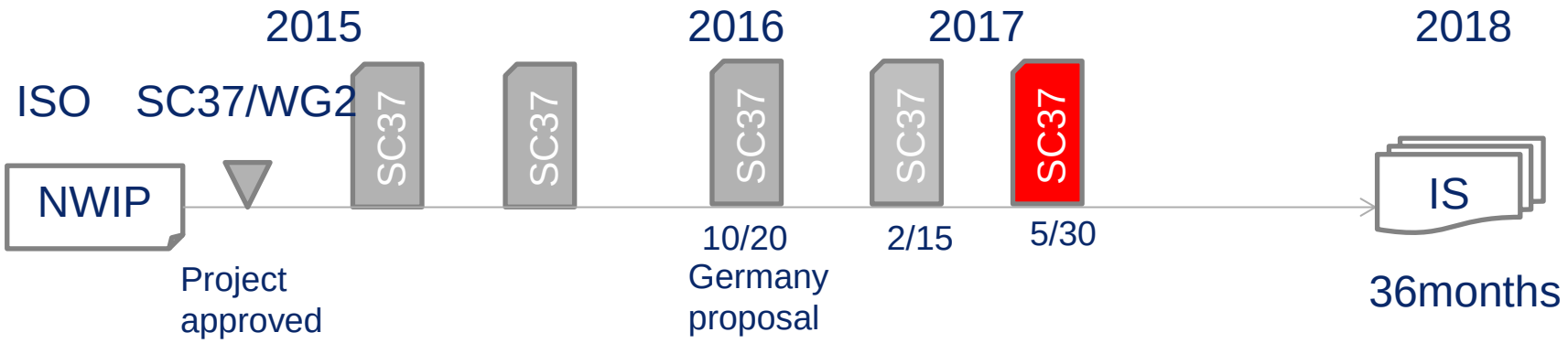
ISO Activity (Jun 7)

ISO CD20762
-Determination of power for propulsion of hybrid-electric vehicle

Masao KUBODERA

ISO activity

ISO /CD 20762 Determination of power for propulsion of hybrid electric vehicles



WG 2 agreed on that the draft reflecting the meeting results will be balloted as a Draft International Standard at May 31.

CD voting from 9.Mar. to 5.May 2017

ISO CD 20762 has been formally approved May 8.

May Meeting : WG will propose the DIS vote

DIS Voting from Jun to Nov. 2017

EVE will be able to refer the document which will be published by ISO in Nov. 2017.

NWIP : New Work Item Proposal , CD: Committee Draft ,
DIS: Draft International Standard , IS : International Standard

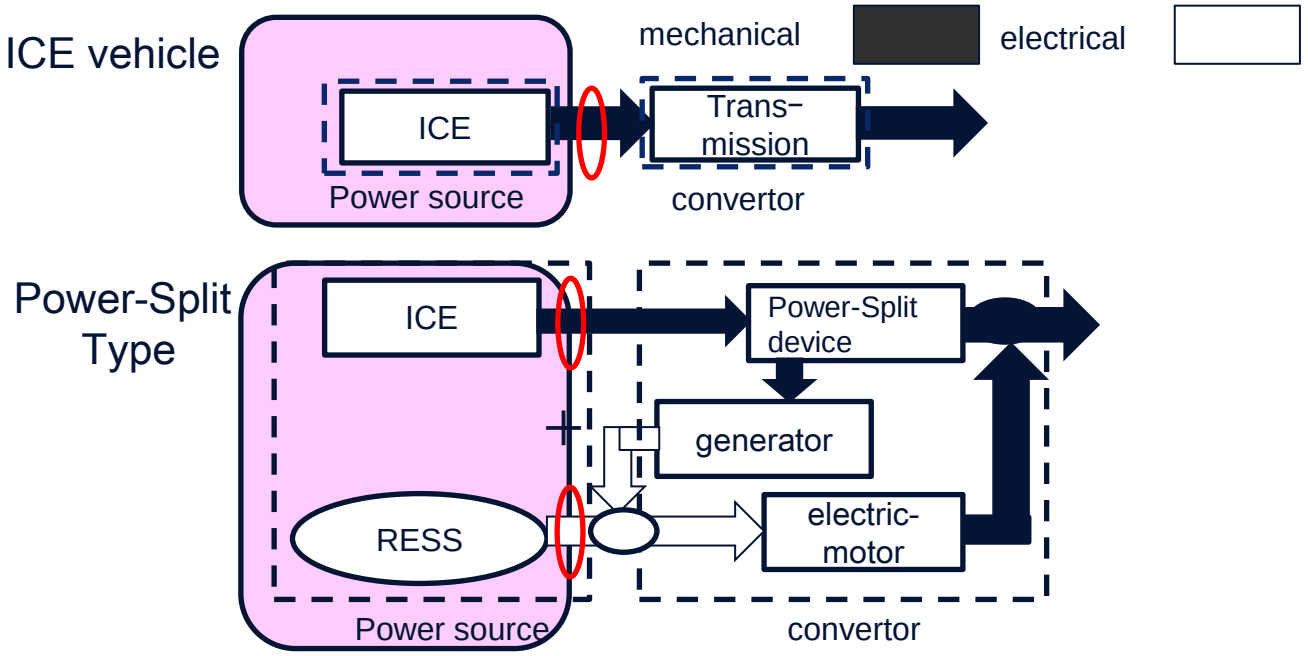
Test method

TP1:JARI method

TP2:VDA method

Power source & HEV System layout

JARI proposed to compare “Power source” to be input to the HEV system so as to be compared with the Conventional Vehicle.



In order to evaluate the power source(s) , it is appropriate to add the power of ICE and RESS.

By evaluating the power source,
the single formula can show HEV system power of various types.

HEV system power = ICE power + RESS power

JARI proposal considering over-estimation

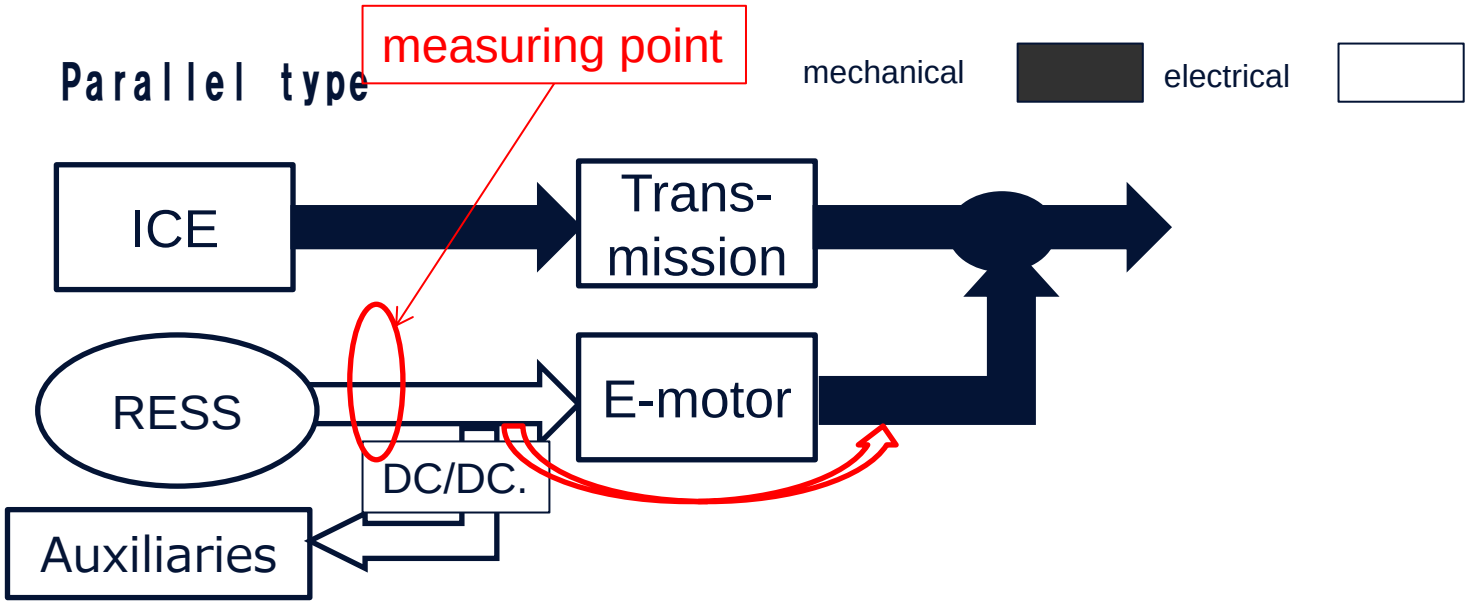
JARI made the following suggestions to overcome concerns of overestimation for adding all of the measured RESS power.

(1)Power to the DC/DC converter for auxiliaries is around 0,3 – 1,0 kW.
It is subtracted from the RESS measured power since it does not contribute to the propulsion power. The amount of power to be subtracted is specified to 1,0kW or measured value. The 1,0kw can be commonly agreeable as shown by the actual measurements.

(2)The power to be supplied from the RESS to the driving motor is multiplied by the conversion efficiency (for example, 0,85 or the measured value) and converted into the mechanical power.

HEV system power ＝
ICE power ＋ （RESS measured power－P_{DCDC}） x K

P_{DCDC} : power to d.c./d.c. converter for 12V auxiliaries(1,0kW or measured value) [kW]
K : conversion factor from electrical power to mechanical power (0,85 or measured value)
Conversion factor is defined as output power of motor divided by input power of inverter.



RESS power = (RESS measured power – P_{DCDC})

P_{DCDC} (kW) : consumed for 12V auxiliaries (1,0kW or measured value)

RESS power is converted into mechanical power by motor.

Converted RESS power = RESS power x K

K : conversion factor from electrical power to mechanical power auxiliaries (0.85 or measured value)

HEV system power =
ICE power + (RESS measured power − P_{DCDC}) x K

Test method

Test condition

>the vehicle at a fixed speed

>the RESS of the vehicle shall be charged to the SOC specified by the vehicle manufacturer.

1) a 2 s peek power ;the maximum power can be identified by applying a 2 s moving average filter sufficient duration such as 10 s.
2) a sustained power; 10 s time duration and take the 2 s average torque and speed values at the time between 8 and 10 s.

TP1:JARI method

HEV system power = ICE power *
+ (RESS measured power - power to DCDC converter)
x conversion efficiency from electrical power to mechanical power

ICE power *:Prepare measurement values in advance according to ISO 1585.

TP2:VDA method

To measure the power at the gear box output shaft and calculate back the system output by the gearbox efficiency

$$\text{HEV system power} = \frac{\text{HEV system power value at axle/wheel}}{\text{gearbox system efficiency factor}}$$

TP1:JARI method

Rev.
Intake press.

W

Dyno

Measurement duration: 10 s
1) a 2 s peek power
2) a sustained power

Power

ICE+RESS

ICE_Rev

RESS_power

10s

Time →

Engine test result

KW

rev

ICE + RESS = Hybrid system power

RESS power= $(U_{RESS} \times I_{RESS} - P_{DCDC}) \times k$

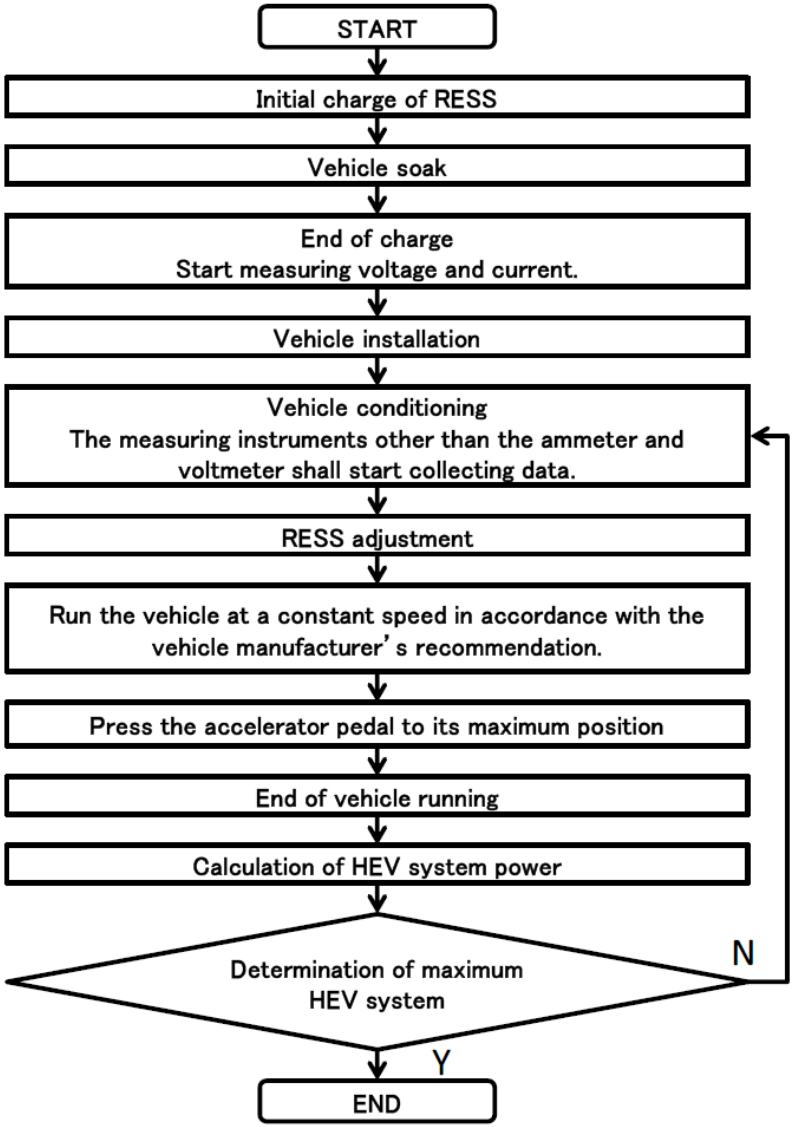
Power curve preliminarily measured according to ISO 1585

※unit test data of ICE was provided by manufacturer at this test.

25℃ charge for OVC-HEV

Warm up and stabilized

The SOC shall be adjusted by regenerative braking



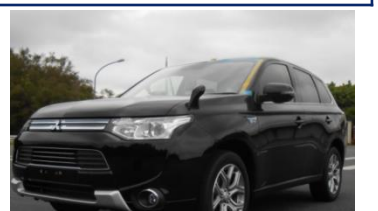
JARI Activity for max. HEV system power

JARI TEST REPORT

specification

		2015		2016
		A	B	C
vehicle	Length × width × height m	3.99×1.69×1.44	3.95×1.69×1.52	4.69×1.80×1.71
	Vehicle Weight kg	1080	1160	1820
	Gross vehicle weight kg	1355	1435	2095
	Test vehicke kg	1340	1360	1933
engine	displacemt L	1.496	1.496	1.998
	Maximum power kW	54	81	87
motor		AC SYNCHRONOUS MOTOR		
	Maximum power kW	45	22	60/60
*HEV system	Maximum HEV system power kW	73	101	-

*HEV system : OEM info

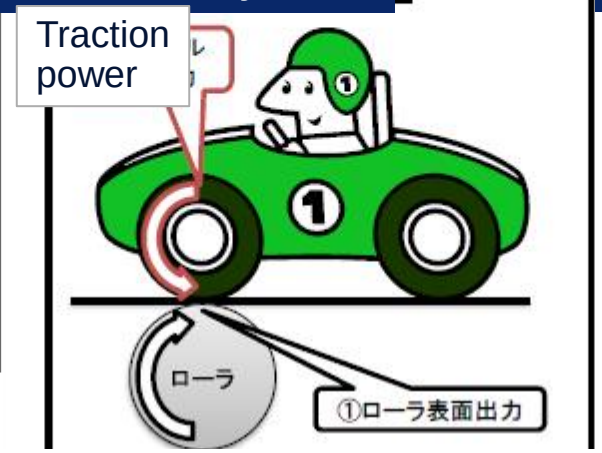


JARI test (test facility)

Test course

①Vehicle power
=Vehicle speed X
Vehicle Mass X acc.
+ Road load
(GPS speed meter accelerate sensor)
②Wheel power
Wheel torque sensor

Chassis dynamo



①Roller surface power
=Roller torque X Roller speed

②Wheel power
Wheel torque sensor

Hub dynamo

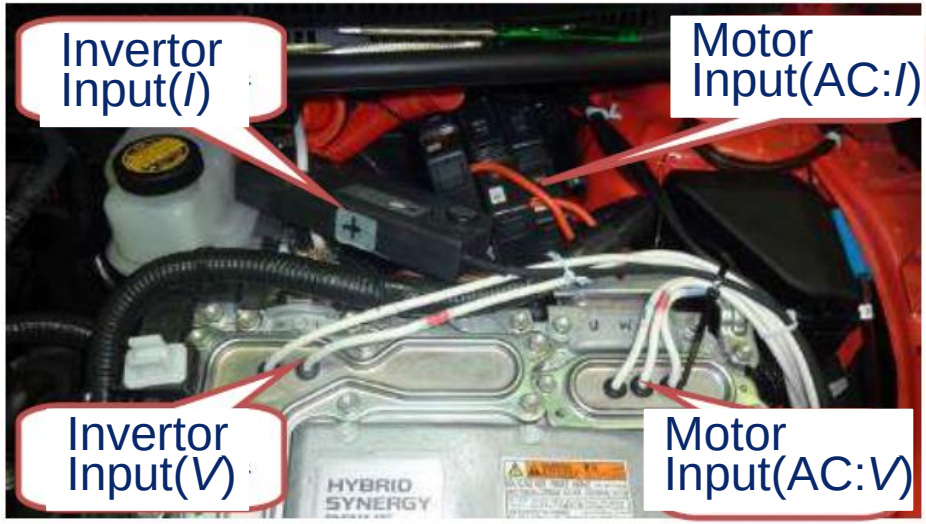
②Wheel power
Hub dynamo

*試験自動車の回転部分の相当慣性重量は，TRIASに準じて車両重量の3.5%とした

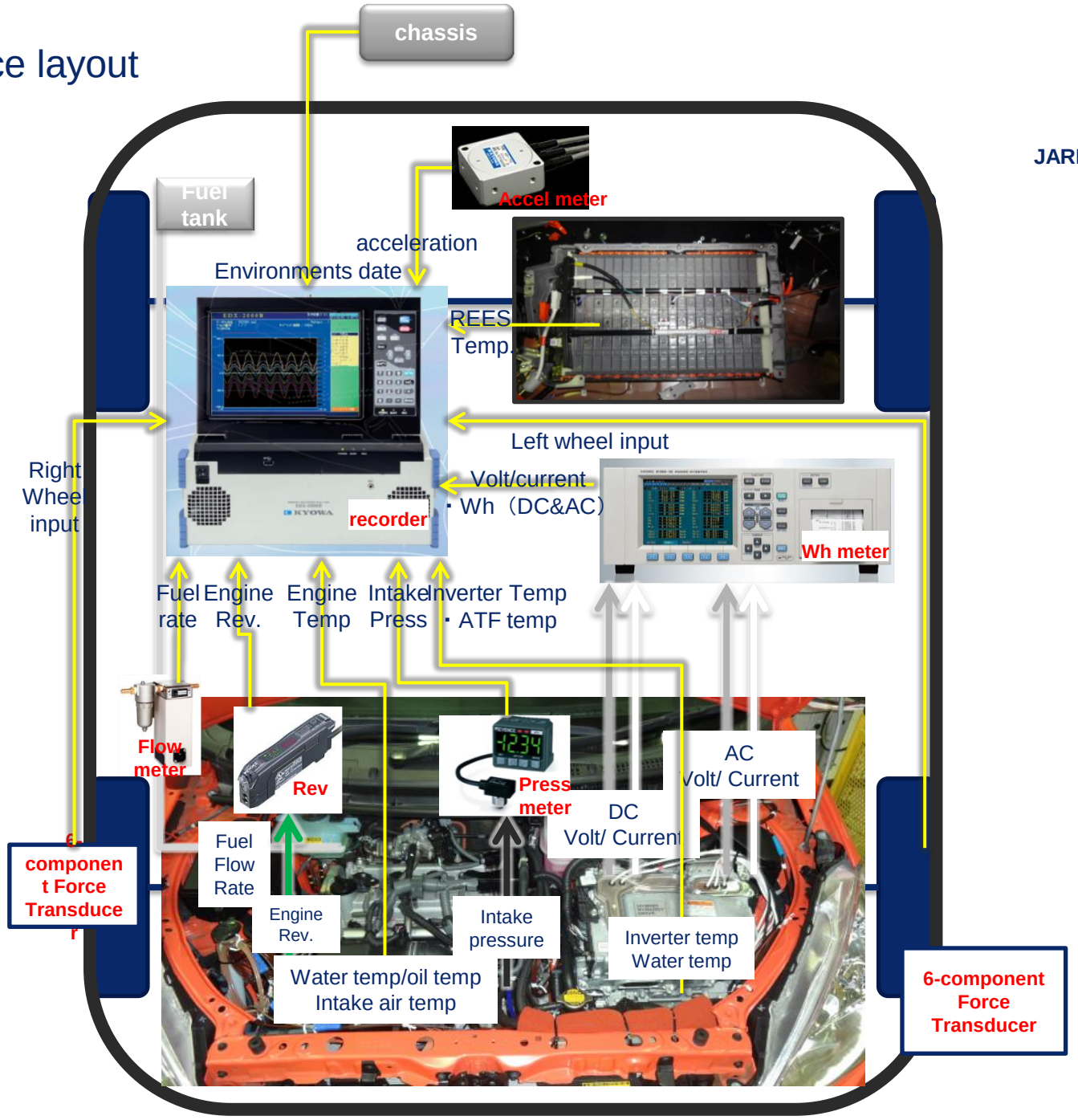
Example of measurement point

Intake manifold press.

Electric power measurement



Measuring device layout



Test result － deviation

JARI TEST REPORT

		Test course			chassis dynamometer			Hub dynamometer		
試験車両		A	B	C	A	B	C	A	B	C
Accel-mertor	HEV system power	58.1kW	72.6kW	131.6kW	61.2kW	84.8kW	123.6kW	-	-	-
	Measurement method	Accelerometer			Roller torque			Hub dynamo		
Roller torque (CD)	deviation	**-1.2～2.4%**	**-10.9～10.9%**	**-2.1～1.9%**	**-0.7～1.1%**	**-2.2～2.0%**	**-0.2～0.3%**	-	-	-
	Measurement error factor	Tire loss, environments, accelerometer			Tire loss			-		
hub	HEV system power	62.8kW	73.3kW	131.3kW	63.9kW	88.7kW	137.0kW	64.0kW	88.0kW	131.6kW
	Measurement method	Wheel torque meter			Wheel torque meter			Hub dynamometer		
	deviation	**0.5～0.5%**	**-11.7～11.6%**	**-3.3～2.8%**	**-1.3～0.8%**	**-2.1～1.8%**	**-0.9～0.6%**	**-1.3～0.8%**	**-0.3～0.2%**	**-0.5～0.5%**
JARI method	HEV system power	73.8kW	91.8kW	146.4kW	73.2kW	92.6kW	147.3kW	73.1kW	92.6kW	147.3kW
	Measurement method	ICE+RESS*			ICE+RESS*			ICE+RESS*		
	deviation	**-0.5～0.4%**	**-1.7～1.0%**	**-0.3～0.2%**	**-0.4～0.4%**	**-0.3～0.4%**	**-0.1～0.1%**	**-0.2～0.2%**	**-0.8～1.1%**	**-0.1～0.1%**

* In JARI test report , RESS means U_{RESS} x I_{RESS}

The JARI method has a smaller measurement deviation than other methods

Warming up

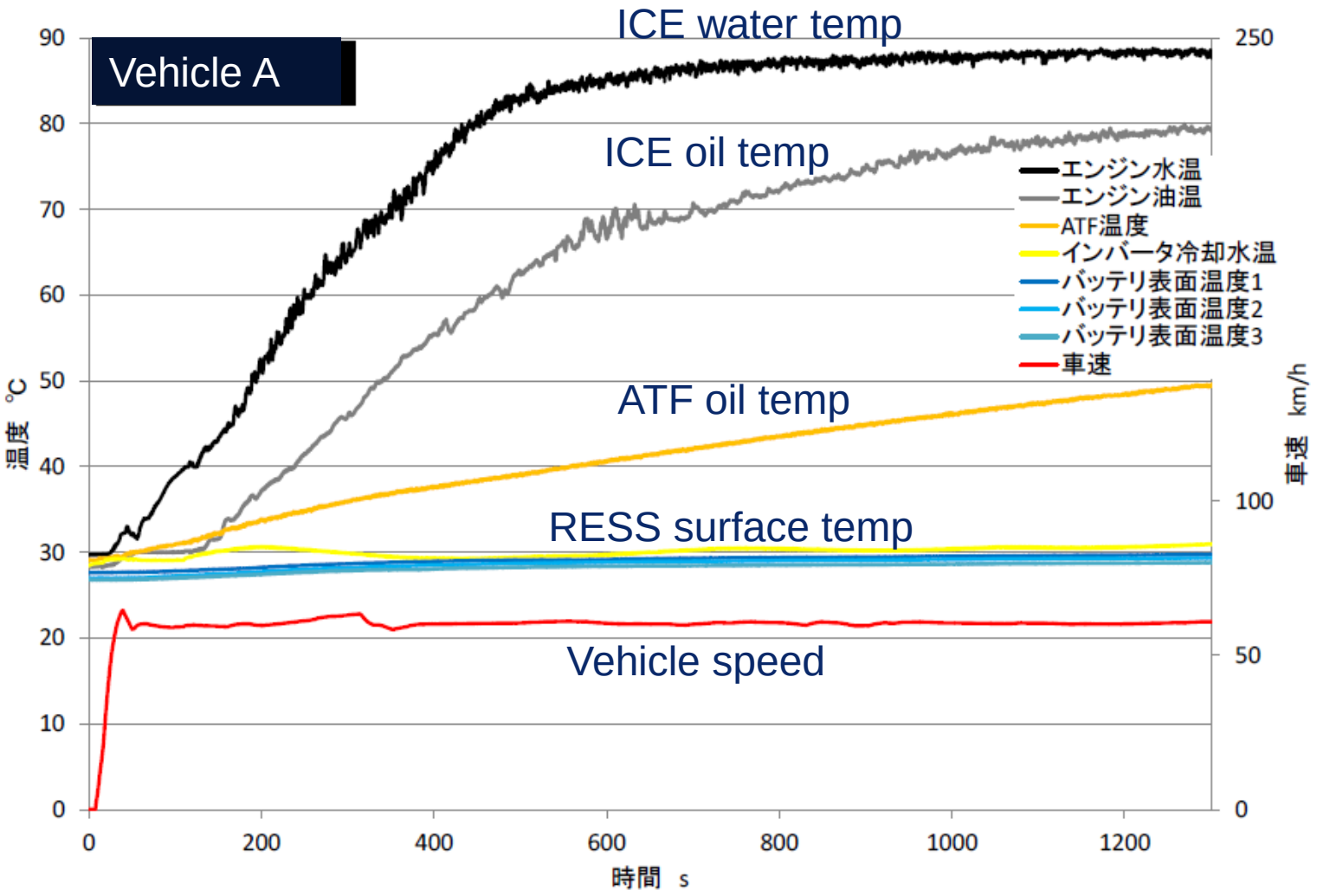
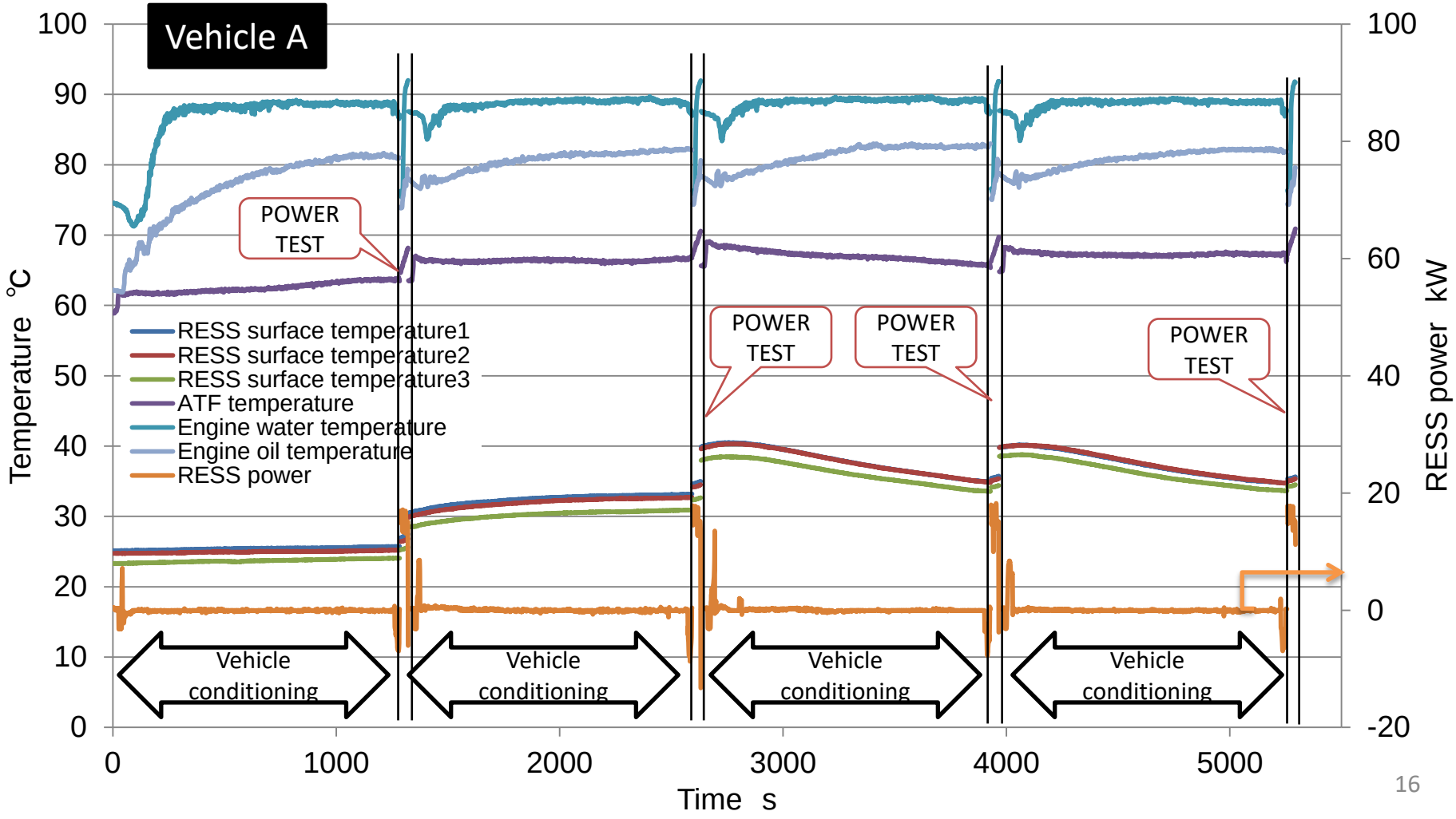


図 5.41　60km/h 一定速度で暖機した場合の温度変化（試験車両 A）

ICE warm up ends at 20 minutes(25℃ Ambient Temp. SOAK　12Hr moreover）

Vehicle conditioning

In order to stabilize the vehicle, it shall run at the speed of 60km/h at varying loads for at least 20 min or with the vehicle manufacturer's recommendation.



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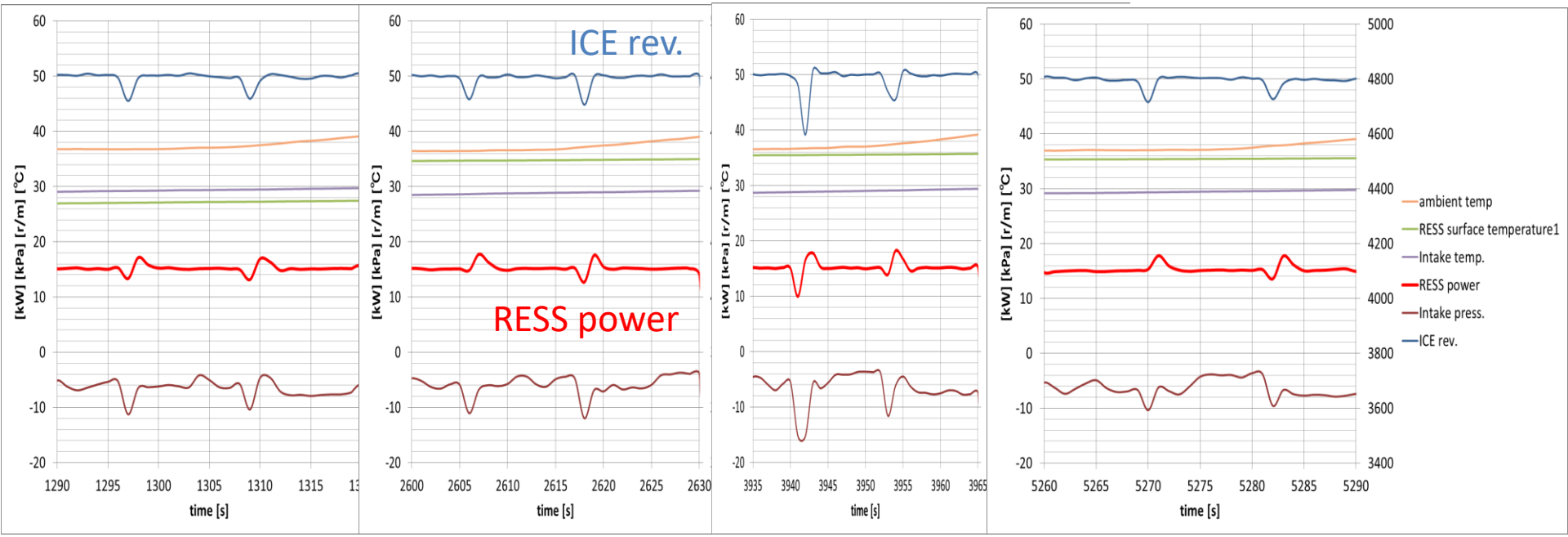
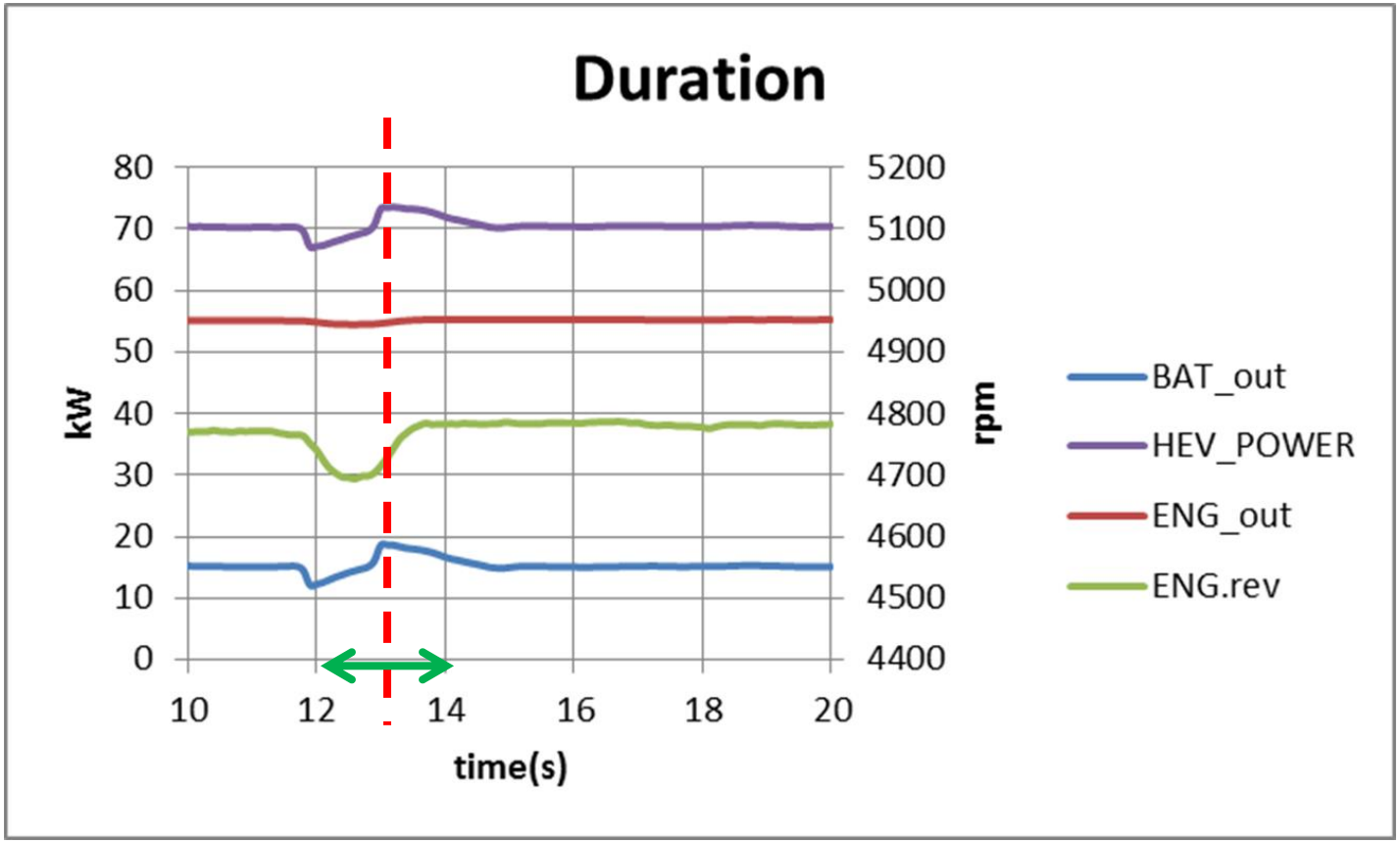
Power test



The test results are repeatable, and stabile.

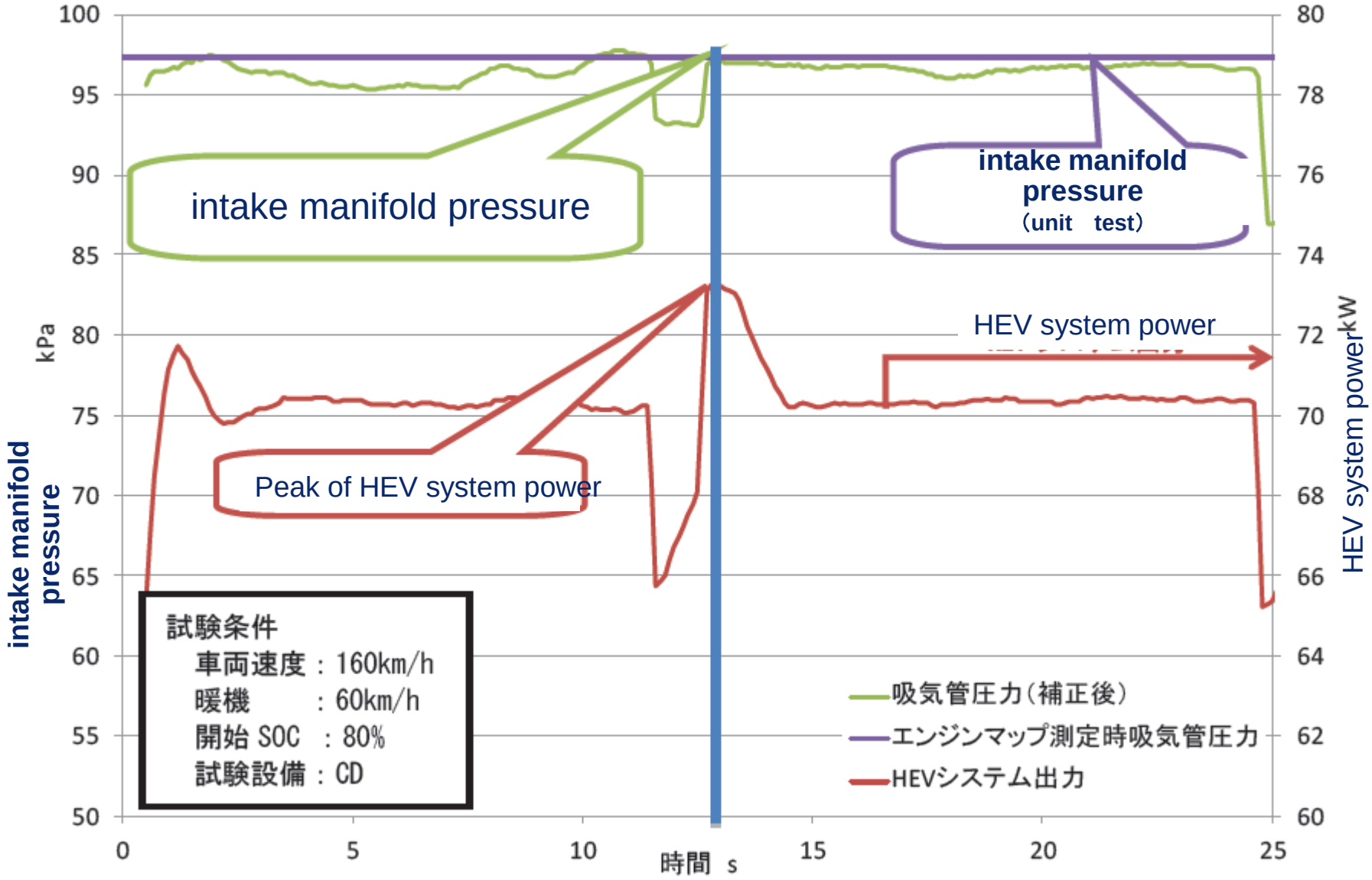
* In JARI test report , RESS means U_{RESS} x I_{RESS}

2 s peek power



Sufficient duration such as 10 s when the maximum power can be identified by applying a 2 s moving average filter.

The value at which the total of ICE power and RESS power becomes maximum is maximum HEV system power at this vehicle speed.


intake manifold pressure
intake manifold pressure
（unit　test）
HEV system power
Peak of HEV system power
intake manifold pressure
kPa
HEV system power kW
時間　s
試験条件
車両速度：160km/h
暖機　　：60km/h
開始 SOC　：80%
試験設備：CD
吸気管圧力（補正後）
エンジンマップ測定時吸気管圧力
HEVシステム出力
100
95
90
85
80
75
70
65
60
55
50
80
78
76
74
72
70
68
66
64
62
60
0
5
10
15
20
25

Directive 80/1269/EEC as amended, ECE Regulation 85

Engine power (positive ignition)

Job/Rep

Prius 1．8 L ECE－R85 test results

Engine: 2ZR-FXE
Cubic capacity: 1.798 Litres
Number of cylinders: 4
2 or 4 stroke: 4

Density: 0.7477 kg/l@15°C

Engine Speed	rpm		1600	2000	2400	2699	2799	3200	3599	4000	4400	4499	4800	5100	5200	5300
Indicated torque	Nm	1.	128.0	133.0	140.3	142.3	144.1	143.8	143.8	143.8	143.5	142.3	141.5	137.1	135.6	129.8
		2.														
Indicated Power	kW		21.45	27.86	35.26	40.22	42.24	48.19	54.20	60.23	66.12	67.04	71.13	73.22	73.84	72.04
Fuel consumption	kg/hr	1.	5.06	6.28	7.92	9.01	9.38	10.72	12.18	13.77	15.35	15.62	16.72	17.64	17.97	18.15
		2.														
Temperature at injection pump	°C		25.9	26.5	26.7	26.8	26.8	26.8	26.8	26.6	26.5	26.5	26.4	26.4	26.4	26.4
Temperature at fuel measurement	°C		24.8	24.8	24.9	25.2	25.3	25.7	25.7	25.9	26.0	26.2	26.3	26.6	26.8	26.9
Temperature of Coolant	°C		85.7	86.3	87.0	87.3	87.2	87.3	87.2	87.1	87.1	87.3	87.5	87.4	87.4	87.5
Oil temperature @ main gallery	°C		87.5	95.3	99.7	103.0	106.1	108.4	107.0	100.6	102.3	102.4	105.8	105.2	105.2	105.5
Air Intake temperature	°C	1.	23.8	25.0	25.0	24.9	24.7	24.9	24.9	24.7	24.6	24.7	24.7	24.7	24.5	24.4
	°C	2.														
Intake depression	kPa (X)		1.27	1.91	2.85	3.02	3.06	3.91	5.00	5.30	3.95	3.18	2.26	2.04	2.07	2.07
Temperature after turbo-charger	°C															
Pressure after turbo-charger	bar															
	kPa															
Temperature at intercooler outlet	°C															
Pressure at intercooler outlet	bar															
	kPa (Y)															
Exhaust temperature	°C		657.5	694.7	737.3	759.0	769.6	785.1	805.6	831.8	844.8	846.3	858.8	877.2	883.5	895.3
Exhaust pressure	mbar															
	kPa		5.73	8.81	10.98	13.38	14.32	17.98	21.12	24.82	28.28	28.83	31.83	33.85	34.90	35.40
Barometric pressure(H:72/306)	mbar															
	kPa		101.54	101.54	101.54	101.54	101.54	101.54	101.54	101.54	101.54	101.54	101.54	101.54	101.54	101.54
Humidity	%															
Vapour pressure	kPa		1.75	1.78	1.78	1.79	1.75	1.70	1.73	1.77	1.84	1.84	1.83	1.81	1.78	1.78
Dry atmospheric (ps)	kPa		99.79	99.76	99.76	99.75	99.79	99.84	99.81	99.77	99.70	99.70	99.71	99.73	99.76	99.76

Intake manifold pressure

Determination of maximum HEV system power

The maximum HEV system power shall be determined as the maximum value in the power-speed curve (see Figure). This requires measurements at various fixed dynamometer speeds or at one fixed speed only, if defined in accordance with the vehicle manufacturer's recommendation.

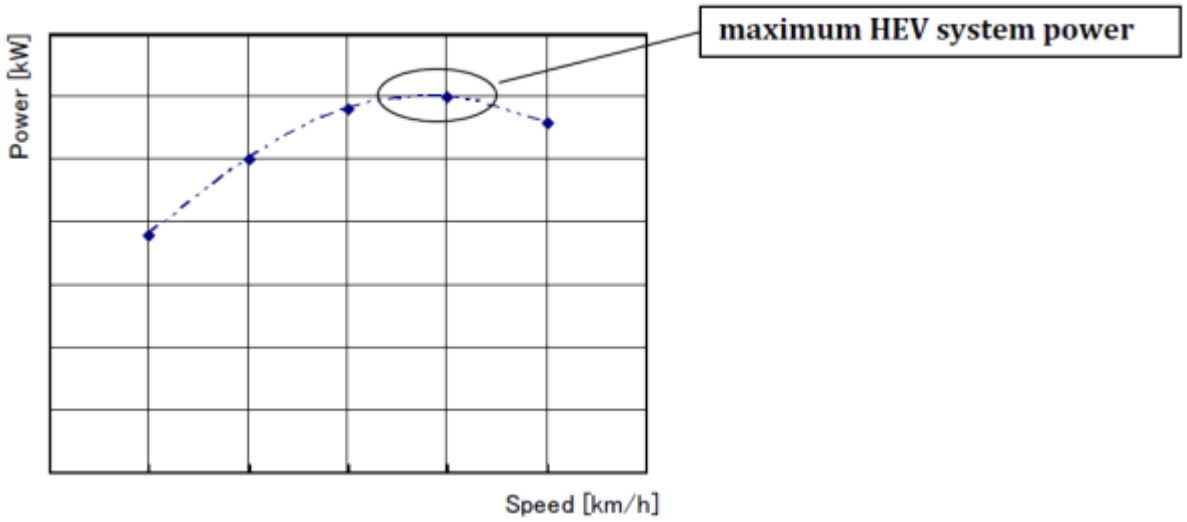
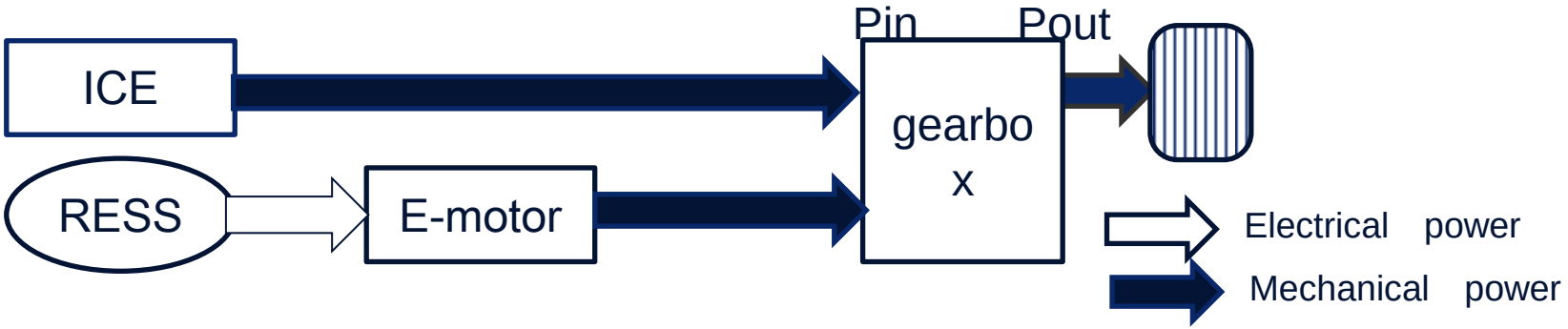


Figure — Power vs. speed curve

TP2 (VDA method)

Parallel hybrid electric vehicle (Parallel HEV)



$$\eta Gearbox\ (Parallel\ Hybrid, Dual - clutch\ automatic\ gearbox) = 0{,}97$$

$$\eta Gearbox\ (Parallel\ Hybrid, Dual\ /\ Multi - speed\ automatic) = 0{,}96$$

VDA method: TP2

To measure the power at the gear box output shaft and calculate back the system output by the gearbox efficiency

$$\text{HEV system power} = \frac{\text{HEV system power value at axle/wheel}}{\text{gearbox system efficiency factor}}$$

TP2 (VDA method)

The gearbox system efficiency factor ,ηGearbox, indicates the efficiency value for the mechanical power transfer for propulsion from input (Pin) to output (Pout) of the gearbox system.
The gearbox system efficiency factor depends on individual gearbox system configurations. Therefore a value for this factor shall be used according to the vehicle manufacturer's recommendation.
Or if not available, according to similar HEV examples .

ICE power correction factors
The ICE power portion of the maximum HEV system power shall be corrected according to the provision given in ISO 1585 clause 6, if the reference atmospheric and temperature conditions, given in ISO 1585 clause 6.2.1, or the automatic control conditions according to ISO 1585, clause 6.3 cannot be fulfilled.

The torque and rotational speed measurement devices can be substituted by traction force and speed measured by the chassis dynamometer, if the accuracy of this measurement devices fulfill the same requirements as for the shaft/wheel measurement devices. If so, the measured values for traction force and speed have to be transformed by calculation to the required values for torque and rotational speed at shaft/wheel taken into account the specific data of the tires and the proportional vehicle weight at axle/wheel used during the test (e.g.: rolling friction losses, dynamic rolling radius).

APPENDICS

Examples of representative HEV in Japan

The product of inverter and motor efficiency is 0.85 - 0.94
Motor type: Permanent Magnet Motor

2004 PRIUS

International

ISO TC22/SC21/WG2

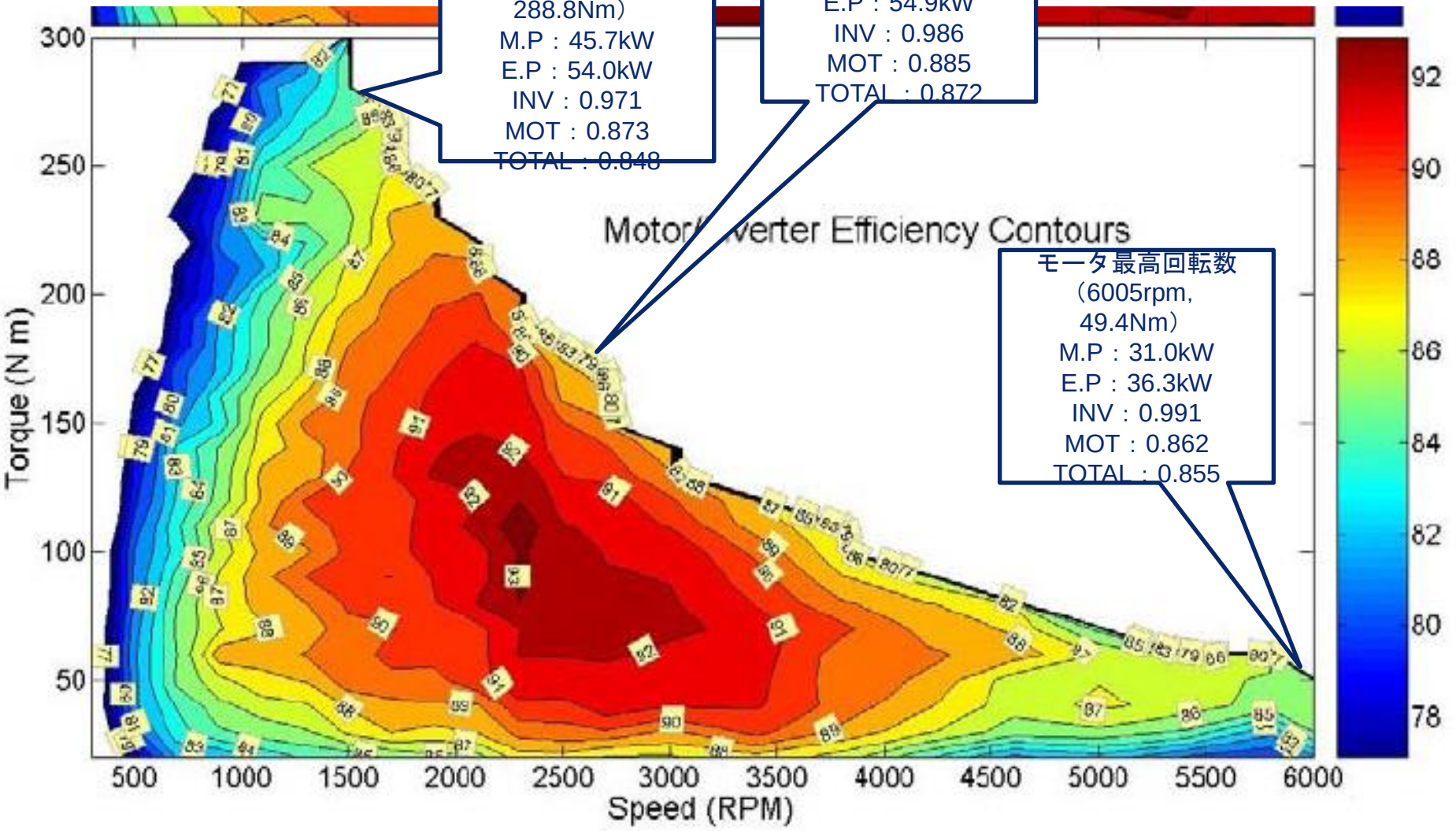
...hance & energy consumption measurement

島村コメント：
この年のレポートはグラフだけでなく，生データ付でしたので，モータ最高出力点が把握できてます．（HEVシステム最大出力点ではありません）

肩の付近
（1512rpm,
288.8Nm）
M.P：45.7kW
E.P：54.0kW
INV：0.971
MOT：0.873
TOTAL：0.848

モータ最大出力点
（2704rpm,
169Nm）
M.P：47.9kW
E.P：54.9kW
INV：0.986
MOT：0.885
TOTAL：0.872

モータ最高回転数
（6005rpm,
49.4Nm）
M.P：31.0kW
E.P：36.3kW
INV：0.991
MOT：0.862
TOTAL：0.855



2005　ACCORD

島村コメント：
この年のレポートはグラフだけですので，効率は目検討です．
TOTALは計算値ではなく，グラフ読み取り値．

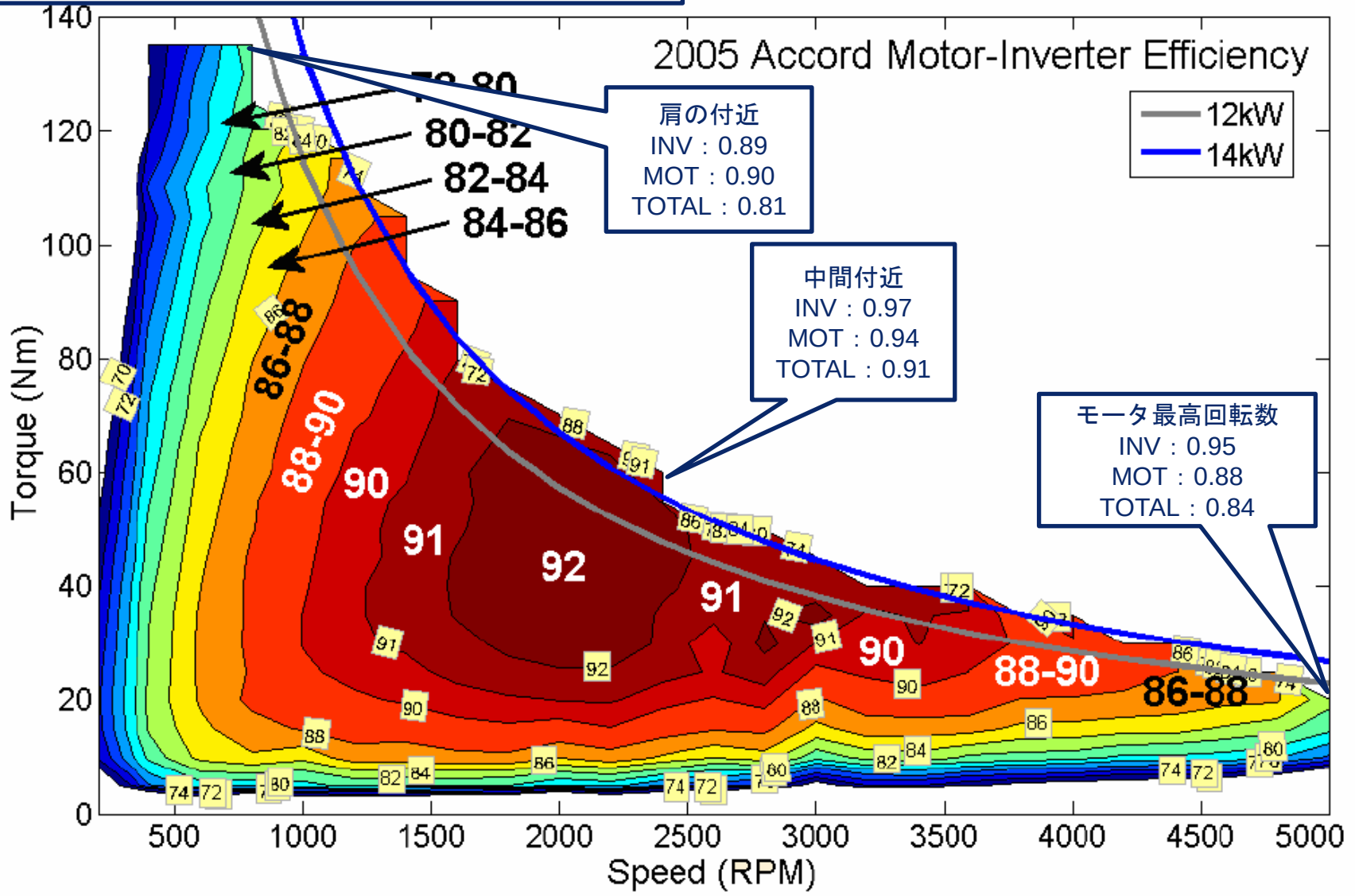


Fig. 3.11. 2005 Accord motor-plus-inverter efficiency contour map.

2010　PRIUS

島村コメント：
この年のレポートはグラフだけですので，効率は目検討です．
TOTALは計算値ではなく，グラフ読み取り値．

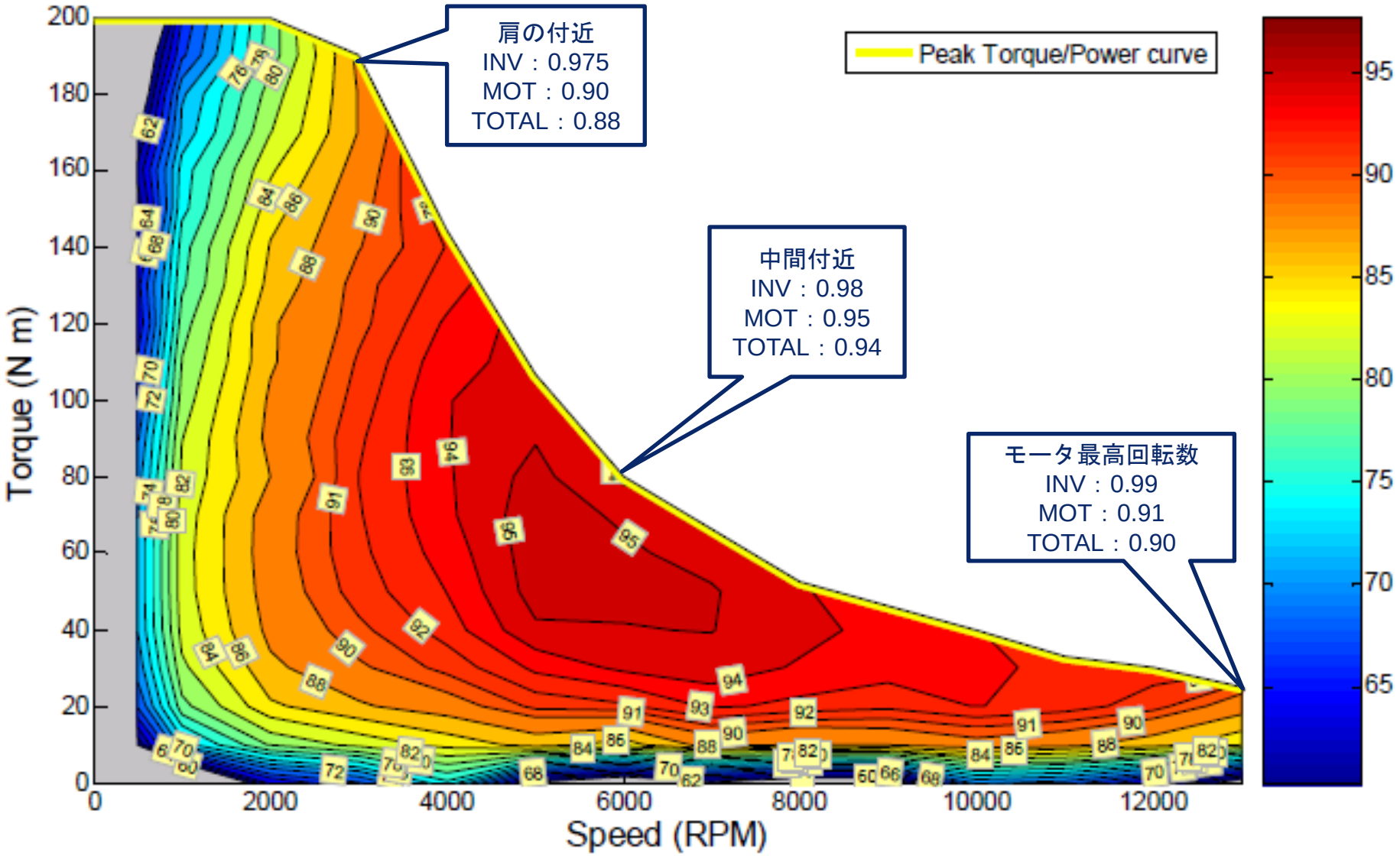
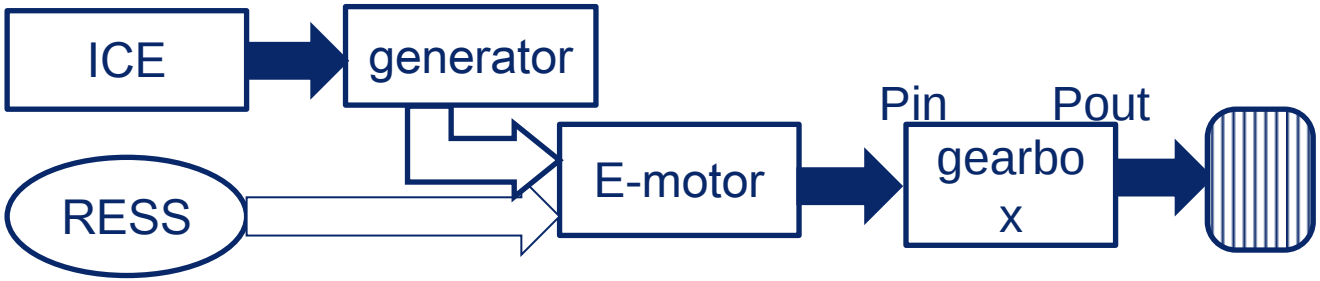


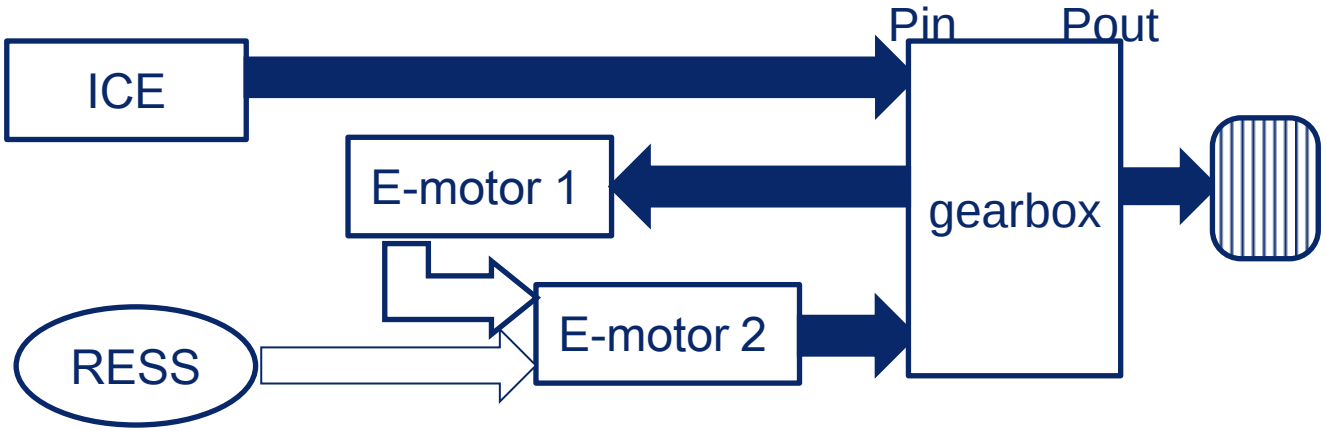
Fig. 3.15. 2010 Prius combined motor-inverter efficiency contours at 650 Vdc.

◆Series hybrid electric vehicle (Series HEV)



$$\eta Gearbox\ (Series\ Hybrid) = 0{,}98$$

◆Power split hybrid electric vehicle (Power split HEV)



ηGearbox (Power split Hybrid,planetary gear transmission system) =0,93