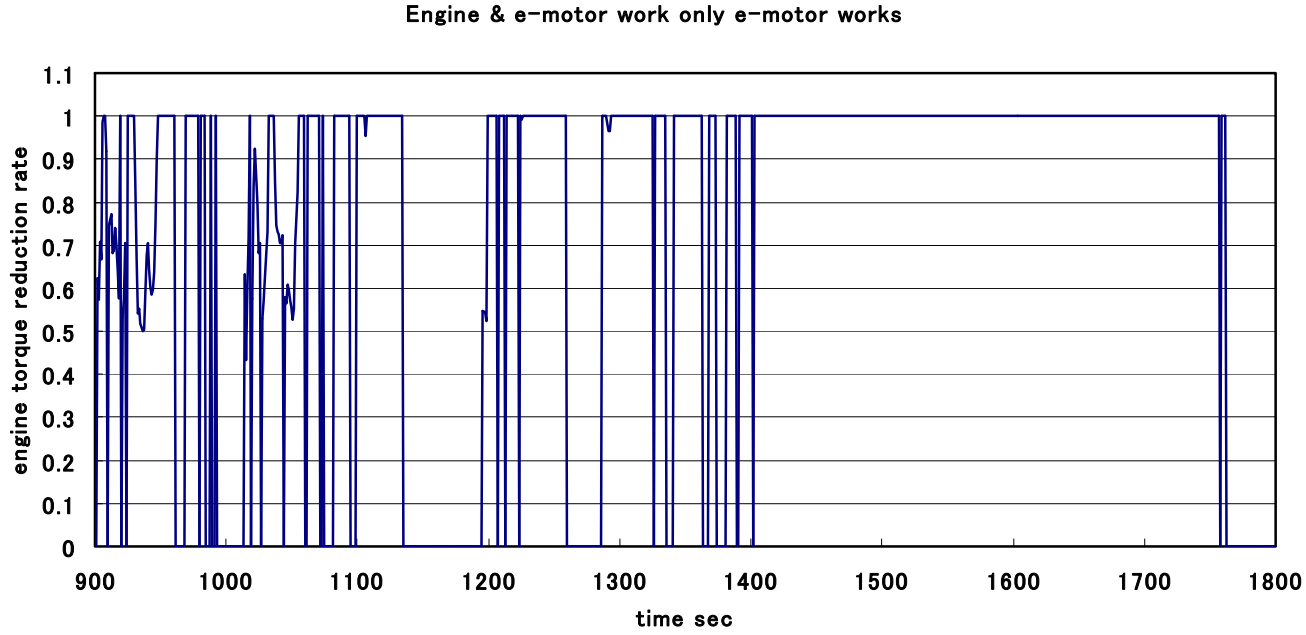
ΔE : Energy conversion value of electricity balance (J)
C : Energy conversion value of cumulative amount of fuel consumption (J)

Modified WHTC for HDH (5): example

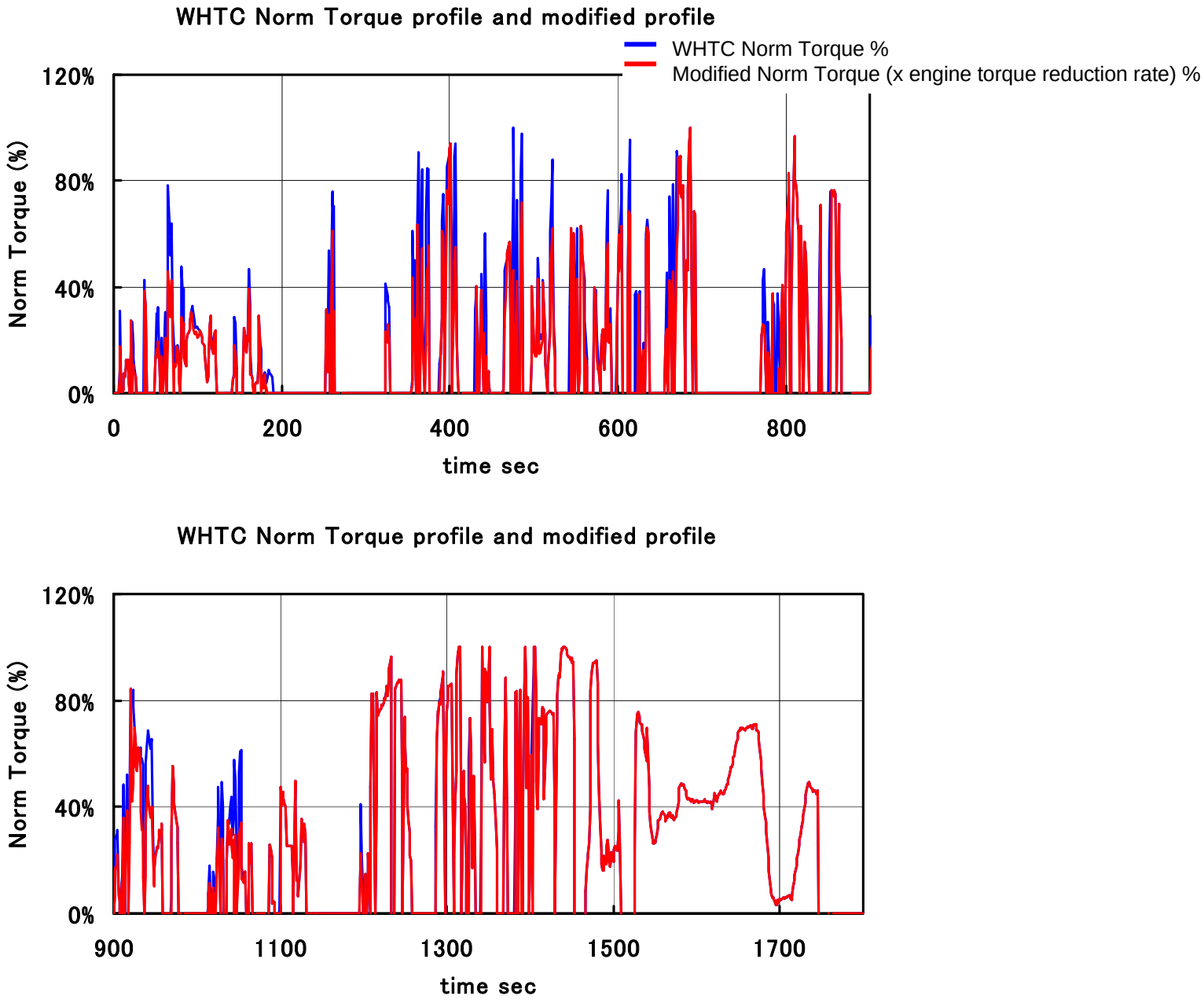


Modified WHTC for HDH (6): example

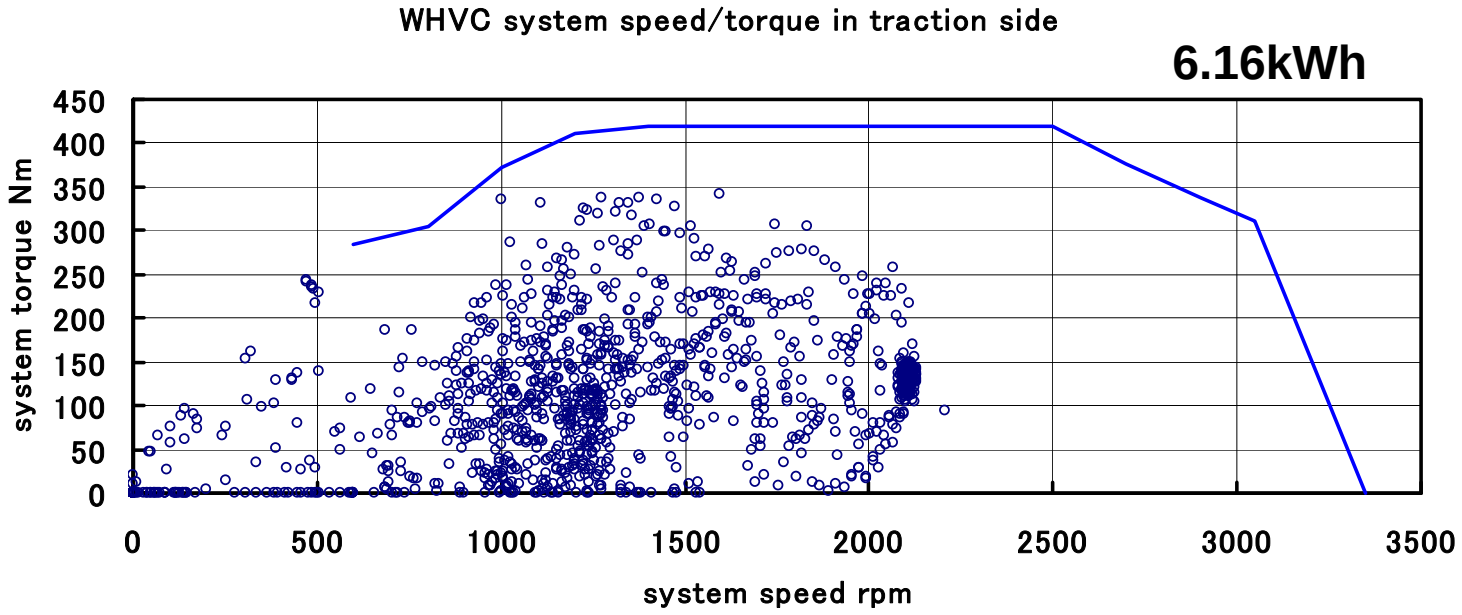


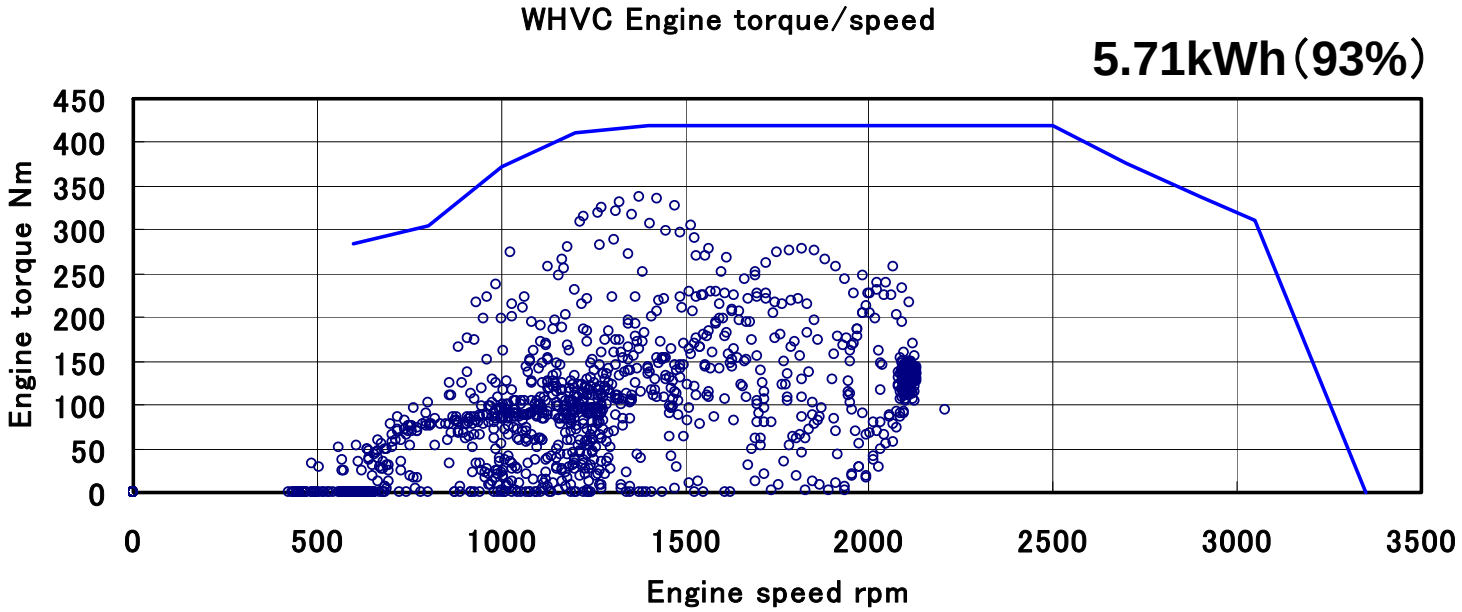


Modified WHTC for HDH (7): example

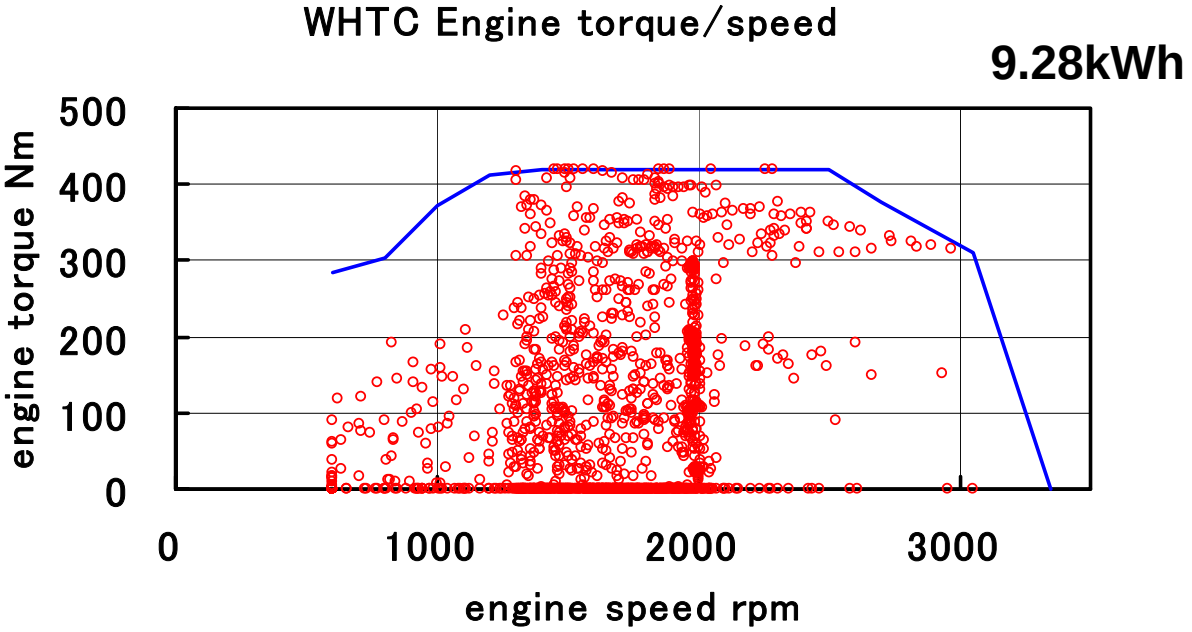


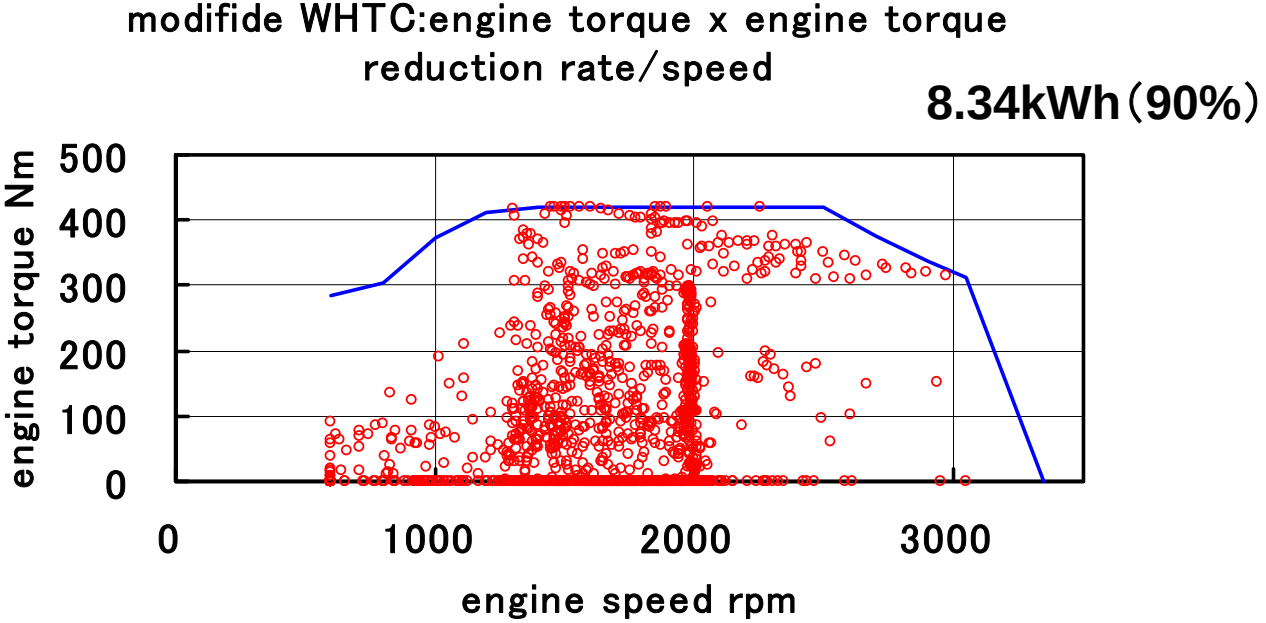
Modified WHTC for HDH (8): example





Modified WHTC for HDH (9): example





Items to be discussed for modified WHTC (1)

- What about engine generating mode?

=> it is counted for more than 1.0 as reduction rate. And ΔSOC=0 should be criteria even if engine generating is occurred.

- What about “Series hybrid”?

=> it should be needed another solution because engine works only as generator. In this case engine driving cycle does not need to be same to “WHTC” if hybrid system does not work.

One solution is to use engine torque/speed in WHVC on flat condition.

Items to be discussed for modified WHTC (2)

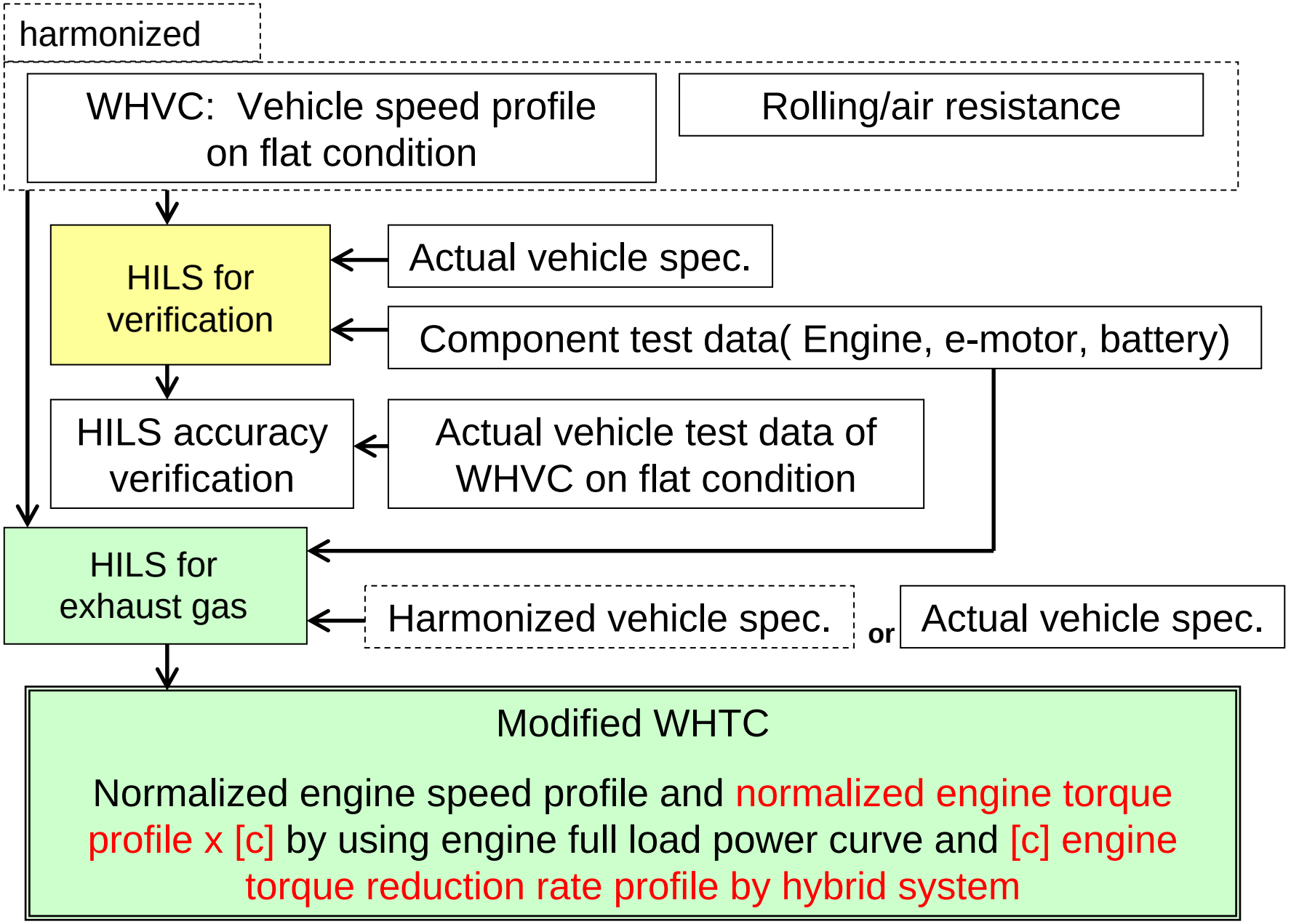
- What about “series-parallel hybrid” like that “Prius”?

=> It is difficult case but If engine is used to mechanically drive tire it is considered one of the parallel hybrid. In case of the conventional narrow speed range engine with CVT is considered as normal one.

- What about “reduction rate of exhaust emission”?

=> it should be confirmed reduction rate of exhaust emission in case of “WHTC” to “modified WHTC” and hybrid effect in “WHVC”.

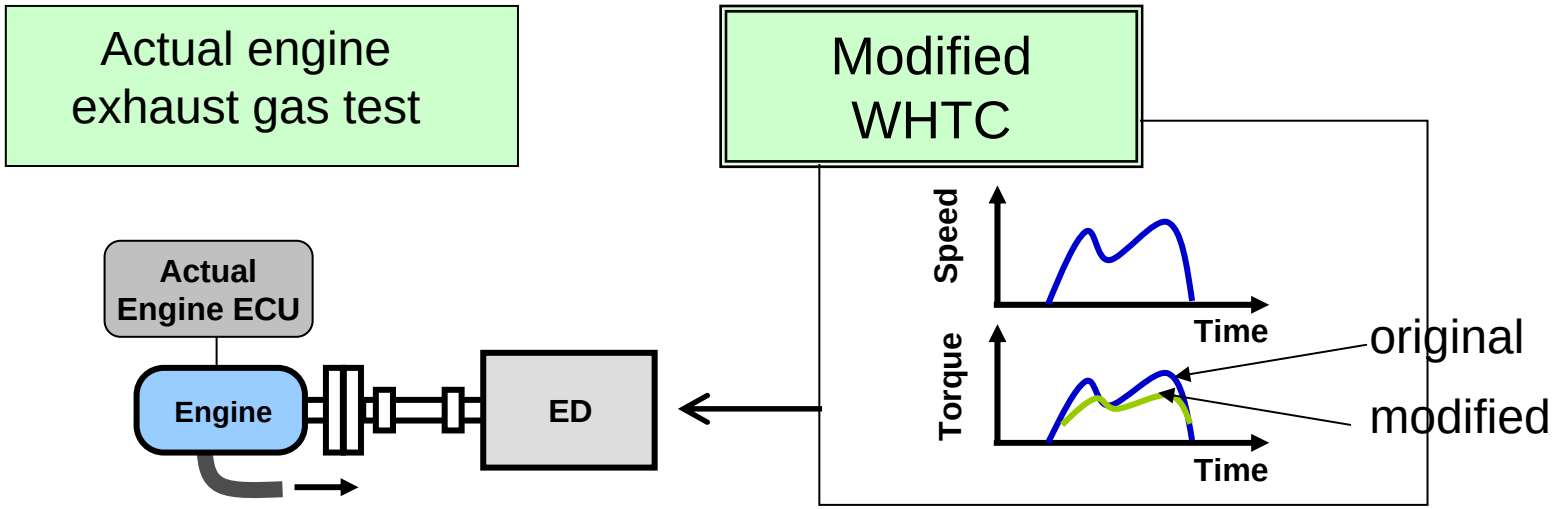
Modified WHTC certification method by HILS(1)



Modified WHTC certification method by HILS(2)

Actual engine exhaust gas test is implemented by using “modified WHTC engine torque/speed”

Total work is calculated by using “original WHTC engine torque/speed”

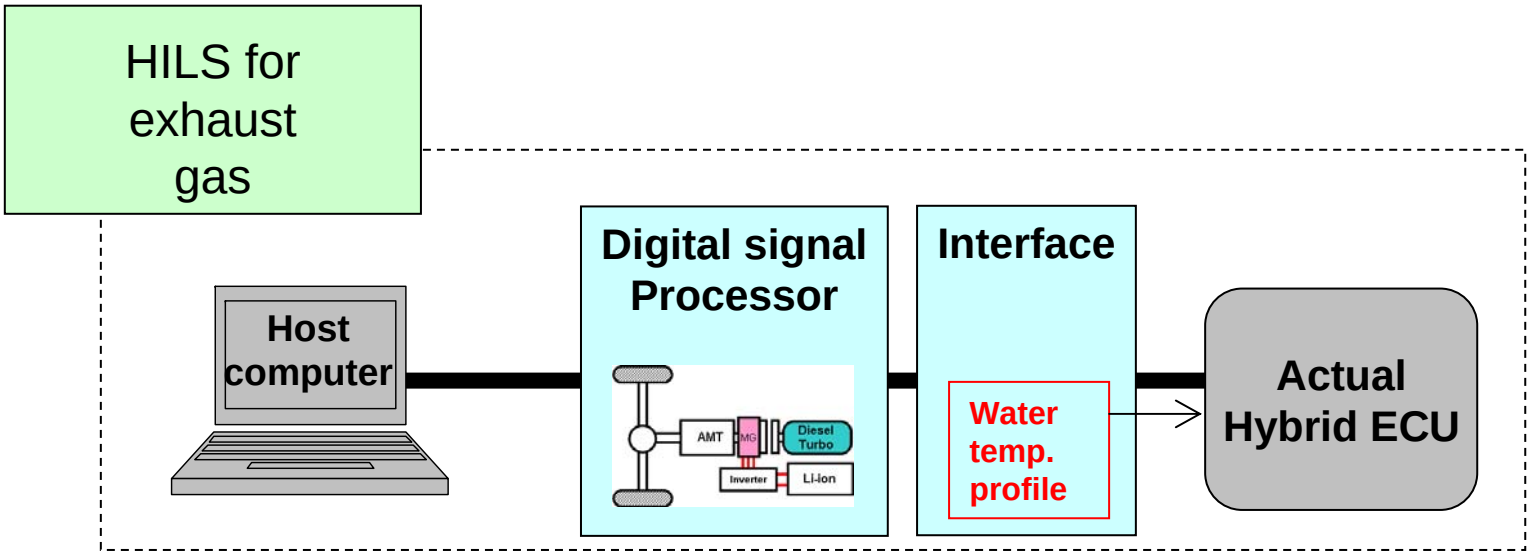


Cold start concept

Basically engine ECU is used for actual engine exhaust gas test so it is possible to realize “engine cold start control algorithm” for cold start test.

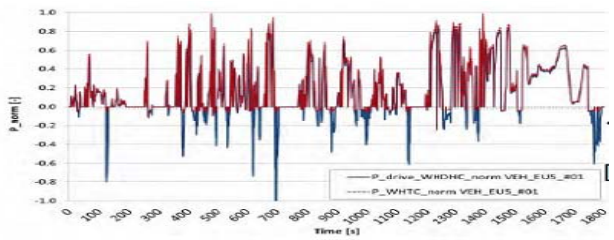
In case of actual hybrid ECU it is used for only HILS simulated run so “hybrid cold start algorithm” should be realized in HILS.

One solution is to put “water temperature profile by test result of actual cold start event of vehicle or engine” into interface model and send them to “actual hybrid ECU” in cold start HILS simulated run.



HILS simulated run concept for WHDHC by using open source model

WHDHC power pattern



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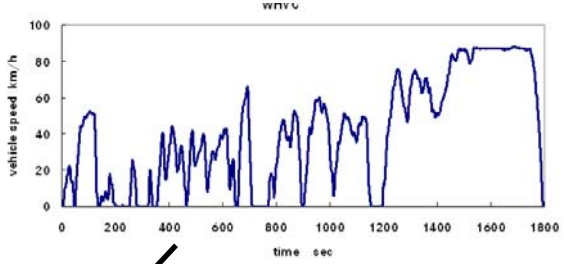
Vehicle speed pattern (WHVC)



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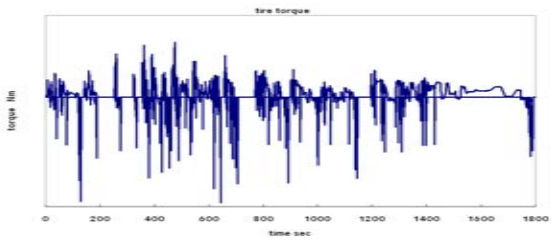
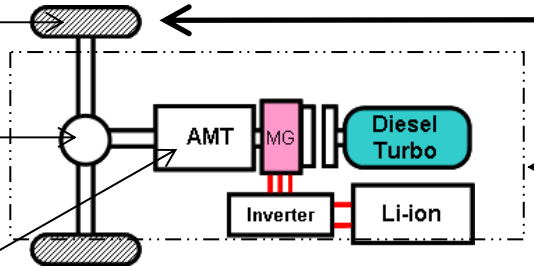
Vehicle tire torque pattern



Dynamic tire radius

Diff. gear ratio

Transmission gear ratios



Road gradient pattern

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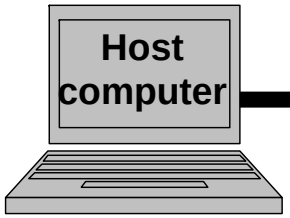
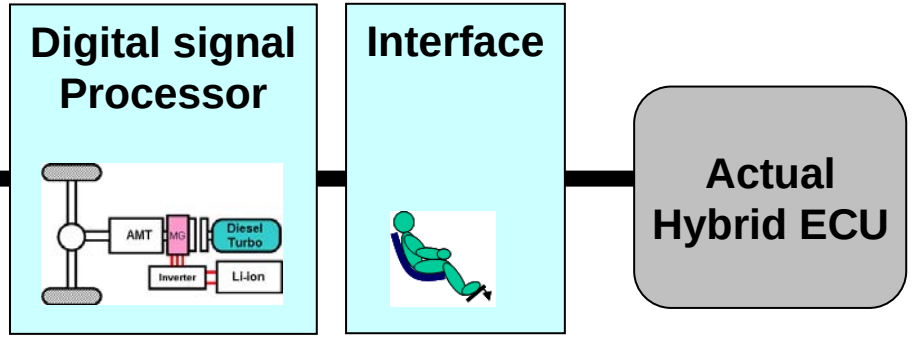
Vehicle mass

HILS system



HILS system



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