Renault presentation discussed and agreed on within ACEA WLTP EV Group

ACEA European Automobile Manufacturers Association

RENAULT Z.E.

WLTP:
Specific issues of ‘Pure Electric Vehicle’

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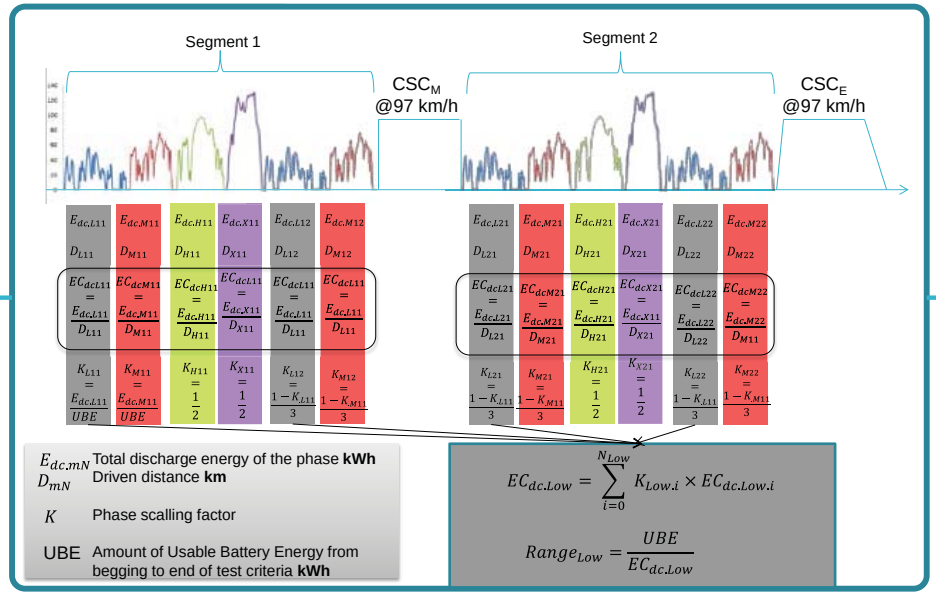
RENAULT

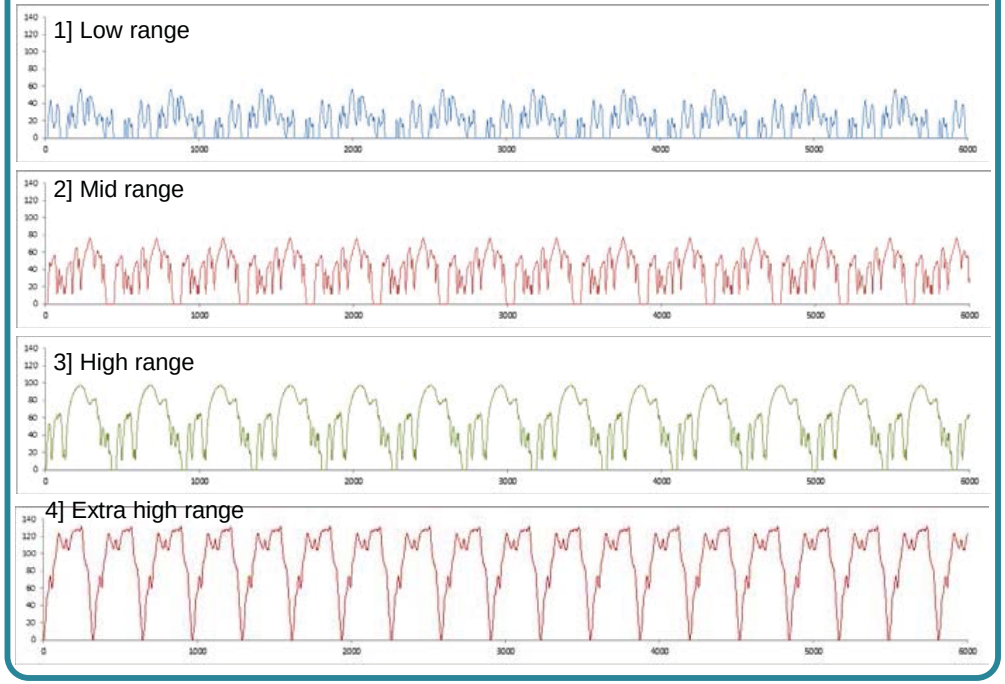
Shortening of test procedure

3 Shortening of range test

- Measurement on a Multiple Cycle Test
- All required range estimation by calculation only



Individual range value **may be required**



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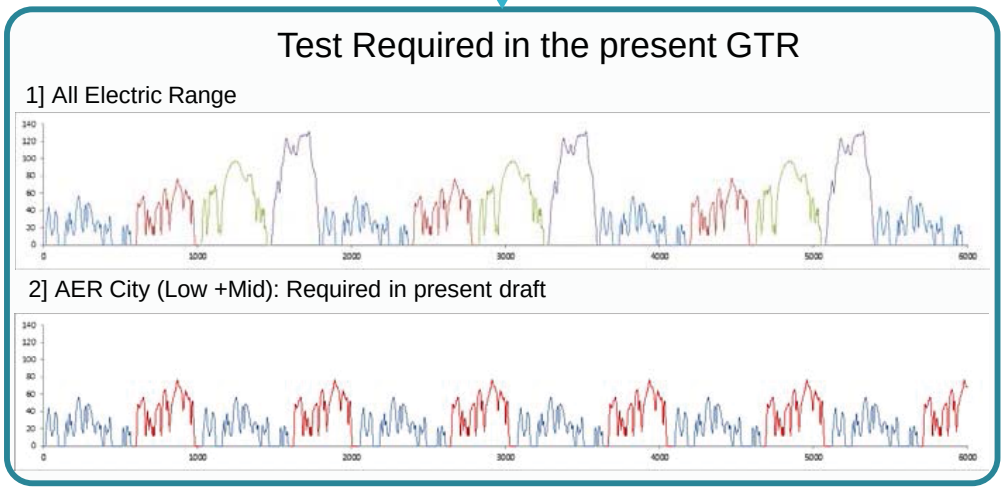
Test Required in the present GTR



3 Shortening of test procedure : Introduction

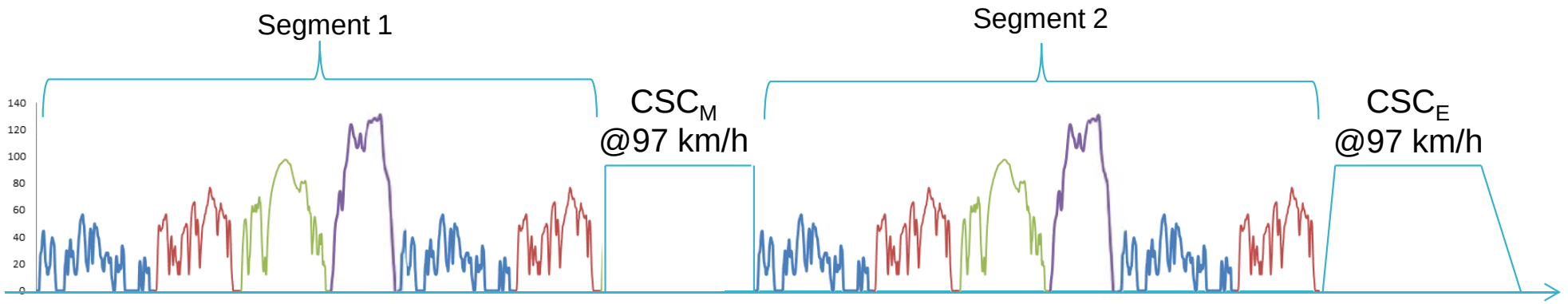
- Purpose: Reduce the range test procedure as well as provide the range & energy consumption value for each phase .

- The multiple cycle test (MCT) consist of 4 parts
  - 1. ‘Segment 1’-Dynamic drive cycle (L-M-H-XH-L-M) :
    - To quantify the performance associated with WLTC drive cycle at high value of SOC
  - 2. Constant Speed Cycle-mid (CSCm): @97km/h(65mph) same as SAE J1634
    - Required to ensure that ‘segment 2’ is conducted at a “substantially” lower SOC condition than ‘segment 1’
    - Distance traveled is based on ‘good engineering judgment’
  - 3. ‘Segment 2’-Dynamic drive cycle (L-M-H-XH-L-M) :
    - To quantify the performance associated with WLTC drive cycle at low value of SOC
  - 4. Constant Speed Cycle-end(CSCe):
    - Reduce test duration by depleting the battery more rapidly than the established certification drive schedules
    - Prevent inconsistent triggering of end of test criteria that can occur at high power-demand points when a PEV is following a dynamic drive schedule at low states-of-charge.

- Phase Scaling Factors : The phase scaling factors determine the contribution of each phase’s energy consumption value to the total energy consumption for a given drive cycle type.

- The obtained DC energy value can be converted to AC energy (grid energy) by using the RAF

3 Shortening of test procedure: Method



$E_{dc.L11}$	$E_{dc.M11}$	$E_{dc.H11}$	$E_{dc.X11}$	$E_{dc.L12}$	$E_{dc.M12}$	$E_{dc.L21}$	$E_{dc.M21}$	$E_{dc.H21}$	$E_{dc.X21}$	$E_{dc.L22}$	$E_{dc.M22}$
D_{L11}	D_{M11}	D_{H11}	D_{X11}	D_{L12}	D_{M12}	D_{L21}	D_{M21}	D_{H21}	D_{X21}	D_{L22}	D_{M22}
$EC_{dcL11} = \frac{E_{dc.L11}}{D_{L11}}$	$EC_{dcM11} = \frac{E_{dc.M11}}{D_{M11}}$	$EC_{dcH11} = \frac{E_{dc.H11}}{D_{H11}}$	$EC_{dcL11} = \frac{E_{dc.X11}}{D_{X11}}$	$EC_{dcL11} = \frac{E_{dc.L11}}{D_{L11}}$	$EC_{dcL11} = \frac{E_{dc.L11}}{D_{L11}}$	$EC_{dcL21} = \frac{E_{dc.L21}}{D_{L21}}$	$EC_{dcM21} = \frac{E_{dc.M21}}{D_{M21}}$	$EC_{dcH21} = \frac{E_{dc.H21}}{D_{H21}}$	$EC_{dcX21} = \frac{E_{dc.X11}}{D_{X21}}$	$EC_{dcL22} = \frac{E_{dc.L22}}{D_{L22}}$	$EC_{dcM22} = \frac{E_{dc.M22}}{D_{M11}}$
$K_{L11} = \frac{E_{dc.L11}}{UBE}$	$K_{M11} = \frac{E_{dc.M11}}{UBE}$	$K_{H11} = \frac{1}{2}$	$K_{X11} = \frac{1}{2}$	$K_{L12} = \frac{1 - K_{L11}}{3}$	$K_{M12} = \frac{1 - K_{M11}}{3}$	$K_{L21} = \frac{1 - K_{L11}}{3}$	$K_{M21} = \frac{1 - K_{M11}}{3}$	$K_{H21} = \frac{1}{2}$	$K_{X21} = \frac{1}{2}$	$K_{L22} = \frac{1 - K_{L11}}{3}$	$K_{M22} = \frac{1 - K_{M11}}{3}$

$E_{dc.mN}$	Total discharge energy of the phase **kWh**
D_{mN}	Driven distance **km**
K	Phase scalling factor
UBE	Amount of Usable Battery Energy from begging to end of test criteria **kWh**

$$EC_{dc.Low} = \sum_{i=0}^{N_{Low}} K_{Low.i} \times EC_{dc.Low.i}$$

$$Range_{Low} = \frac{UBE}{EC_{dc.Low}}$$

3 Shortening of test procedure: Simulation

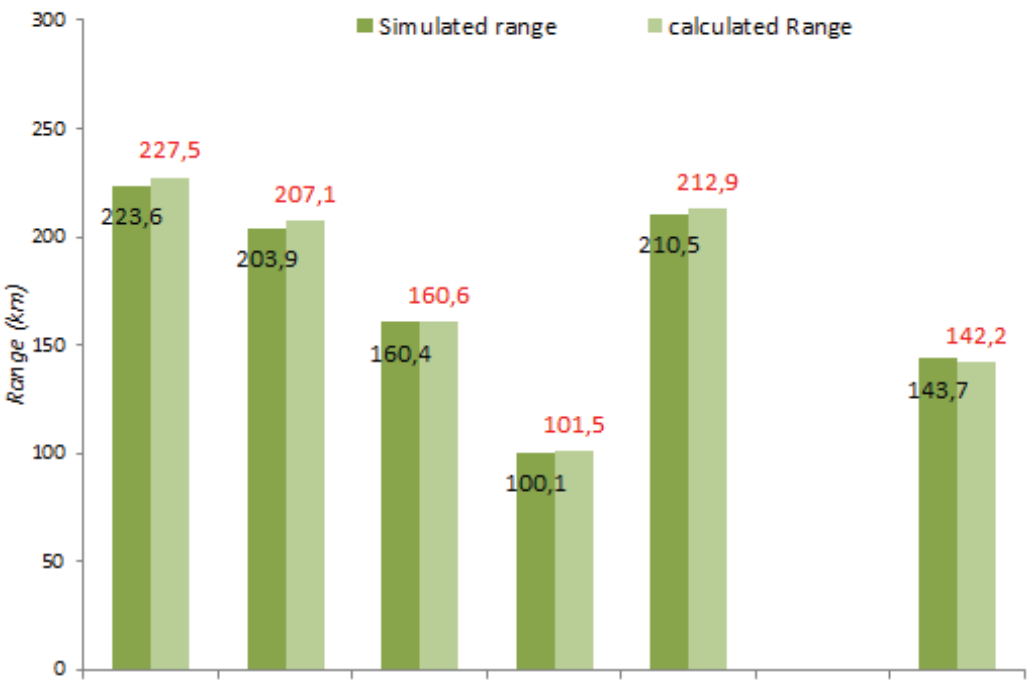
- Vehicles: Two different kind of electric vehicles were selected for simulation

    1. Kangoo EV : Utility vehicle , maximum speed of 130 km/h, not able to follow the drive cycle in extra-high phase , SAE J1634 method applied
    2. Zoe : Passenger vehicle, maximum speed of 135 km/h , non problem in following the drive cycle , higher range than Kangoo EV

- Simulation : Following simulations were done one each vehicle for two different mass TM_H & TM_L
    1. Range test with sequence L-L-L-L…..
    2. Range test with sequence M-M-M-M….
    3. Range test with sequence H-H-H-H….
    4. Range test with sequence XH-XH-XH-XH….
    5. Range test with sequence LM-LM-LM-LM….
    6. Range test with sequence LMHXH-LMHXH-LMHXH-LMHXH….
    7. **Range test with sequence LMHXH-30min@97km/h-LMHXH-CSC@97km/h**

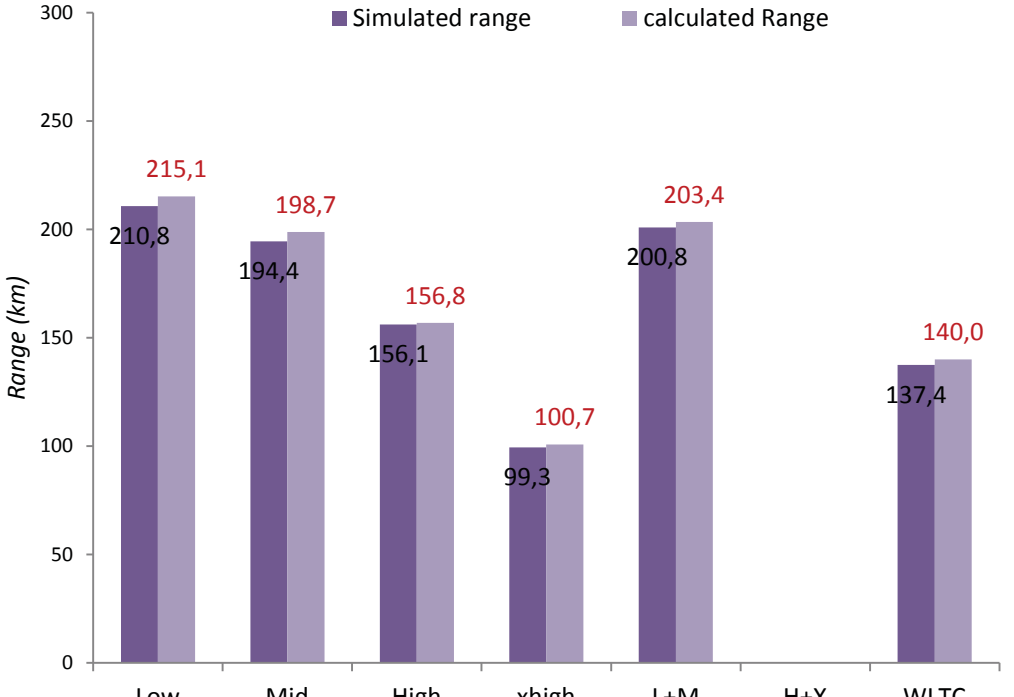
3 Shortening of test procedure: : Kangoo ZE Simulation results

- Test mass Low: 1722 kg



Δ%	1,7%	1,5%	0,1%	1,3%	1,1%		-1,0%

- Test mass High: 1939 kg

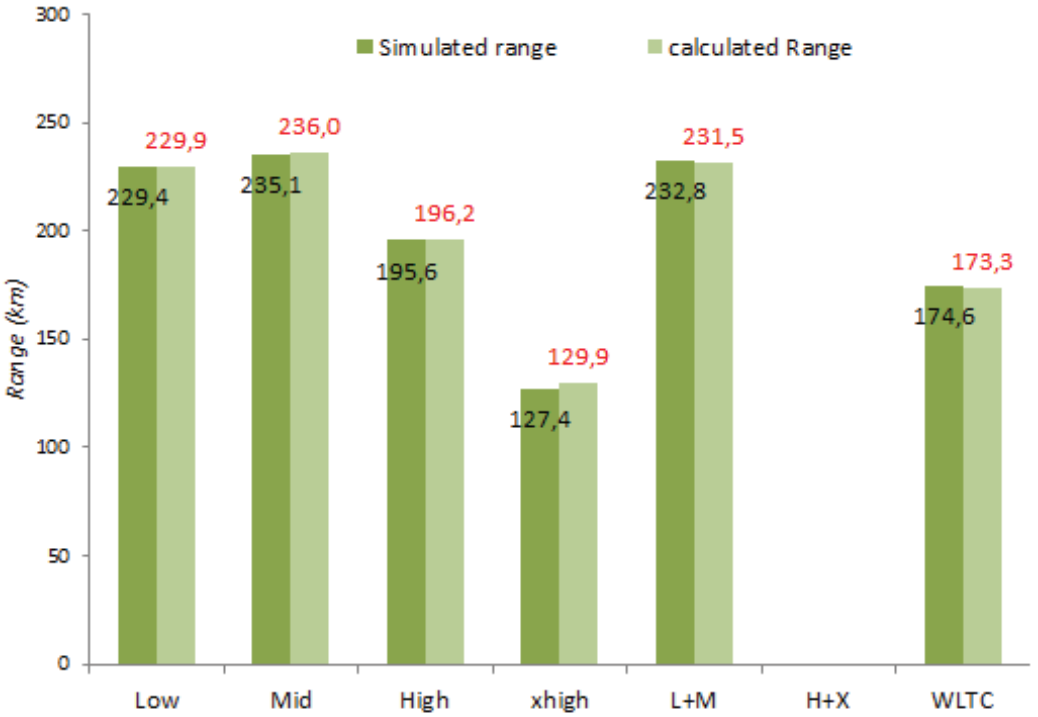


Δ%	2,1%	2,2%	0,4%	1,4%	1,3%		1,9%

- Test time reduce from 180 minutes to 140 minutes (-22%)
- The 'scalling factor' is not used for 'city cycle range' and 'complete WLTC range' estimation

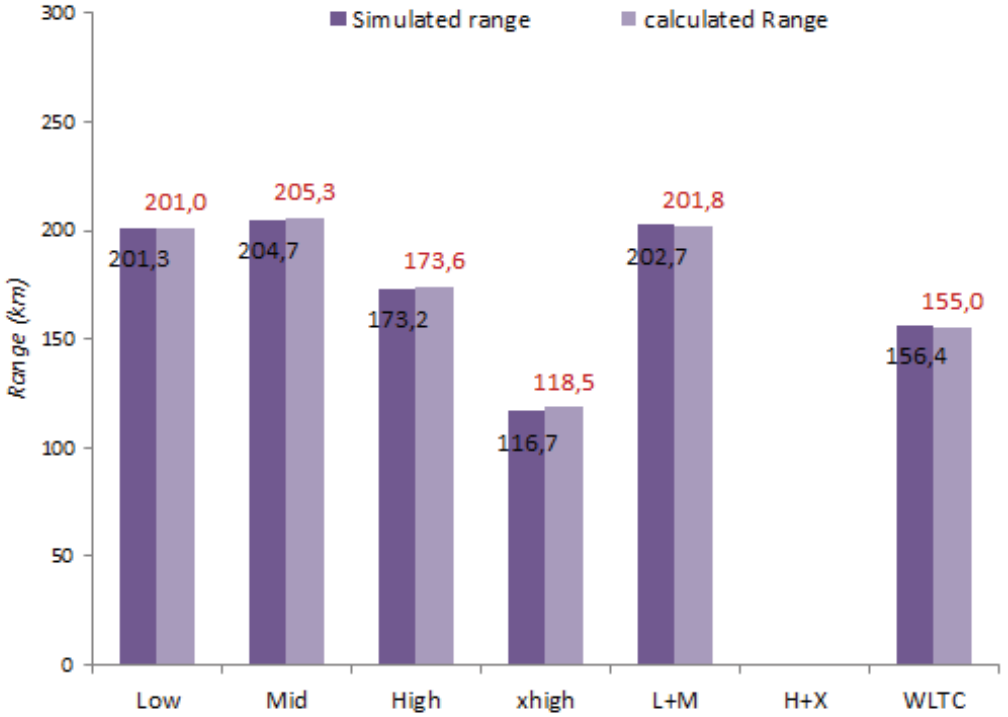
3 Shortening of test procedure: : Zoe Simulation results

- Test mass Low: 1593 kg



Δ%	0,2%	0,4%	0,3%	2,0%	-0,6%		-0,8%

- Test mass High: 1674 kg



Δ%	-0,2%	0,3%	0,2%	1,5%	-0,5%		-0,9%

- Test time reduce from 230 to 160 min (-31%)
- The ‘scaling factor’ is not used for ‘city cycle range’ and ‘complete WLTC range’ estimation

3 Shortening of test procedure: Conclusion

- The simulation results on Kangoo ZE and Zoe suggest an error margin of <1% for ‘City Range’ and ‘All Electric Range’
- The shortening test method is already accepted in the USA and under discussion in Japan, Brazil
- The city range (L+M) test required in the GTR draft can be replaced by phase based calculation
- The proposed method can also provide result of ‘Low+Mid+High’ range (required in other non-EU countries) results from a single complete WLTC cycle range
- The initial simulation shows that the results from proposed test in the GTR and shortened test procedure gives similar results (2% error margin)

Comments and concerns - STP

ACEA is supporting the Shortening Test Procedure

But:
There is a need of clarification on

- Minimum range above which the method is applicable
- What speed should be applied for the Constant Speed Cycles?
  - Evaluation of the impact of the speed on UBE and the behavior of the battery (need of more simulation at different speeds)
  - Real test data (expected from JP tests)
- Duration of CSEm cycle
- Battery behavior (accuracy of the simulation, impact of electro-chemical and thermal effects)
- Acceptable error margin for test results in the evaluation and validation phase