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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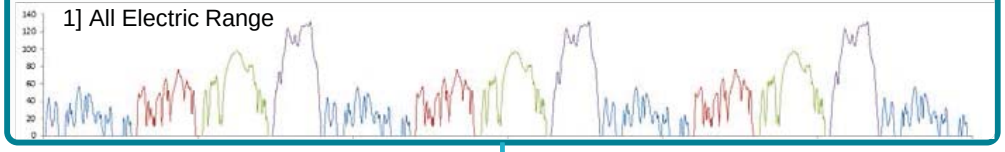
Each phase range estimation

2 Each phase range estimation : Introduction

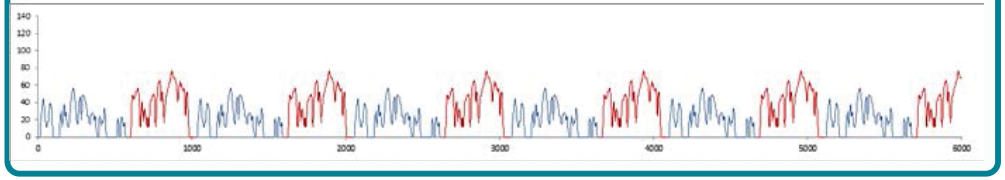
Test Required in the present GTR

1] All Electric Range



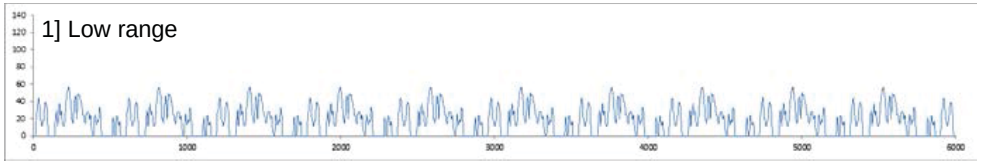
Range determination on chassis dyno

2] AER City (Low +Mid): **Required** in present draft

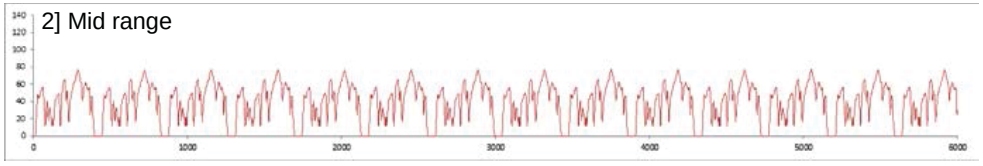


Individual range value **may be required**

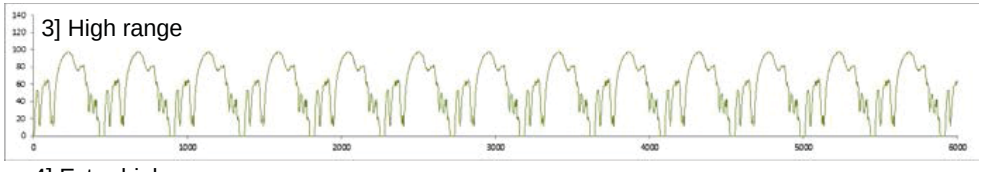
1] Low range



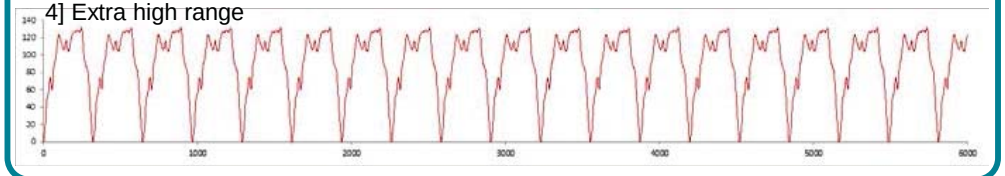
2] Mid range



3] High range

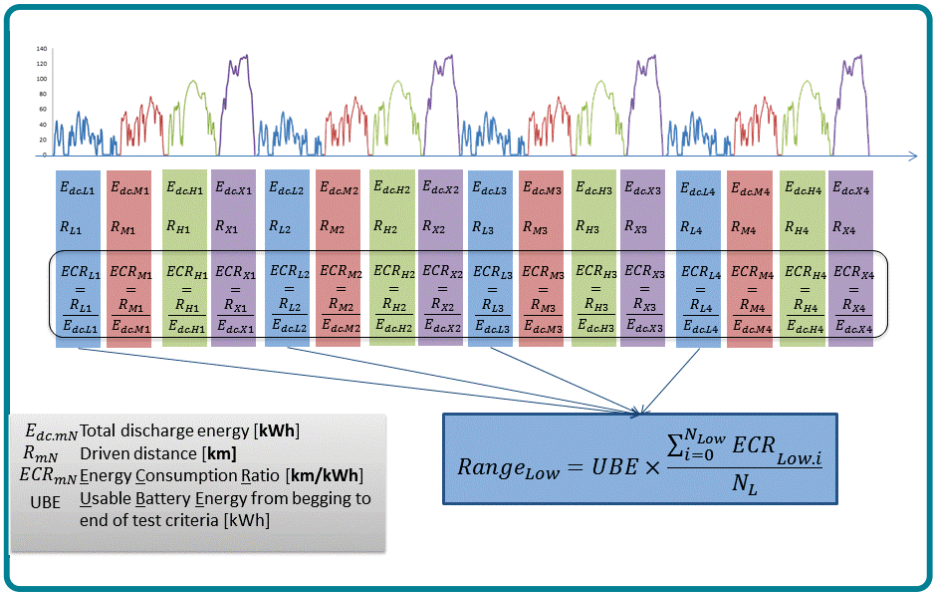


4] Extra high range



OR

Range estimation by calculation only

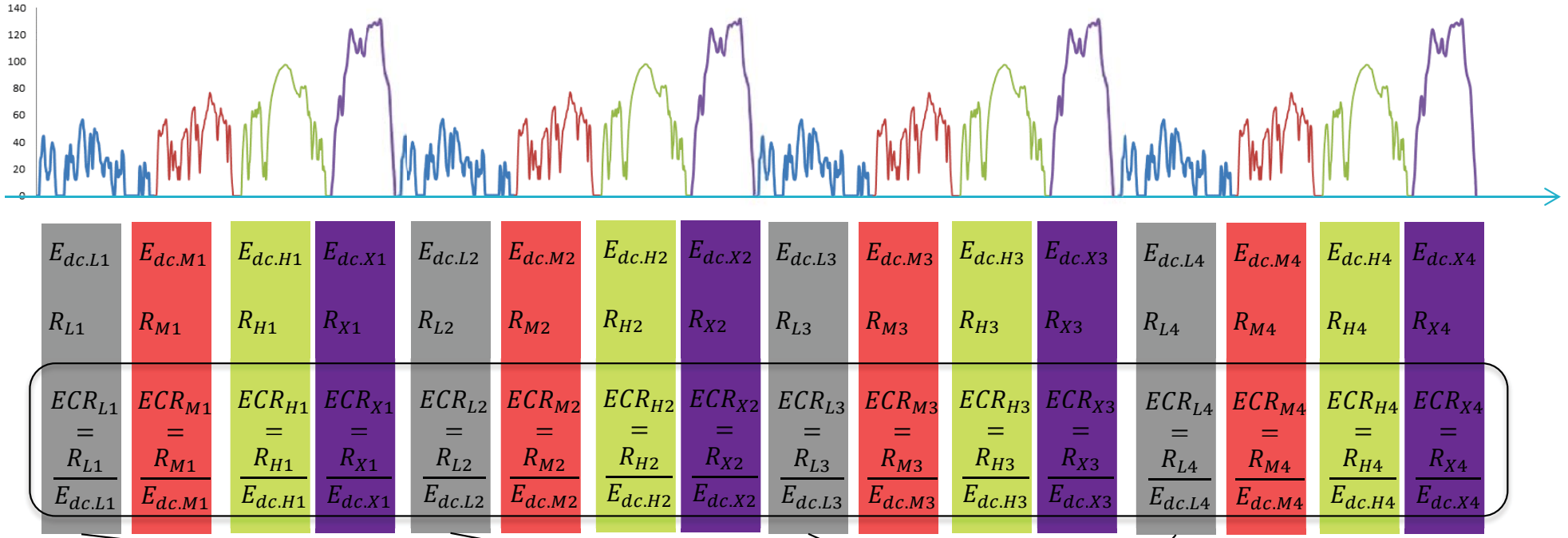


2 Each Phase Result calculation : Concept

- Purpose:
  - Estimate the range & energy consumption value for each phase instead of real test on chassis dyno
  - This calculation method can replace the ‘city range test’ required in the present draft GTR for PEV.

- Concept:
  - Complete WLTC cycle range test is performed as required in the present GTR draft
  - Usable Battery Energy (UBE) is measured until the test termination criteria because UBE means the capacity of dischargeable energy.
  - Obligation to measure DC energy (current + voltage) for each phase
  - Only the complete driven phase is considered for range estimation
  - Energy consumption ratio of each phase is calculated and range is determined from UBE and ECR

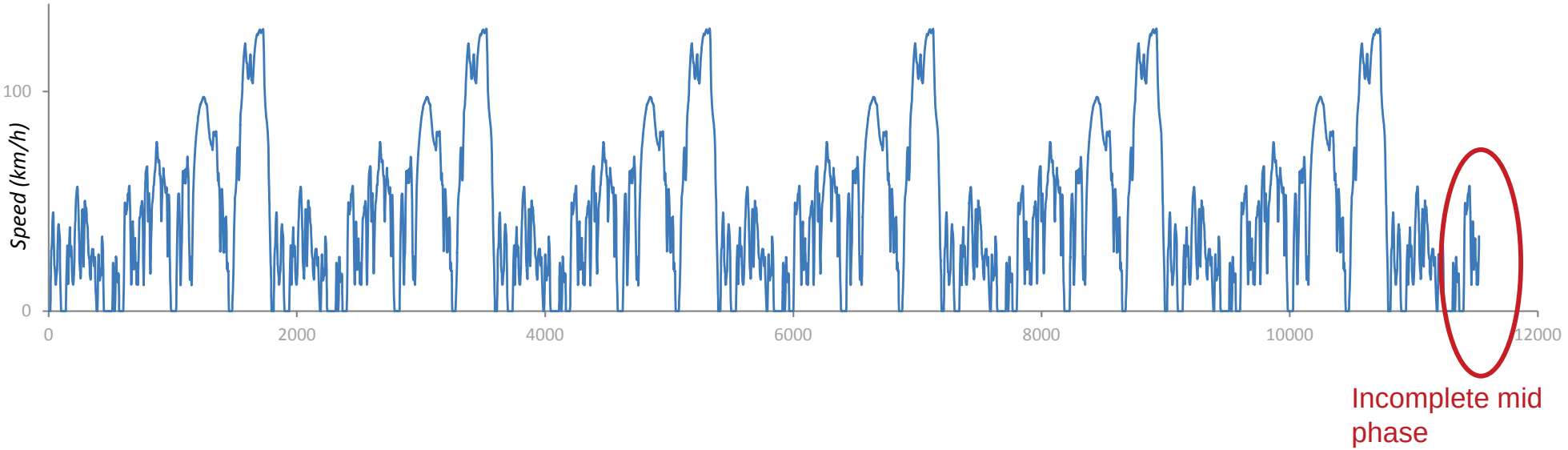
2 Each Phase Result calculation : Method – Example of Low phase cycle



$E_{dc.mN}$ Total discharge energy [**kWh**]
R_{mN} Driven distance [**km**]
ECR_{mN} Energy Consumption Ratio [**km/kWh**]
UBE Usable Battery Energy (DC) from begging to nd of test criteria [kWh]

$$Range_{Low} = UBE \times \frac{\sum_{i=0}^{N_{Low}} ECR_{Low.i}}{N_L}$$

2 Each Phase Result calculation : Method – consideration of data



- The incomplete phase is not considered for calculation
- In the above example this phase data are not included for calculation of ‘mid phase range ‘ ,‘city cycle range’ and ‘complete WLTC range’
- But for the ‘Usable Battery Energy’ include this incomplete mid phase

2 Each Phase Result calculation : Simulations

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

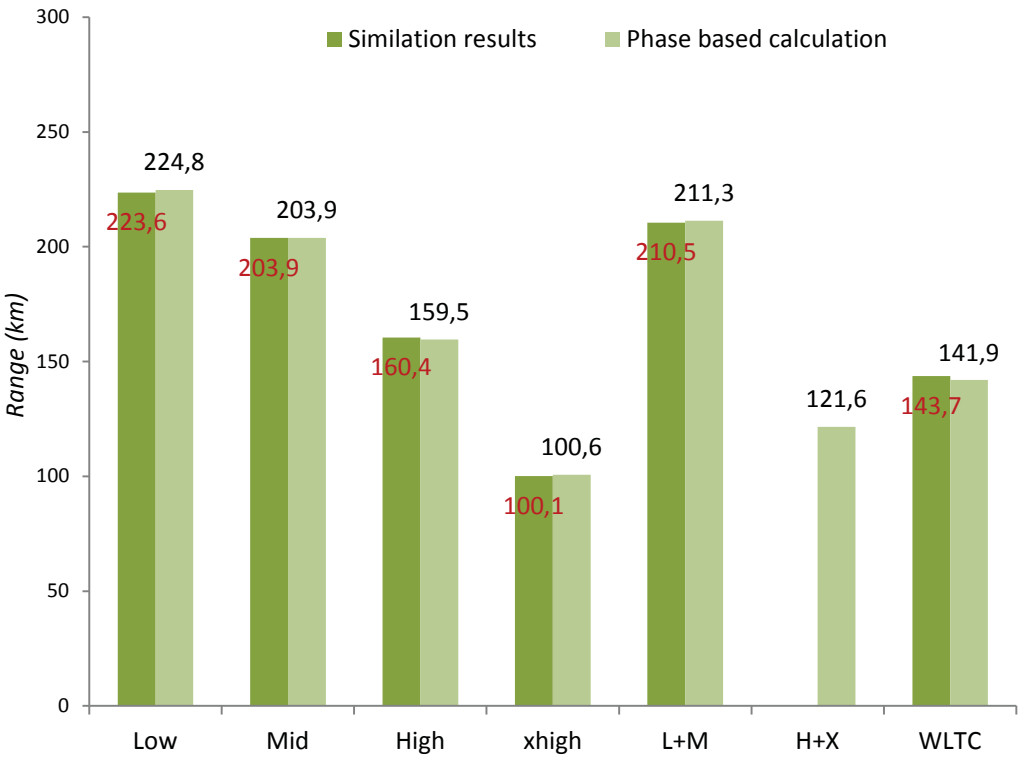
    1. Kangoo EV : Utility vehicle , maximum speed of 130 km/h, not able to follow the drive cycle in extra-high phase , SAE J1634 method applied
    2. Zoe : Passenger vehicle, maximum speed of 135 km/h , non problem in following the drive cycle , higher range than Kangoo EV

- 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….

- Calculation:
    - As suggested by the proposal , only complete phases were considered for calculation
    - An additional compete WLTC cycle range also calculated to check the over all error margin

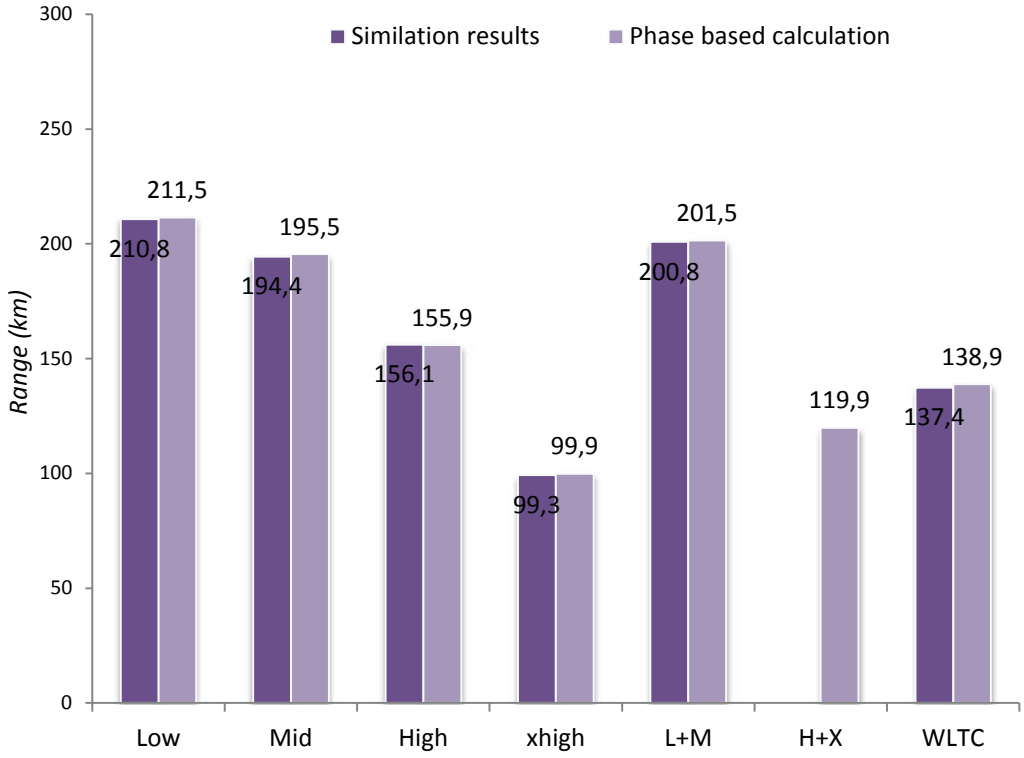
2 Each Phase Result calculation : Kangoo ZE Simulation results

- Test mass Low: 1722 kg



Δ%	0.52%	-0,01%	-0,53%	0,50%	0,35%		-1,21%

- Test mass High: 1939 kg

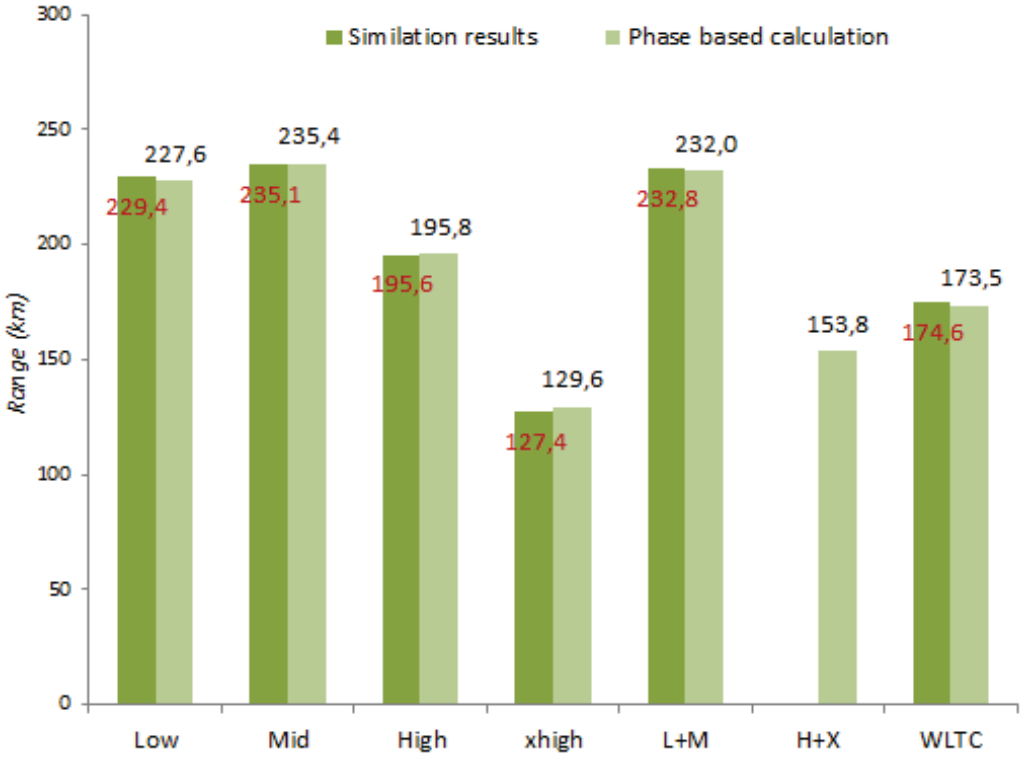


Δ%	0,34%	0,55%	-0,12%	0,58%	0,33%		1,08%

- Simulation results shows that the 'proposed phase based calculation' has an error margin of <0.5% for 'City range' calculation
- To verify the method we calculate the complete WLTC cycle range with proposed method and we found the error margin to be around 1%

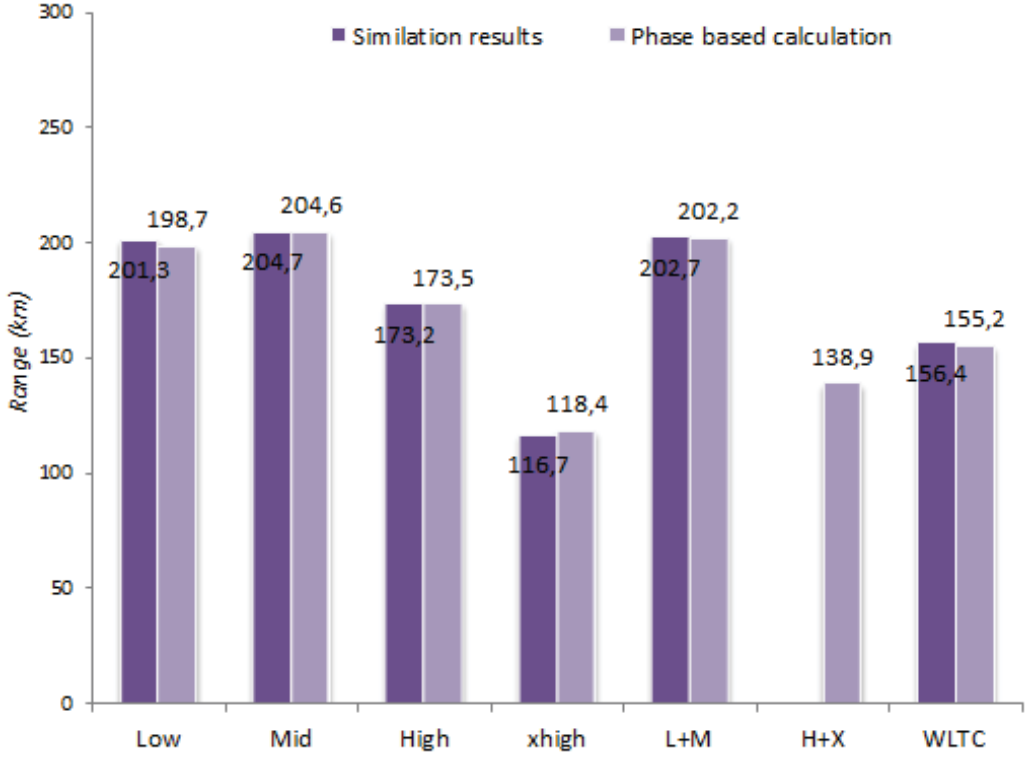
2 Each Phase Result calculation : Zoe Simulation results

- Test mass Low: 1593 kg



Δ%	-0,79%	0,10%	0,12%	1,79%	-0,37%		-0,63%

- Test mass High: 1674 kg



Δ%	-1,30%	-0,04%	0,15%	1,45%	-0,26%		-0,78%

- Simulation results shows that the 'proposed phase based calculation' has an error margin of <0.5% for 'City range' calculation
- To verify the method we calculate the complete WLTC cycle range with proposed method and we found the error margin to be < 1%

2 Each Phase Result calculation : Conclusion

- The simulation results of two different test mass shows that the range of each phase can be estimated by the proposed method with acceptable error margin (≈0.5% ; max ≈1 km)
- Simulation on Kangoo ZE shows that this proposed method can even work well on vehicle which can not follow the drive cycle
- The incomplete phase should not be included in the range calculation
- 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