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European Commission

HDH Validation Program 2 (HILS)

A. Perujo
EC-DG JRC, Inst. for Energy and Transport,
Sustainable Transport Unit.

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San Francisco, USA

JRC

Content

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Goals

Provide methodology to verify the HILS model in the GTR

- Verification of HILS simulation model according to
  - Japanese method
  - test alternative methods
- Analyse relevant accuracy between HILS model and measurement for each measured magnitude
- Elaborate tolerable margins for the relevant magnitudes

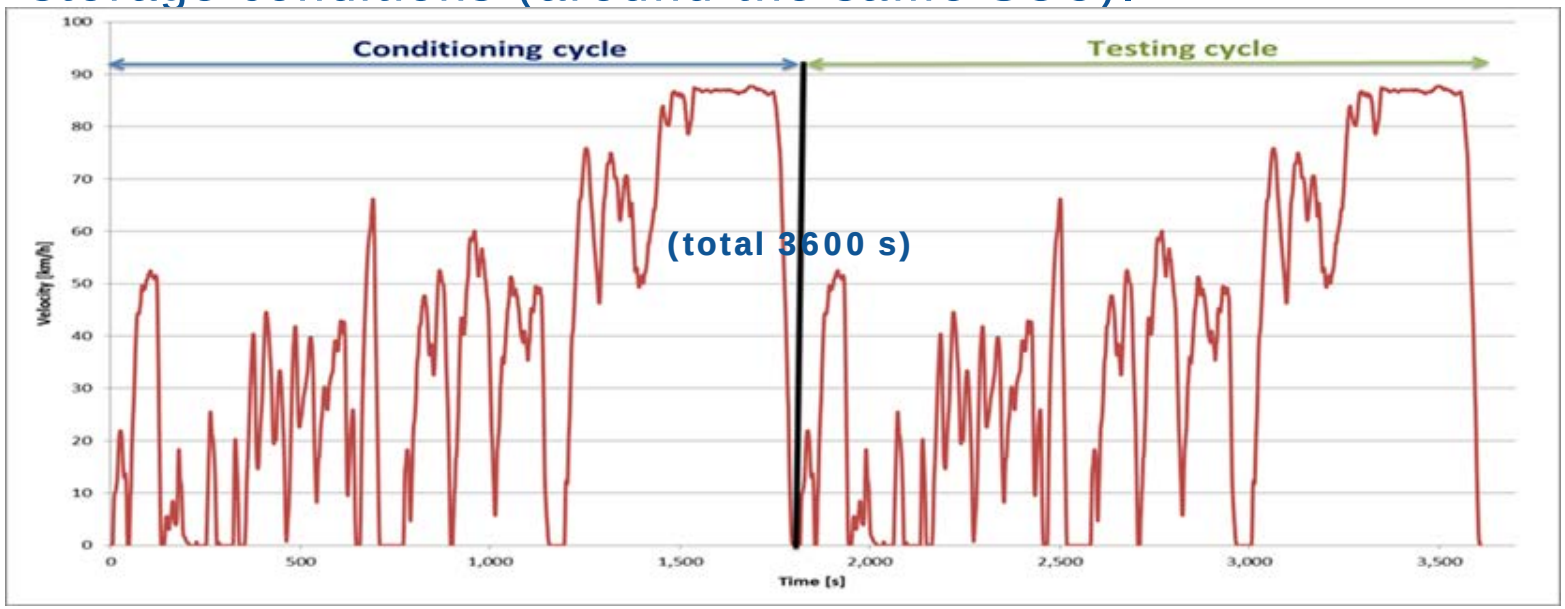
Elaborate new draft verification procedure for GTR (if necessary)

- on-road / dyno / both
- simulation rules for gear box and gear shift needed
- description of interface model and hybrid ECU needed

Measurement procedures

Procedure

- VTP2 tests shall be carried out with as many auxiliaries as possible shut down and for those required for the proper operation of the vehicle to measure/estimate their power consumption.
- Each test starts with a WHVC cycle. This has the objective to start the measurements (VTP2) having stabilized energy storage conditions (around the same SOC).



Measurement procedures

Kokujikan No. 281

10–5 Rolling resistance coefficient and air resistance coefficient

The rolling resistance coefficient and air resistance coefficient shall be calculated by the following formulas: Here, the rolling resistance coefficient and air resistance coefficient of route buses or general buses shall be the value obtained by multiplying by 0.680 the value calculated using the following formulas:

$$\mu_r = 0.00513 + \frac{17.6}{W}$$

$$\mu_a A = 0.00299 B \cdot H - 0.000832$$

where:

μ_r	:	Rolling resistance coefficient	(kg/kg)
$\mu_a A$	:	Air resistance coefficient × frontal projected area	(kg/(km/h)^2)
W	:	Vehicle mass at time of test	(kg)
		In the case of a truck, etc.: {Vehicle kerb mass + maximum loading capacity / 2 + 55}	(kg)
		In the case of a route bus or general bus: {Vehicle kerb mass + riding capacity × 55 / 2}	(kg)
		In the case of a tractor: {Vehicle kerb mass (tractor + trailer) + maximum loading capacity / 2 + 55}	(kg)
B	:	Overall width	(m)
H	:	Overall height	(m)

During the test of the second bus the universities realised that the factor 0.680 was to be applied only to the air resistance coefficient → the test with the first bus was repeated

Measurement procedures

Procedure

- Feed the torque/speed trace into the program provided by the universities to create the WHVC with ‘slopes’.
- Feed the new cycle to the Chassis Dyno and run the test with WHVC+slope (altitude compensated).
- Same as in point above but for a program to create a WHVC adjusted with slopes using 30sec moving average.

Measurement Campaign

3 vehicles (HDH) has been tested at JRC-Ispra

Parallel Hybrid

2 test campaigns
- 2nd half May 2013
- 2nd half of Sept 2013

Serial Hybrid

1 test campaign
- 2nd half June 2013

Parallel Hybrid

1 test campaign
- 1st half June 2013

Data Processing (status)

- **Data processing and comparison between experimentally measured parameters and parameters obtained by the HILS model is underway.**
- **Some difficulties need yet to be resolved concerning discrepancies.**
  - They might be due to differences in precision between both data sets.
  - **<u>Further investigation are being pursuit</u>**.

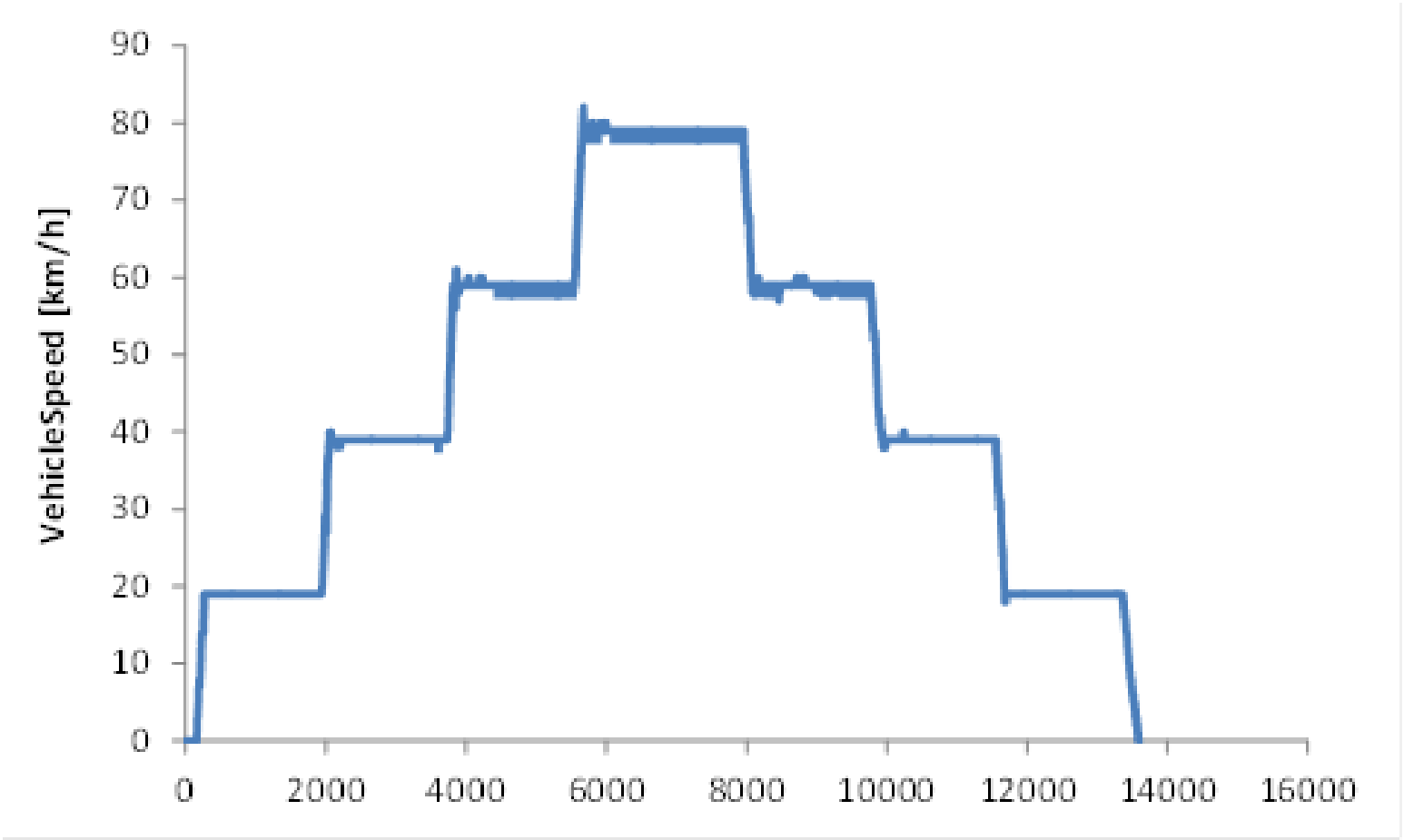
JRC - Chassis Dyno (VELA7)

Accuracy of VELA 7

- 20 ton truck was set up at VELA 7
- The truck wheels were set with torque measurement devices
- The truck run at steady speeds within the speed profile of the WHVC
- Values of engine torque (ECU), wheels torque and Dyno-roller torque were collected.
- The truck run the WHVC cycle (transient cycle)

JRC - Chassis Dyno (VELA7)

Speed profile:



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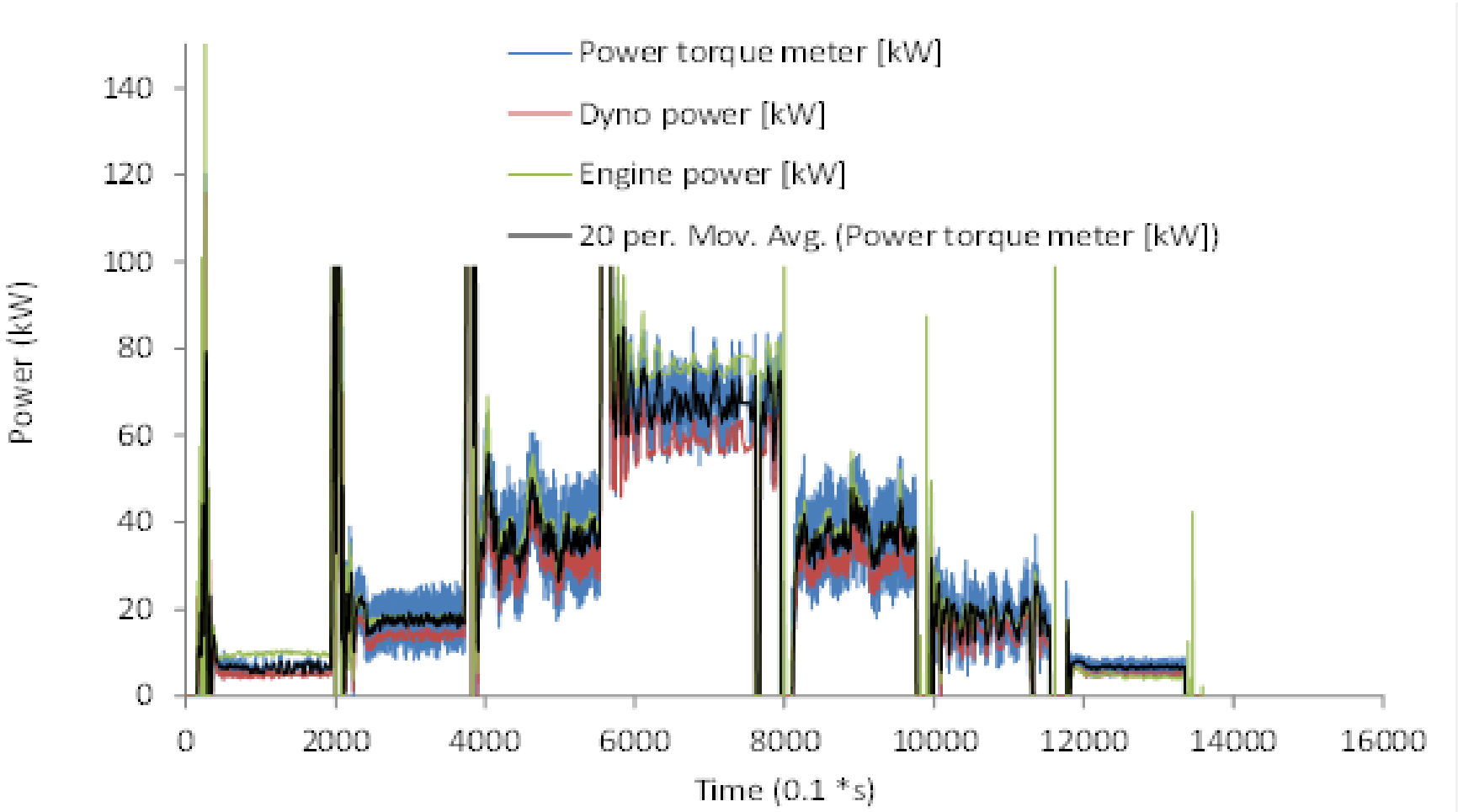
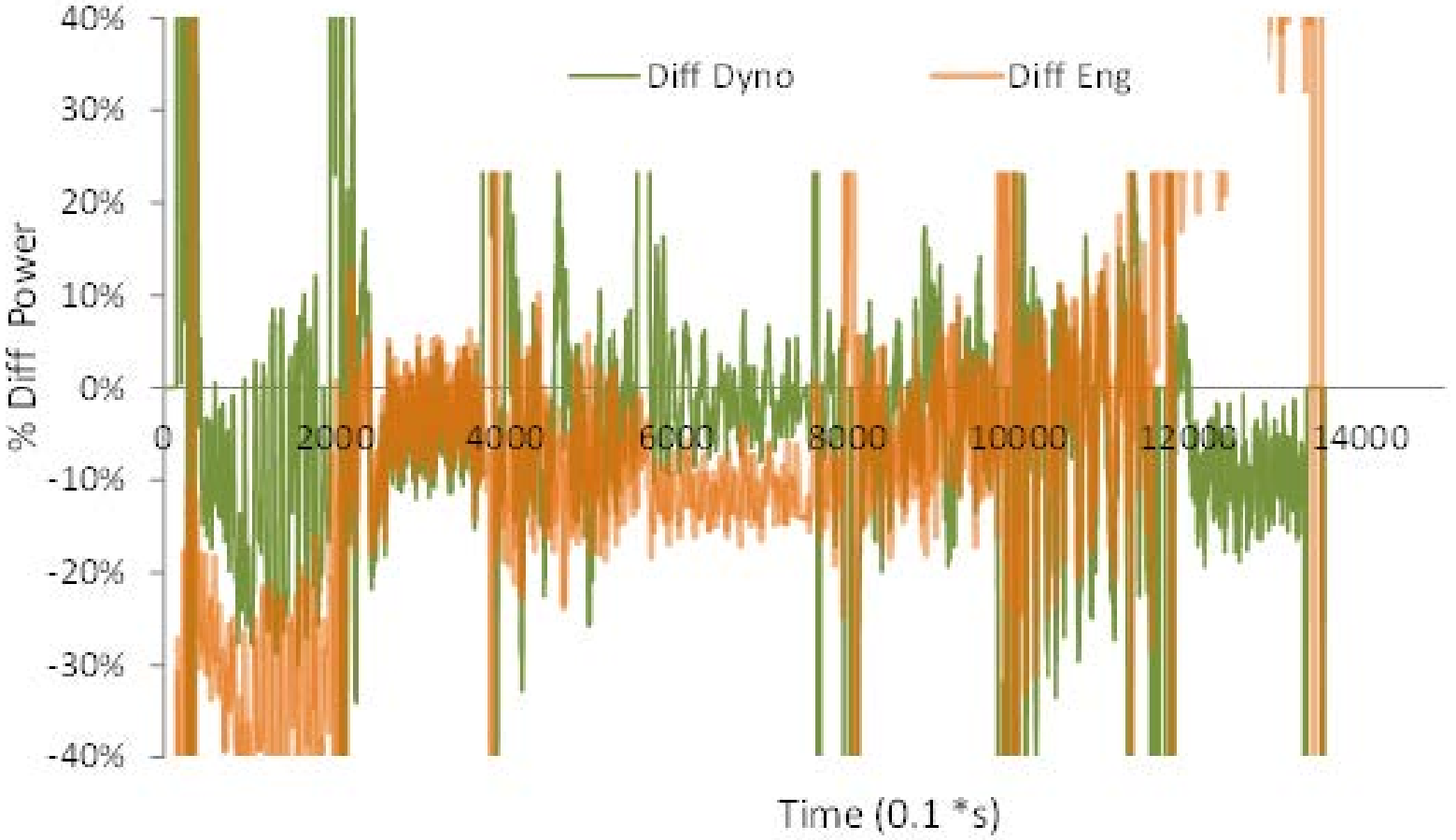
Recorded power profile:



JRC - Chassis Dyno (VELA7)

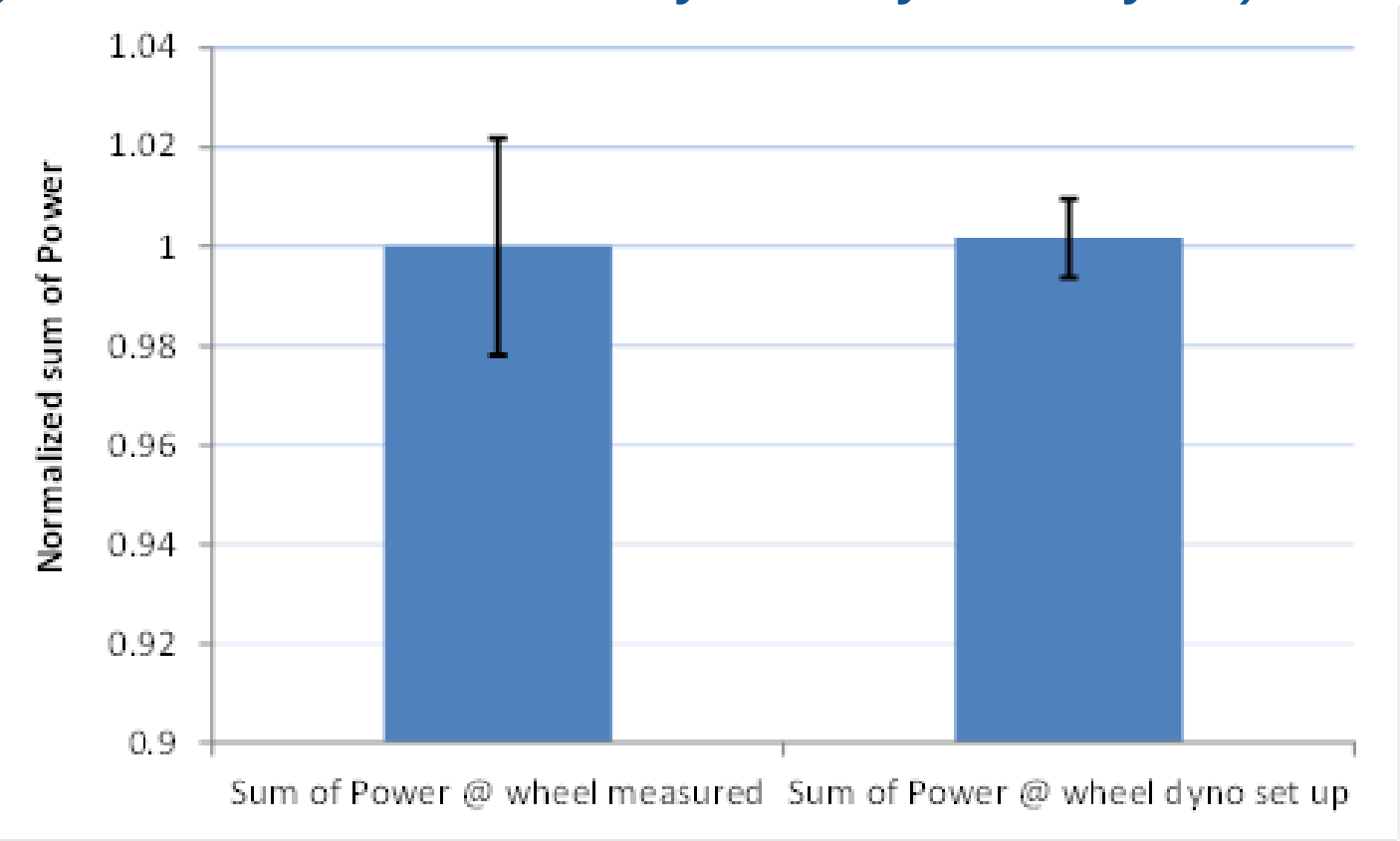
Difference between power @ the whieel (measure with torque sensor) and ECU power (orange) and Dyno measured power (green) as percentage of the power measured at the wheel.



JRC - Chassis Dyno (VELA7)

WHVC Results

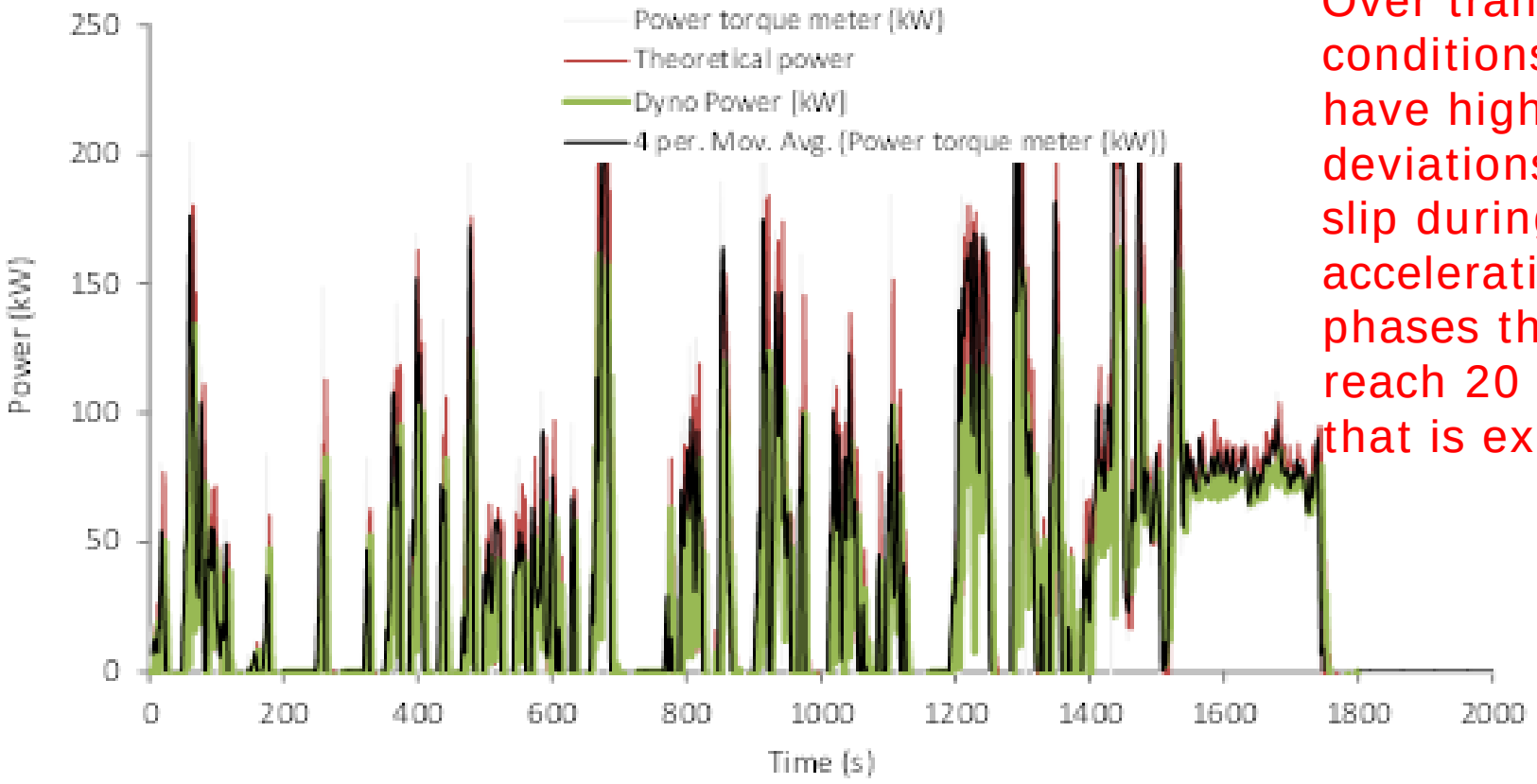
Total positive power over the cycle (normalized by the average measured over 6 cycles by the dyno)



JRC - Chassis Dyno (VELA7)

WHVC Results

Instantaneous signal over one WHVC cycle



Over transient conditions you have higher deviations due to slip during acceleration phases that may reach 20 % but that is expected.

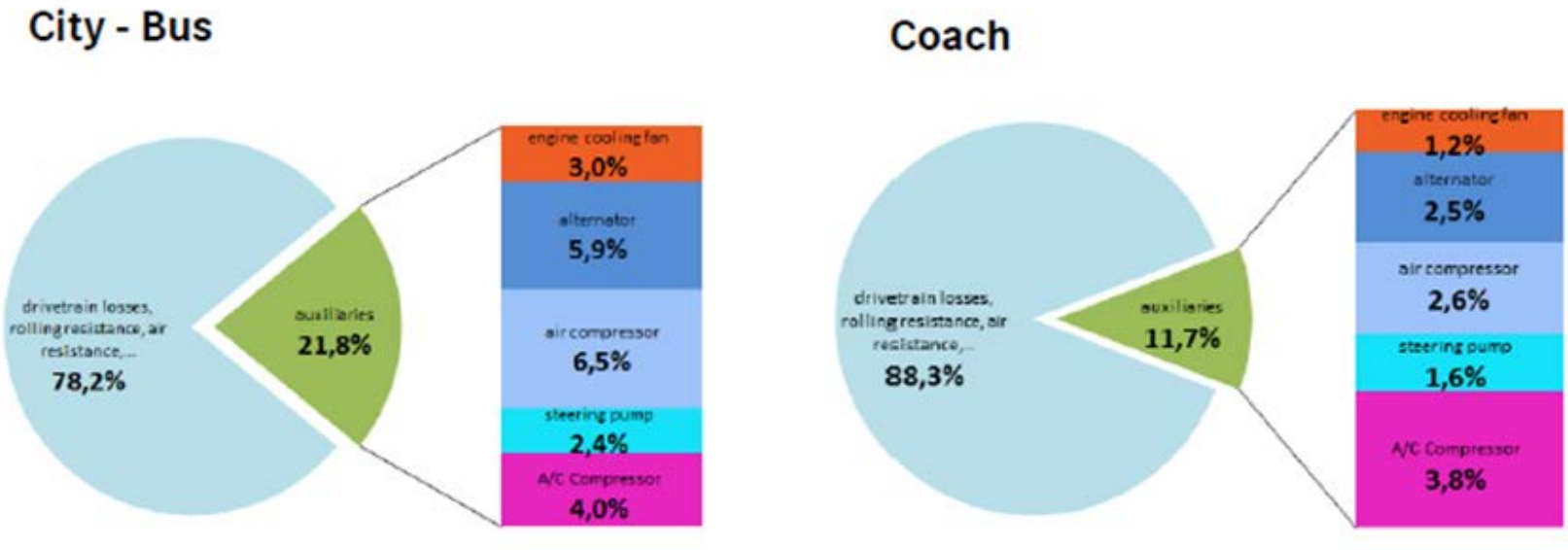
Thank you for your attention

Joint Research Centre (JRC)
IET - Institute for Energy and Transport
Ispra – Italy

Adolfo Perujo (adolfo.perujo@ec.europa.eu)
http://iet.jrc.ec.europa.eu/
http://www.jrc.ec.europa.eu/

Extra slides support

Auxiliaries account for approximately 22% and 11.7% of the energy losses of a city bus and a coach respectively (source: ACEA)



The influence of the auxiliaries in buses & coaches