



OVC-HEV

vehicle family 1: different R_{CDC}

vehicle family 2: identical R_{CDC}

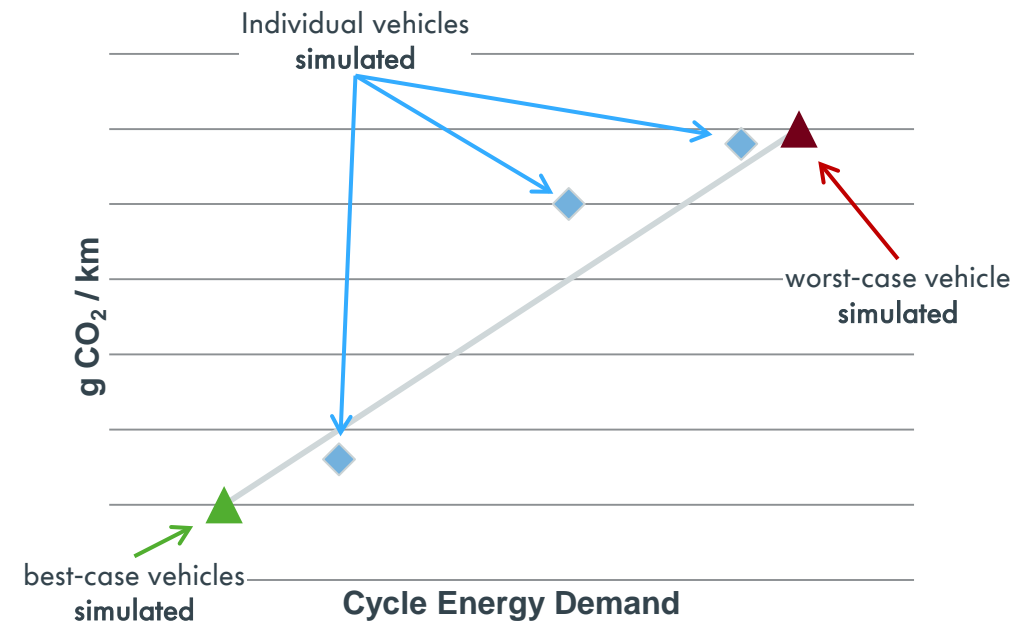
Combined Approach

OVC-HEV: Combined Approach

Evaluation of combined Approach for

Vehicles:

1x best-case vehicle,
1x worst-case vehicle,
3x custom vehicles



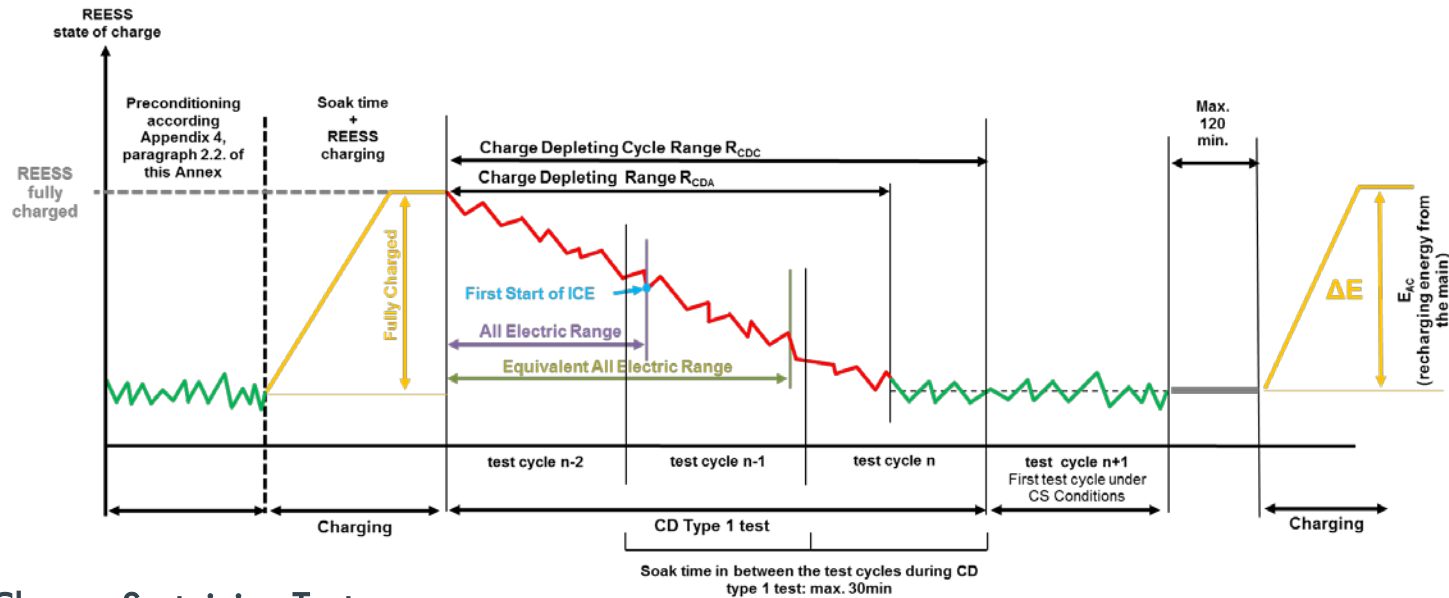
OVC-HEV: Combined Approach

Considered parameters

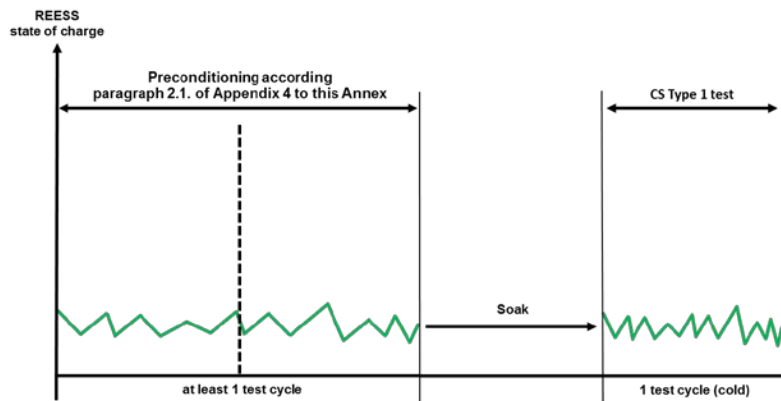
1. $\text{CO}_{2,\text{CD}}$
2. $\text{CO}_{2,\text{CS}}$
3. $\text{CO}_{2,\text{weighted}}$
4. AER
5. EAER
6. $R_{\text{CD}\alpha}$
7. EC_{CD}
8. $\text{EC}_{\text{weighted}}$
9. EC

OVC-HEV: Combined Approach

Charge-Depleting Test:



Charge-Sustaining Test:



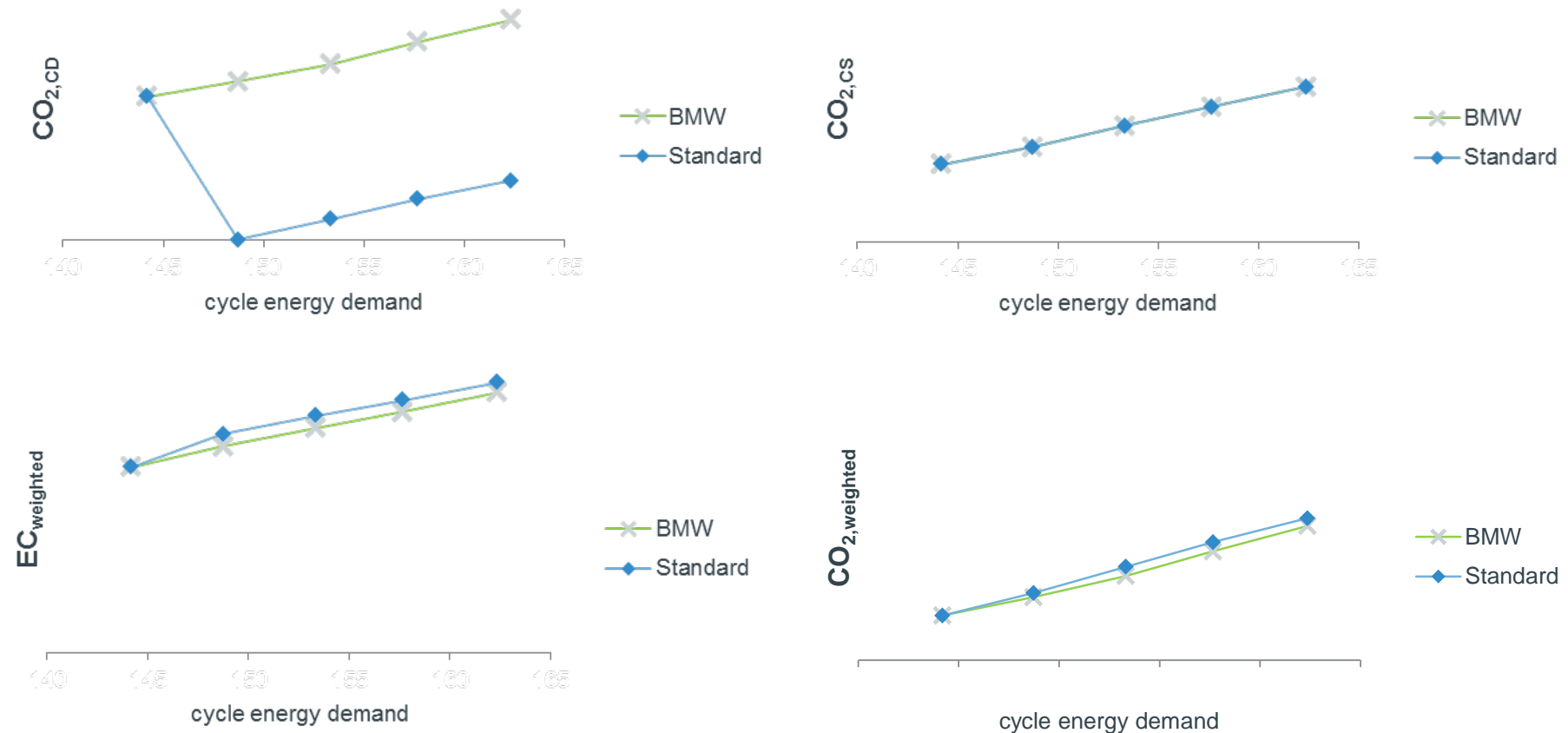
Mit n ist der transiente Zyklus benannt

Results

Combined Approach vs Simulation

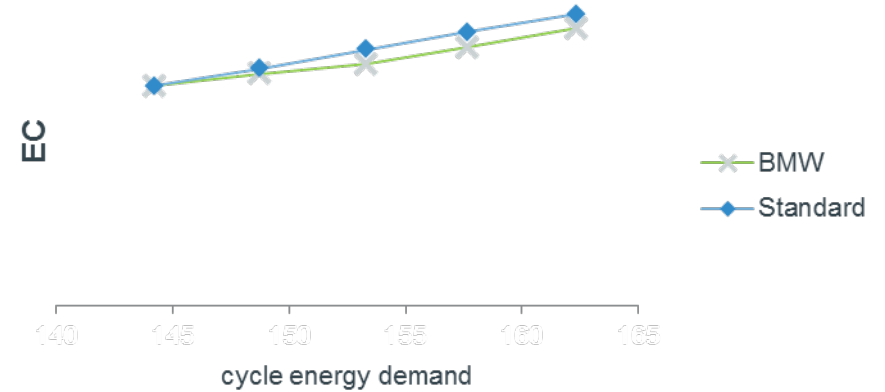
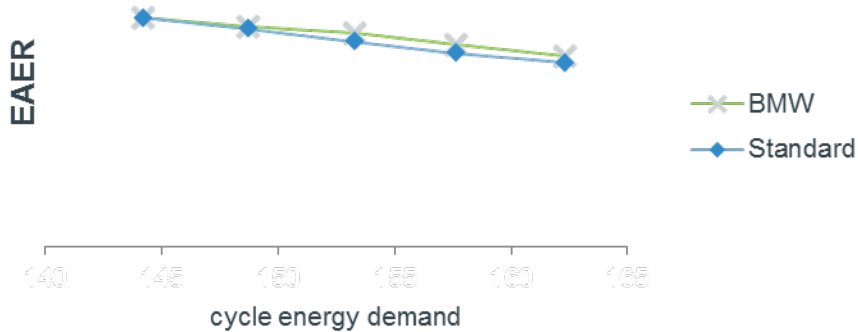
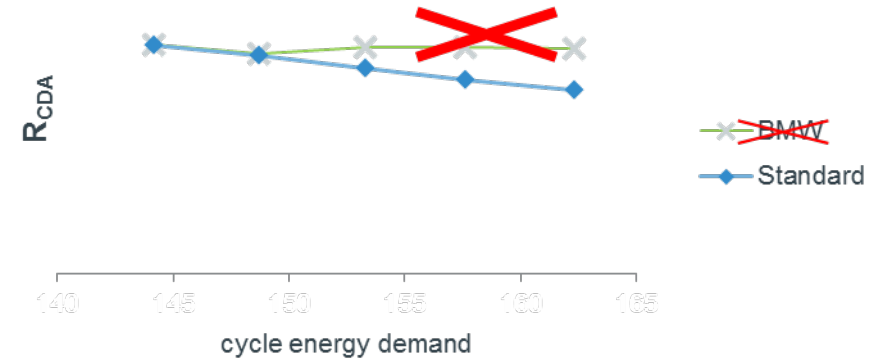
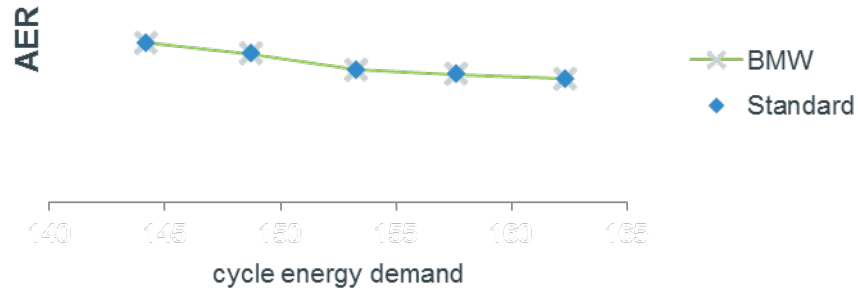
OVC-HEV vehicle family 1: simulation results

R_{CDC} : different ($n_{TMH} = n_{TML} - 1$)



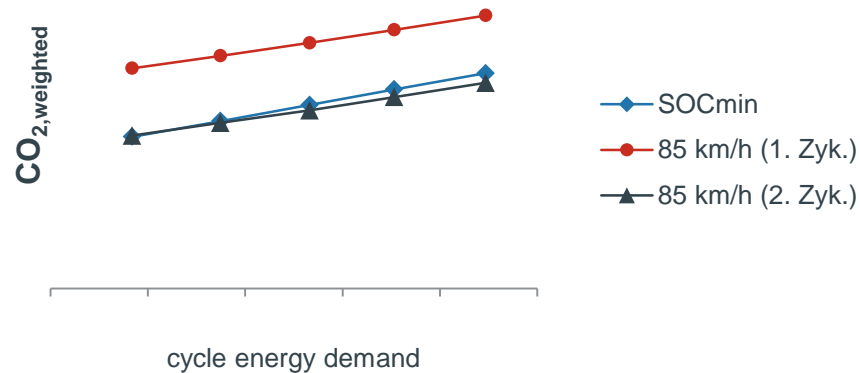
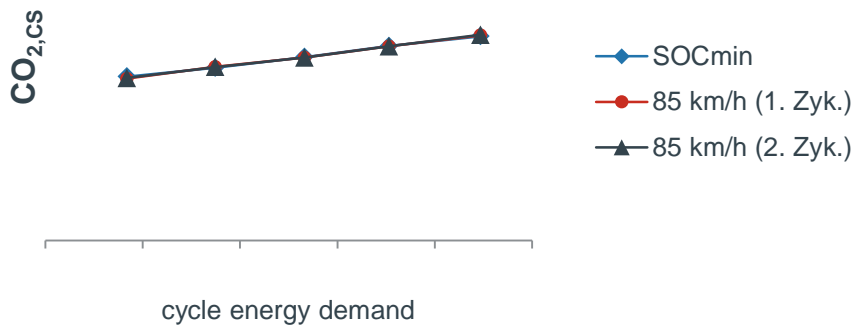
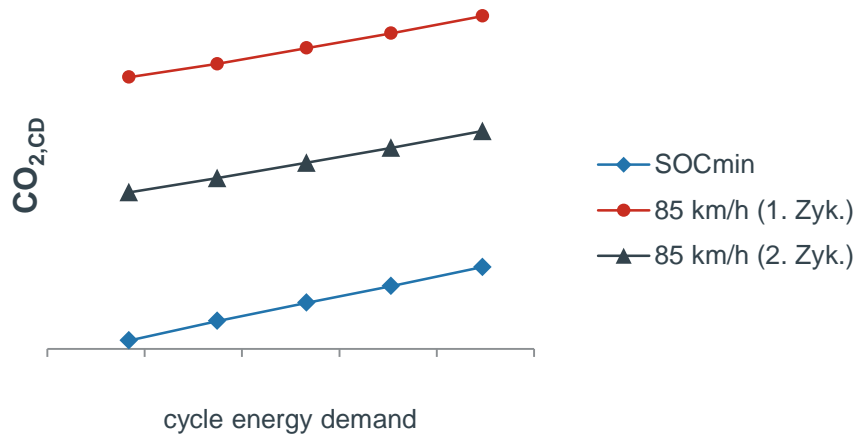
OVC-HEV vehicle family 1: simulation results

R_{CDC} : different ($n_{TMH} = n_{TML} - 1$)



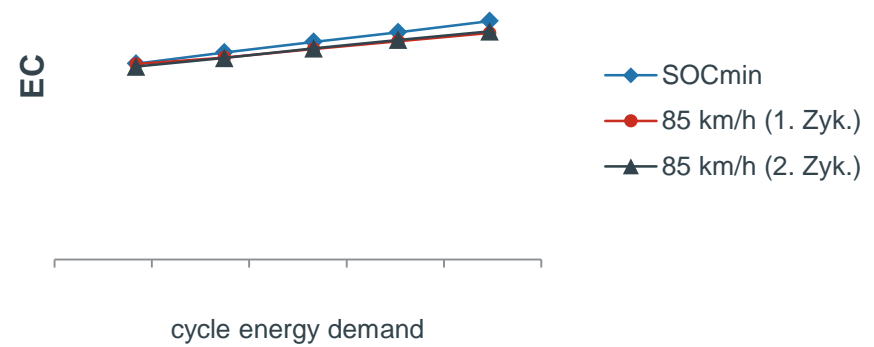
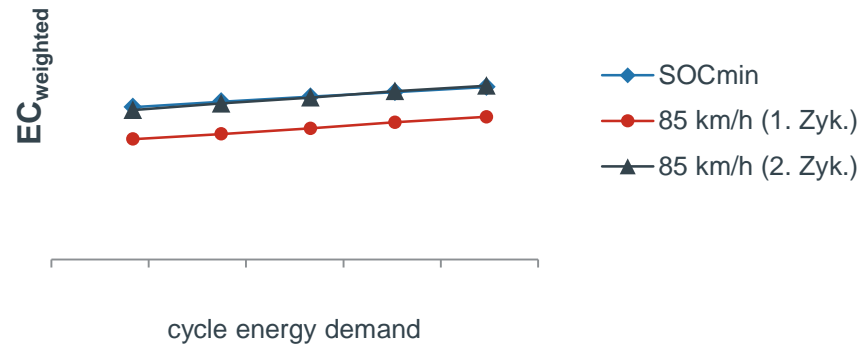
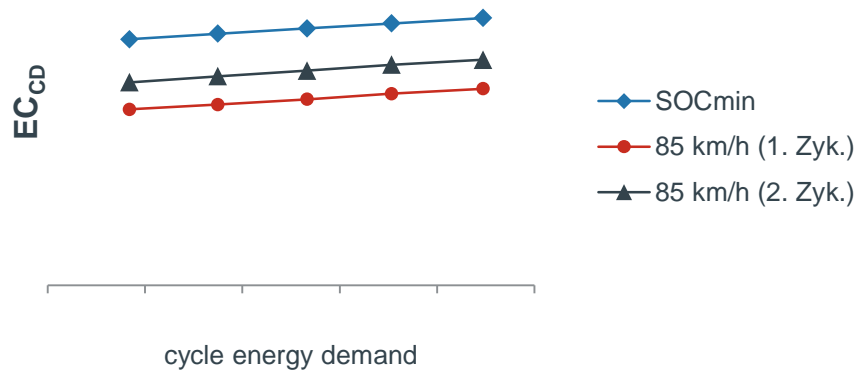
OVC-HEV vehicle family 2: CA vs simulation

R_{CDC} : identical ($n_{TMH} = n_{TML}$)



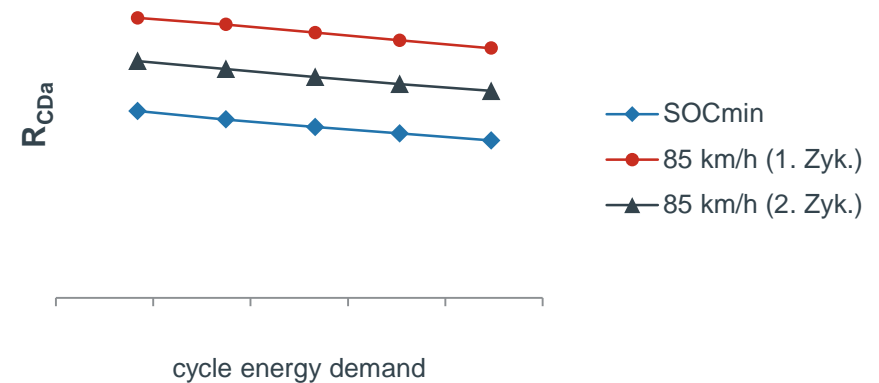
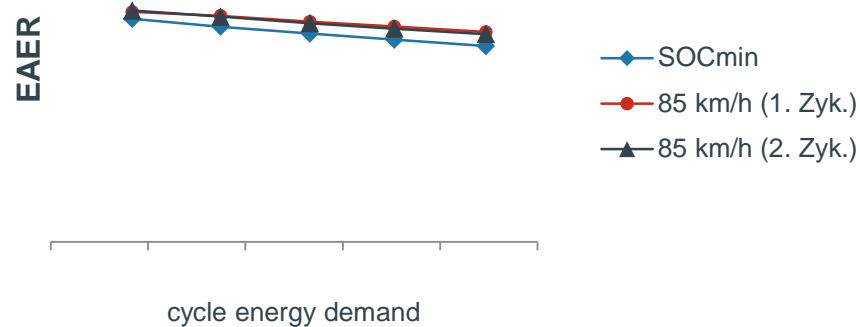
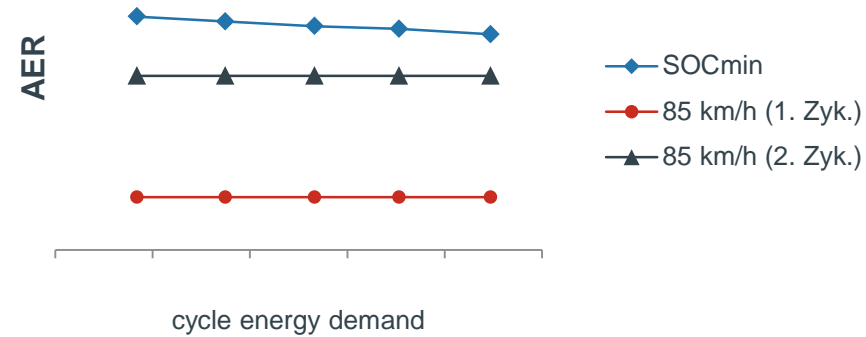
OVC-HEV vehicle family 2: CA vs simulation

R_{CDC} : identical ($n_{TMH} = n_{TML}$)



OVC-HEV vehicle family 2: CA vs simulation

R_{CDC} : identical ($n_{TMH} = n_{TML}$)



Results

AER_{City}: Simulation vs. Calculation

OVC-HEV vehicle family 2: Simulationsergebnisse

AER City: „Simulation“ versus „Calculation (averaged/weighted)“

- $E_{DC,p,c}$ – Used energy of each individual phase, Wh;
- $K_{p,c}$ – Weighting factor for each individual phase, -;
- $EC_{DC,p,c}$ – Electric consumption of each individual phase, Wh/km;
- n_p – Phase specific number of available phases, -;
- $EC_{DC,p}$ – Phase specific electric consumption, Wh/km;
- p – Index for each phase of the test cycle (low, mid,...)
- c – Index for the number of the considered cycle

UBE – Usable battery energy – Used battery energy during type 1 test, Wh;

The usable battery energy is determined from the beginning of type 1 test until the EoT is reached (last incomplete driven phase is included).

Weighting factors

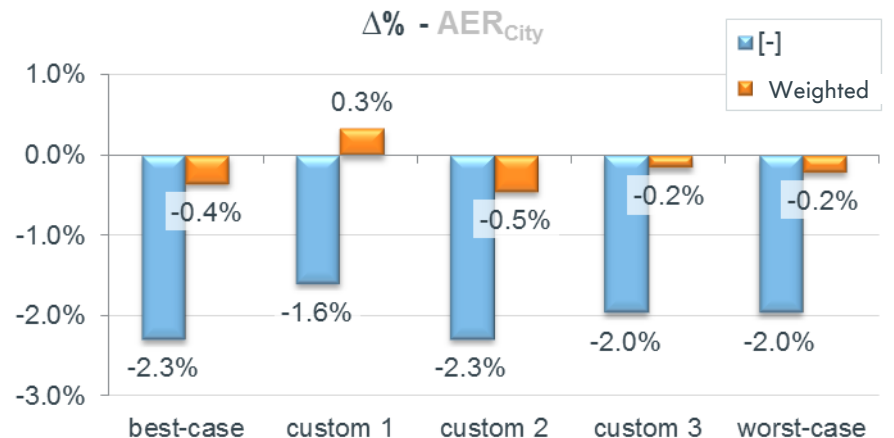
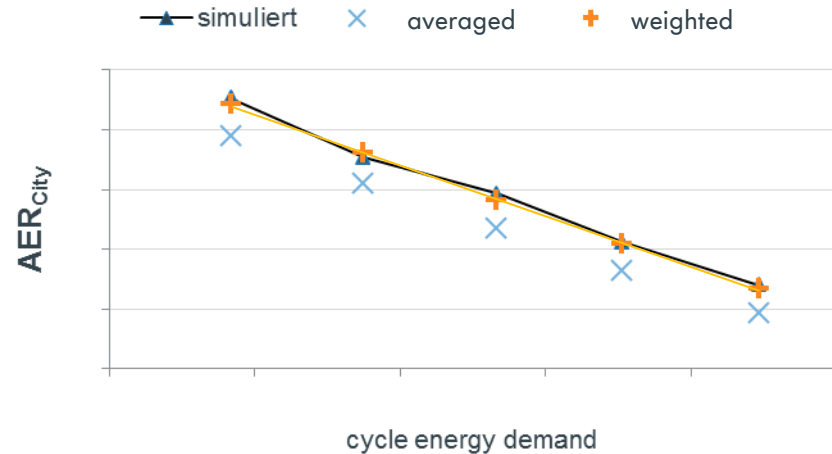
$$K_{p,1} = \frac{E_{DC,p,1}}{UBE} \quad K_{p,i} = \frac{1 - K_{p,1}}{n_p - 1} \text{ for } i = 2 \dots n_p$$

Phase specific electric consumption

$$EC_{DC,p} = \sum_{c=1}^{n_p} EC_{DC,p,c} \times K_{p,c}$$

Phase specific all electric range

$$AER_p = \frac{UBE}{EC_{DC,p}}$$



OVC-HEV vehicle family 2: CA

Phase specific values

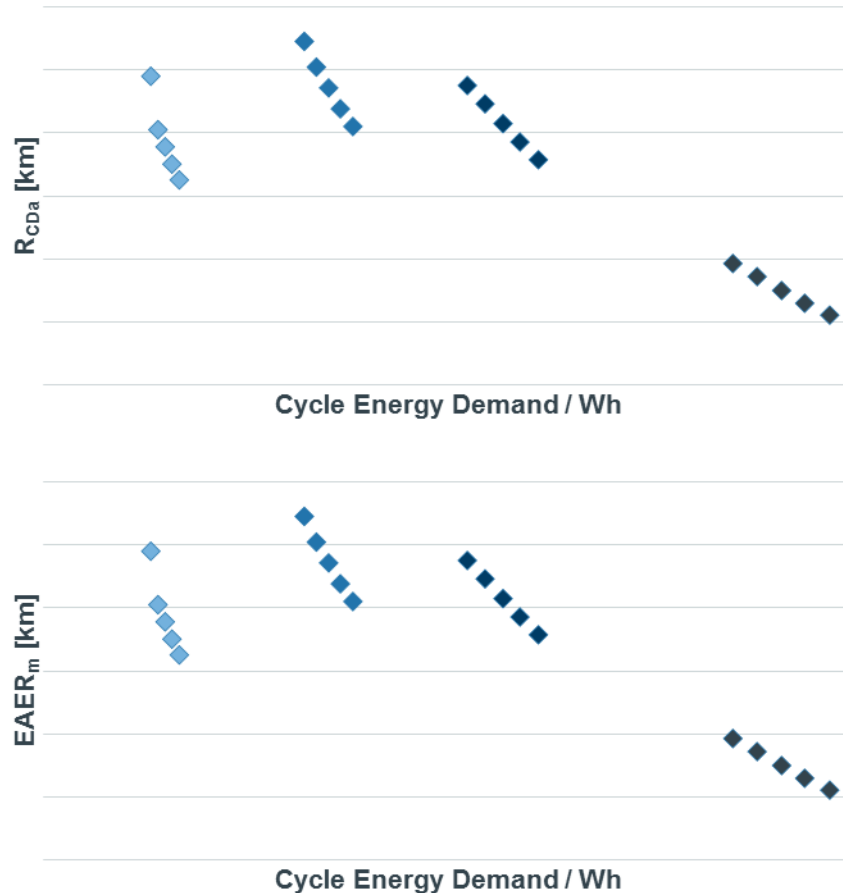
Results

Simulation: Phase spezific (excluding transistion cycle)

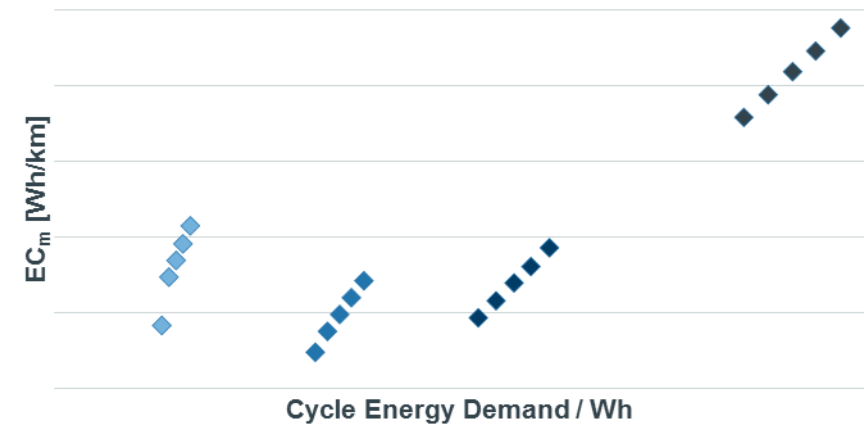
- Case 1 (vehicle family 1): First engine start at SOC_{min} (different R_{CDC})
- Case 2 (vehicle family 2): First engine start at SOC_{min} (same R_{CDC})
- Case 3 (vehicle family 2): First engine start at $v > 85$ km/h in cycle 1
- Case 4 (vehicle family 2): First engine start at $v > 85$ km/h in cycle 2

OVC-HEV vehicle family 1: phase specific values

Results: Case 1 (first engine start at SOC_{min}), different R_{CDC}

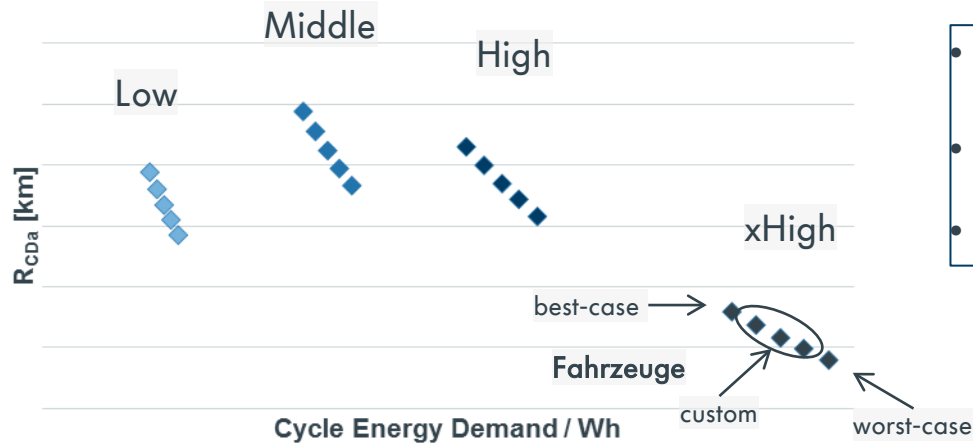


- $$R_{CDA,m} = \frac{UBE}{EC_{CD,m}}$$
- $$EAER_m = \left(\frac{CO_{2,CS,m} - CO_{2,CD,avg,m}}{CO_{2,CS,m}} \right) * R_{CDA,m}$$
- $$EC_m = \frac{E_{AC}}{EAER_m}$$



OVC-HEV vehicle family 2: phase specific values

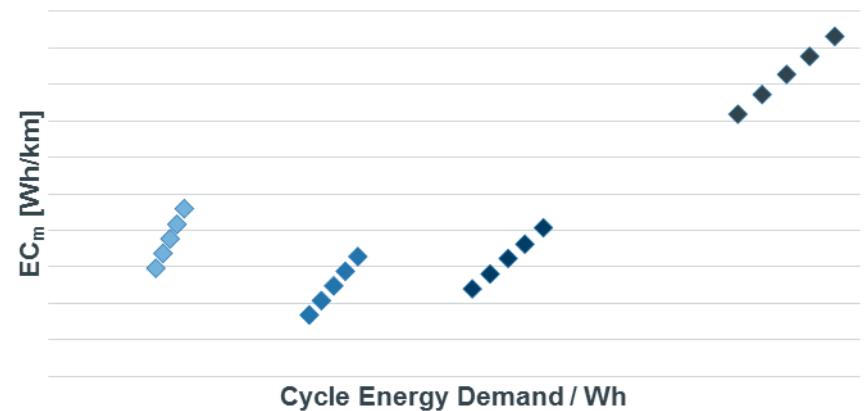
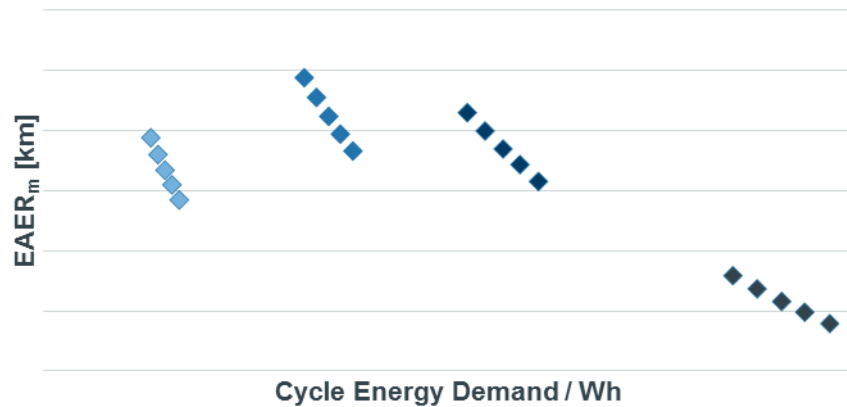
Results: Case 2 (first engine start at SOC_{min}), same R_{CDC}



$$R_{CDA,m} = \frac{UBE}{EC_{CD,m}}$$

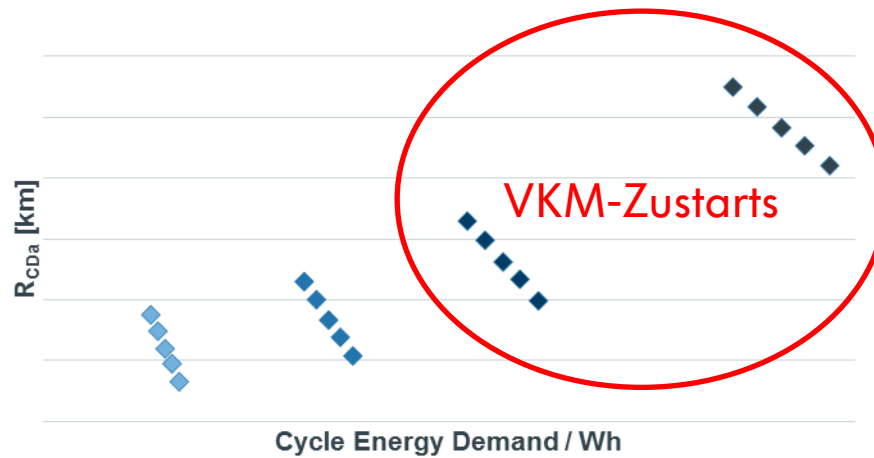
$$EAER_m = \left(\frac{CO_{2,CS,m} - CO_{2,CD,avg,m}}{CO_{2,CS,m}} \right) * R_{CDA,m}$$

$$EC_m = \frac{E_{AC}}{EAER_m}$$

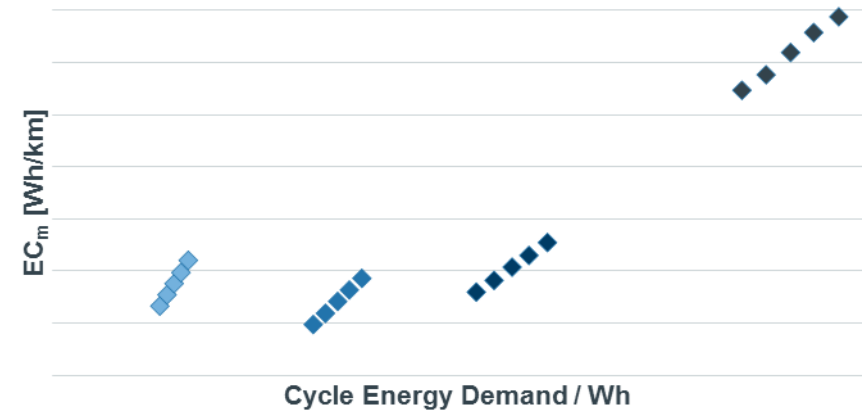
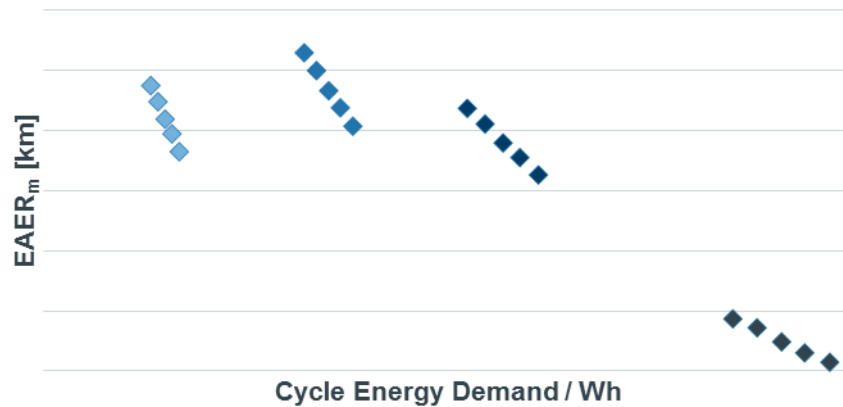


OVC-HEV vehicle family 2: phase specific values

Results: Case 3 (first engine start at $v > 85$ km/h in cycle 1), same R_{CDC}

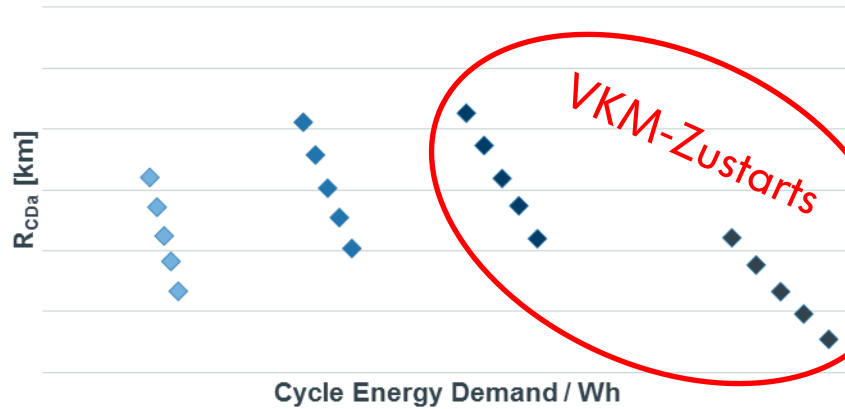


- $R_{CDA,m} = \frac{UBE}{EC_{CD,m}}$
- $EAER_m = \left(\frac{CO_{2,CS,m} - CO_{2,CD,avg,m}}{CO_{2,CS,m}} \right) * R_{CDA,m}$
- $EC_m = \frac{E_{AC}}{EAER_m}$



OVC-HEV vehicle family 2: phase specific values

Results: case 4 (first engine start at $v > 85$ km/h in cycle 2), same R_{CDC}



- $R_{CDA,m} = \frac{UBE}{EC_{CD,m}}$
- $EAER_m = \left(\frac{CO_{2,CS,m} - CO_{2,CD,avg,m}}{CO_{2,CS,m}} \right) * R_{CDA,m}$
- $EC_m = \frac{E_{AC}}{EAER_m}$

