
OVC-HEV Certification according to R83/R101

Mode Selection for condition A and B

OVC-HEV Certification according to UN-ECE R83/R101

Background

Current legislative text could lead to the interpretation that a mode for condition B shall be selected which is not only reflecting the energy (fuel and electric energy) used for vehicle propulsion but also the energy used for energy conversion (recharging the battery – fuel energy to electric energy).

If energy is used for energy conversion, this converted/recharged energy is reflected on the one hand side in a higher fuel consumption but on the other hand side also in a lower electric consumption.

WLTP is taking of this fact and is correcting the Sustaining Test (which is the corresponding test to condition B) towards a neutral charging balance.

R83/R101:

For NOVC-HEVs, a correction of the fuel consumption towards a neutral charging balance is described.

For OVC-HEVs, this correction is not described for condition B.

WLTP:

For NOVC-HEVs, a correction of the fuel consumption towards a neutral charging balance is described.

For OVC-HEVs, this correction is described for the Charge-Sustaining-Test (corresponding to condition B).

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Question on the purpose of the test results

Question: Should the test results reflect

1. energy used for vehicle proposal **and** energy conversion?
2. energy used for vehicle propulsion only?

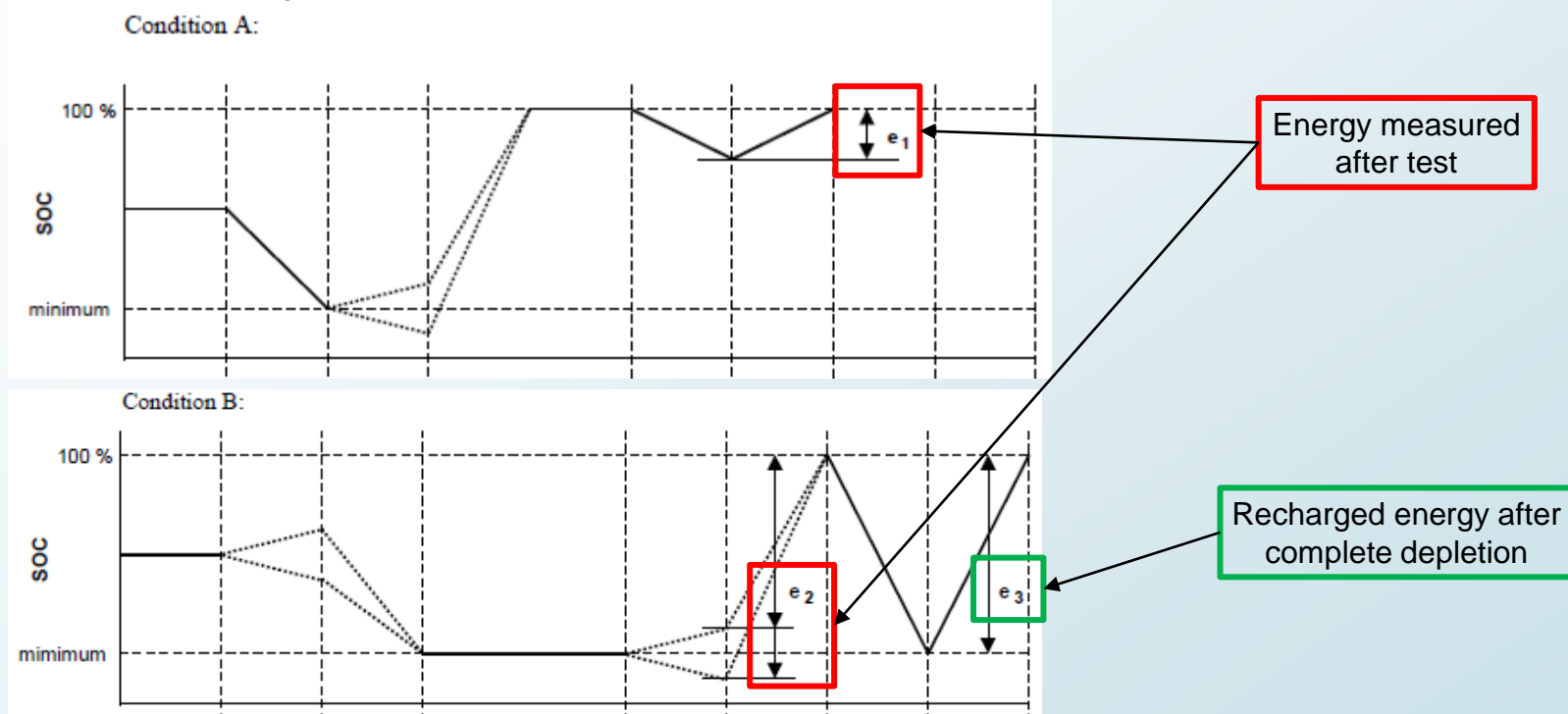
OICA position:

- Test results should reflect the energy used for vehicle propulsion only.
- Therefore, as the legislative text is not reflecting this, action is necessary to reflect this in the text
(Uploaded informal documents)
- Proposed text is a copy from WLTP (with some adaptations), WLTP text already approved
- Although NEDC is facing out in Europe, there are still countries/regions accepting approvals according to R83/R101 and that's why it is necessary to take action and reflect the intention of the legislation into the text of the legislation.

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Measurement of energy after testing in Condition A and Condition B

Reminder: e_1 , e_2 and e_3 have to be measured after testing in condition A and condition B



For condition A:

according to R101, § 4.2.1., the EV-mode has to be selected if your able to drive more than one mode in pure electric operation

Remaining open question: Which mode to select for condition B? (next slide only focus on condition B)

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Mode selection for condition B – effect of different uses cases

Use case 1: Charge-Mode under Condition B

$e_{2,charge} \ll e_3 \rightarrow E_{4,charge}$ is significantly negative

Use case 2: Charging balance neutral mode under condition B

Slight discharge: $e_2 > e_3 \rightarrow E_{4,neutral+}$ is slightly positive

Slight charge: $e_2 < e_3 \rightarrow E_{4,neutral-}$ is slightly negative

Comparison of use case 1 and use case 2 (green: identical, red: difference):

- E_1
- $E_{4,charge}$ is significantly negative, $E_{4,neutral+}$ is slightly positive, $E_{4,neutral-}$ is slightly negative
- $C_{condition A}$
- $C_{condition B,charge} \gg C_{condition A,neutral}$
- D_e and D_{av}

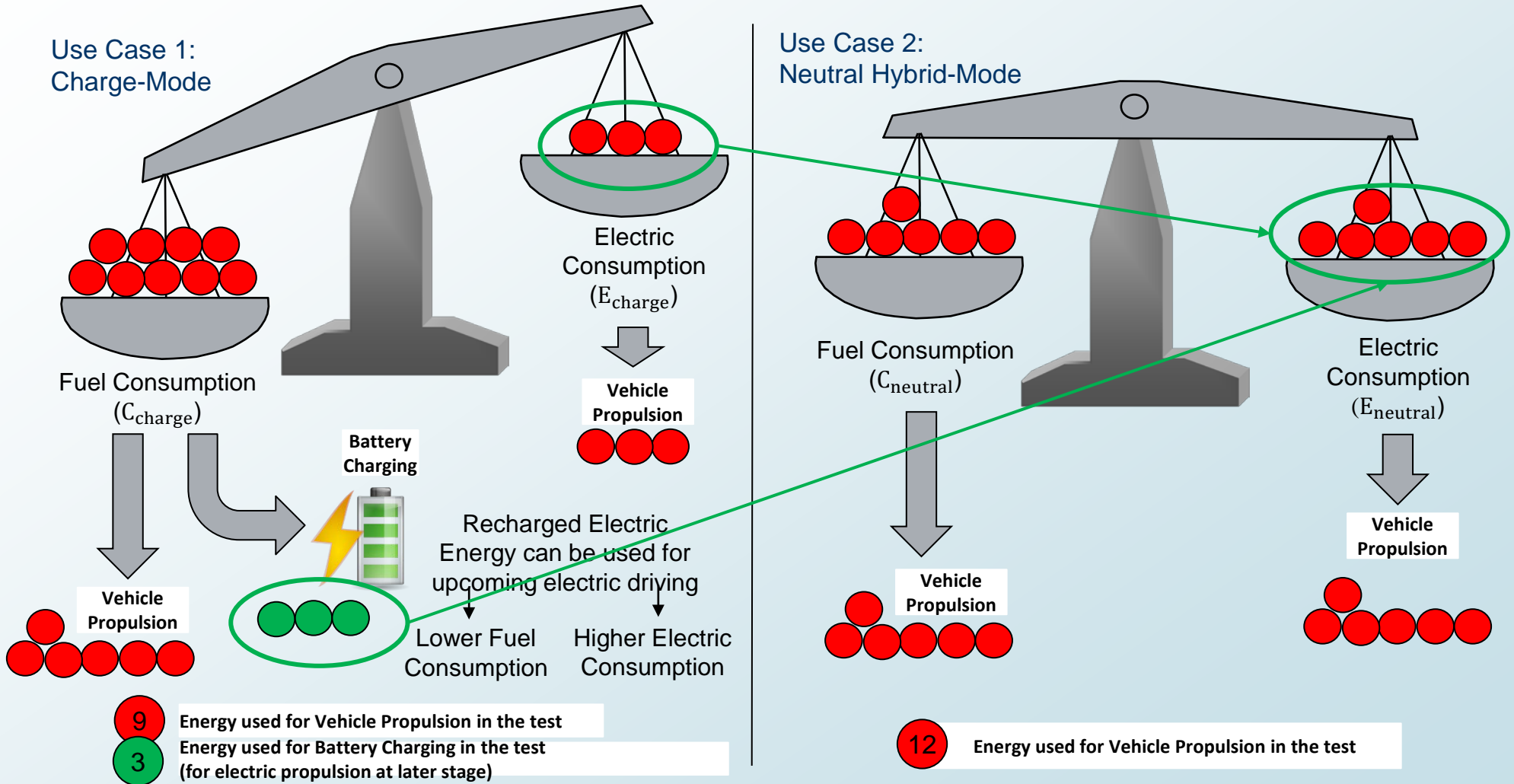
Effect on weighted electric consumption and weighted fuel consumption:

Electric consumption	$E_{charge} = \frac{(D_e * E_1) + (D_{av} * E_{4,charge})}{D_e + D_{av}}$	\ll	$E_{neutral} = \frac{(D_e * E_1) + (D_{av} * E_{4,neutral+/-})}{D_e + D_{av}}$
Fuel Consumption	$C_{charge} = \frac{(D_e * C_{condition A}) + (D_{av} * C_{condition B,charge})}{D_e + D_{av}}$	\gg	$C_{neutral} = \frac{(D_e * C_{condition A}) + (D_{av} * C_{condition B,neutral})}{D_e + D_{av}}$

**Neutral: Intention of R83/101 legislation
(also intention of WLTP)**

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Different use cases for mode selection under condition B



BACK UP

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Example on mode selection “legislative text” – table

Imagine a vehicle with the following mode set up:

- 1 pure electric mode
- Several hybrid modes
 - Intelligent hybrid mode
 - Charging-Balance-Neutral hybrid mode
 - Sport-Mode
 - Hybrid mode which is charging the REESS

None of the columns in 4.1.3. is perfectly fitting

There are arguments for column 4, as – looking at the surface – is not containing the wording “pure electric”, but one could assume that it is covered by the wording “hybrid mode” as the whole line is called “hybrid modes”.

But: Going into column 4 would lead in the case of this vehicle to a mode selection which is reflecting not only the energy used for vehicle propulsion but also the energy used for energy conversion (conversion from fuel into stored electric energy in the REESS)

4.1.3. The operating mode switch shall be positioned according to the table below:

<i>Hybrid-modes</i>	<i>⊗ Pure electric ⊗ Hybrid</i>	<i>⊗ Pure fuel consuming ⊗ Hybrid</i>	<i>⊗ Pure electric ⊗ Pure fuel consuming ⊗ Hybrid</i>	<i>⊗ Hybrid mode n* ⊗ ... ⊗ Hybrid mode m*</i>
<i>Battery state of charge</i>	<i>Switch in position</i>	<i>Switch in position</i>	<i>Switch in position</i>	<i>Switch in position</i>
Condition A Fully charged	Hybrid	Hybrid	Hybrid	Most electric hybrid mode**
Condition B Min. state of charge	Hybrid	Fuel consuming	Fuel consuming	Most fuel consuming mode***

* For instance: sport, economic, urban, extra-urban position ...
 ** Most electric hybrid mode:
 The hybrid mode which can be proven to have the highest electricity consumption of all selectable hybrid modes when tested in accordance with condition A, to be established based on information provided by the manufacturer and in agreement with the technical service.
 *** Most fuel consuming mode:
 The hybrid mode which can be proven to have the highest fuel consumption of all selectable hybrid modes when tested in accordance with condition B, to be established based on information provided by the manufacturer and in agreement with the technical service.

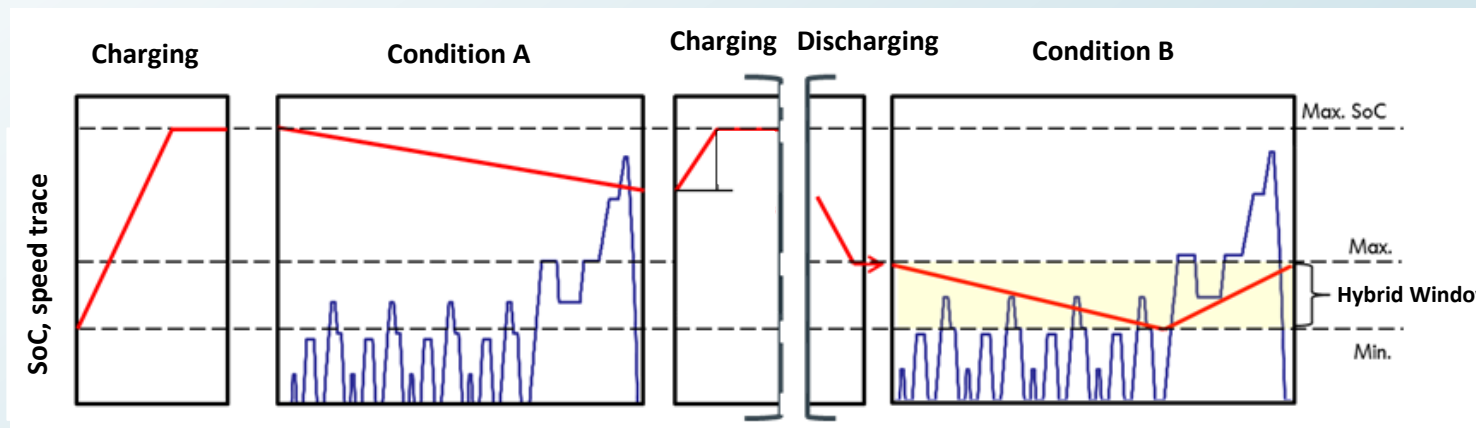
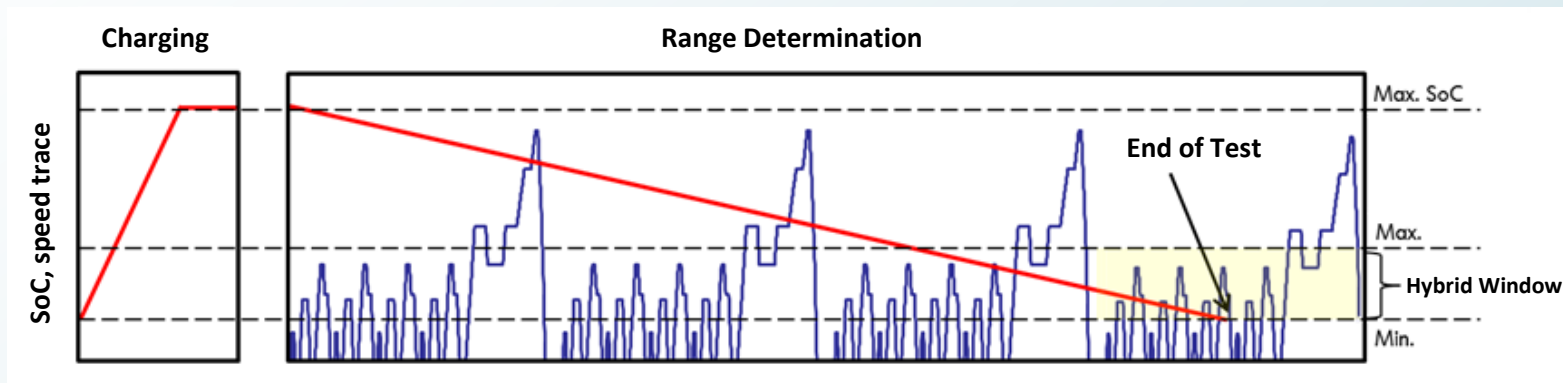
4.2.1. If the electric range of the vehicle, as measured in accordance with Annex 9 to this Regulation, is higher than 1 complete cycle, on the request of the manufacturer, the type I test for electric energy measurement may be carried out in pure electric mode, after agreement of the Technical Service. In this case, the values of M₁ and C₁ in paragraph 4.4. below are equal to 0.

The next slides will explain the effect on the test results fuel consumption and electric consumption.

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Reminder: homologation test procedure

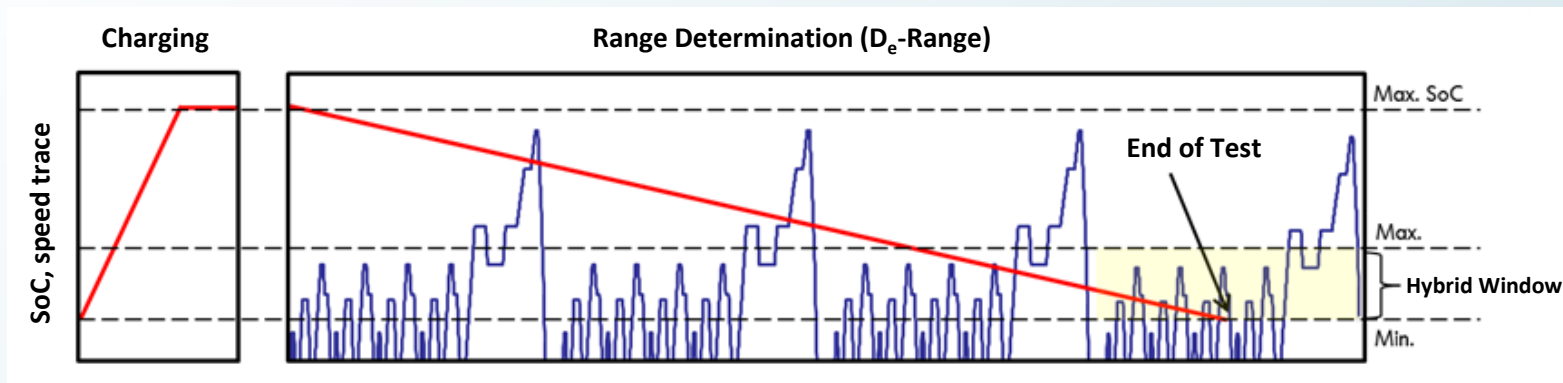
Test procedure for OVC-HEV testing is set up as follows:



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Mode selection for D_e -Range determination

Test procedure for Range Determination



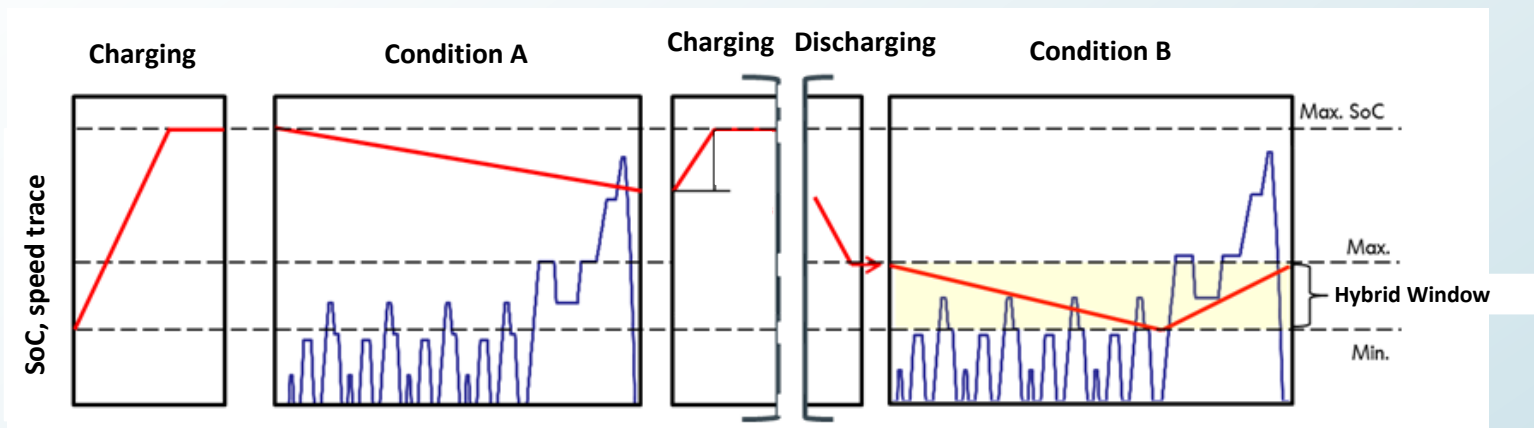
Mode selection for Range Determination (for D_e -Range):

According to UN-ECE R101, Annex 9, Paragraph 4.2.2.1.1.

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Mode selection for Condition A and Condition B testing

Test procedure for Condition A and Condition B testing



Mode selection for Condition A and Condition B:

According to UN-ECE R101, Paragraph 4.1.3. and 4.2.1.

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Mode selection “legislative text”

Mode selection for Condition A and Condition B:

According to UN-ECE R101, Paragraph 4.1.3. and 4.2.1.

4.1.3. The operating mode switch shall be positioned according to the table below:

<i>Hybrid-modes</i> <i>Battery state of charge</i>	⊗ <i>Pure electric</i> ⊗ <i>Hybrid</i>	⊗ <i>Pure fuel consuming</i> ⊗ <i>Hybrid</i>	⊗ <i>Pure electric</i> ⊗ <i>Pure fuel consuming</i> ⊗ <i>Hybrid</i>	⊗ <i>Hybrid mode n*</i> ⊗ ... ⊗ <i>Hybrid mode m*</i>
	<i>Switch in position</i>	<i>Switch in position</i>	<i>Switch in position</i>	<i>Switch in position</i>
Condition A Fully charged	Hybrid	Hybrid	Hybrid	Most electric hybrid mode**
Condition B Min. state of charge	Hybrid	Fuel consuming	Fuel consuming	Most fuel consuming mode***

* For instance: sport, economic, urban, extra-urban position ...

** Most electric hybrid mode:

The hybrid mode which can be proven to have the highest electricity consumption of all selectable hybrid modes when tested in accordance with condition A, to be established based on information provided by the manufacturer and in agreement with the technical service.

*** Most fuel consuming mode:

The hybrid mode which can be proven to have the highest fuel consumption of all selectable hybrid modes when tested in accordance with condition B, to be established based on information provided by the manufacturer and in agreement with the technical service.

4.2.1. If the electric range of the vehicle, as measured in accordance with Annex 9 to this Regulation, is higher than 1 complete cycle, on the request of the manufacturer, the type I test for electric energy measurement may be carried out in pure electric mode, after agreement of the Technical Service. In this case, the values of M_1 and C_1 in paragraph 4.4. below are equal to 0.

Mode selection for Range Determination (for D_e -Range):

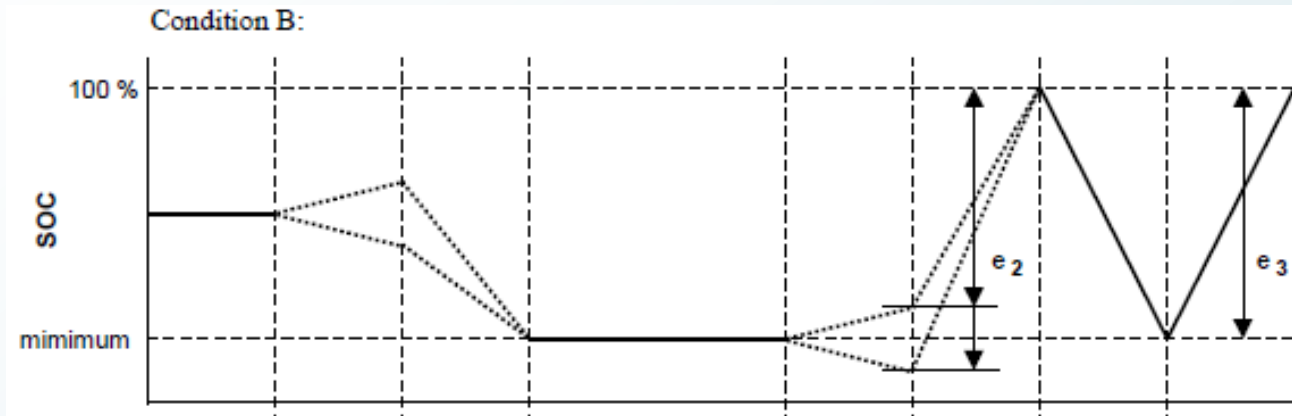
According to UN-ECE R101, Annex 9, Paragraph

4.2.2.1.1. The applicable test sequence and accompanying gear shift prescription, as defined in paragraph 1.4. of Annex 8, is applied on a chassis dynamometer adjusted as described in Appendices 2, 3 and 4 of Annex 4 to Regulation No. 83, until the end of the test criteria is reached.

To determine the electric range (D_e) of OVC HEVs equipped with an operating mode switch the same operating mode position, in accordance with Table 4.1.3 and paragraph 4.2.1 of Annex 8 to this Regulation, shall be used as for the determination of CO_2 and fuel consumption.

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Mode selection for condition B – effect of different uses cases on measured energies



$$e_4 = e_2 - e_3$$

Use case (1.): Charge-Mode under Condition B (vehicle propulsion and conversion)

REESS will be charged significantly under condition $\rightarrow e_{2,charge}$

Recharge of REESS after complete discharge: e_3

Result:

$e_{2,charge} \ll e_3 \rightarrow E_4$ is significantly negative

Use case (2.): Charging balance neutral mode under condition B (only vehicle propulsion)

REESS will slightly charged or discharged but will – more or less – remain on a charging balance neutral level $\rightarrow e_{2,neutral}$

Recharge of REESS after complete discharge: e_3

Result of...

- ...slight discharge: $e_2 > e_3 \rightarrow E_4$ is slightly positive
- ...slight charge: $e_2 < e_3 \rightarrow E_4$ is slightly negative

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Mode selection for condition B – effect of different uses cases

Use case 1: Charge-Mode under Condition B

$e_{2,\text{charge}} \ll e_3 \rightarrow E_4$ is significantly negative

$$E_1 = \frac{e_1}{D_{\text{Condition A}}}$$

is electric consumption under Condition A

$$E_{4,\text{charge}} = \frac{e_{2,\text{charge}} - e_3}{D_{\text{Condition B}}}$$

is electric consumption under Condition B (in use case 1)

$$C_{\text{condition A}}$$

is fuel consumption under Condition A

$$C_{\text{condition B,charge}}$$

is fuel consumption under Condition B (in use case 1)

D_e is range driven under pure electric mode

D_{av} is 25km (assumed distance between two battery recharges)

Use case 2: Charging balance neutral mode under condition B

Slight discharge: $e_2 > e_3 \rightarrow E_4$ is slightly positive

Slight charge: $e_2 < e_3 \rightarrow E_4$ is slightly negative

$$E_1 = \frac{e_1}{D_{\text{Condition A}}}$$

is electric consumption under Condition A

$$E_{4,\text{neutral}} = \frac{e_{2,\text{neutral}} - e_3}{D_{\text{Condition B}}}$$

is electric consumption under Condition B (in use case 2)

$$C_{\text{condition A}}$$

is fuel consumption under Condition A

$$C_{\text{condition B,neutral}}$$

is fuel consumption under Condition B (in use case 2)

D_e is range driven under pure electric mode

D_{av} is 25km (assumed distance between two battery recharges)

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Comparison of use case 1 and use case 2 (green: identical, red: difference):

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- $C_{condition A}$
- $C_{condition B,charge} \gg C_{condition A,neutral}$
- D_e and D_{av}

Effect on weighted electric consumption and weighted fuel consumption:

$E_{charge} = \frac{(D_e * E_1) + (D_{av} * E_{4,charge})}{D_e + D_{av}}$	\ll	$E_{neutral} = \frac{(D_e * E_1) + (D_{av} * E_{4,neutral+/-})}{D_e + D_{av}}$
$C_{charge} = \frac{(D_e * C_{condition A}) + (D_{av} * C_{condition B,charge})}{D_e + D_{av}}$	\gg	$C_{neutral} = \frac{(D_e * C_{condition A}) + (D_{av} * C_{condition B,neutral})}{D_e + D_{av}}$