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(9th HDH meeting, 21 to 23 March 2012)

HDH vehicle operation on Chassis-Dynamometer

**TÜV NORD Mobilität
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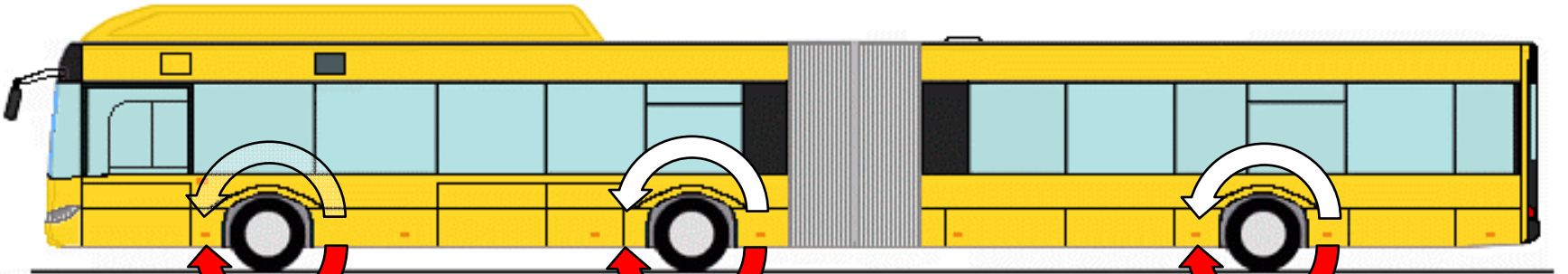
**9th HDH Heavy-Duty Hybrid Informal Group meeting
Tokyo, 21 - 23 March 2012**



- ◆ **Recuperation in real-world operation vs. chassis-dyno operation**
- ◆ **Recuperation Correction**
- ◆ **Evaluation of state of charge**
- ◆ **Miscellaneous**

Driving and brake force / 18m articulated bus real-world operation

dynamic axle load distribution



F_{motive}

F_{motive}

$F_{\text{brake, mechanical}}$

$F_{\text{brake, mechanical}}$

$F_{\text{brake, mechanical}}$

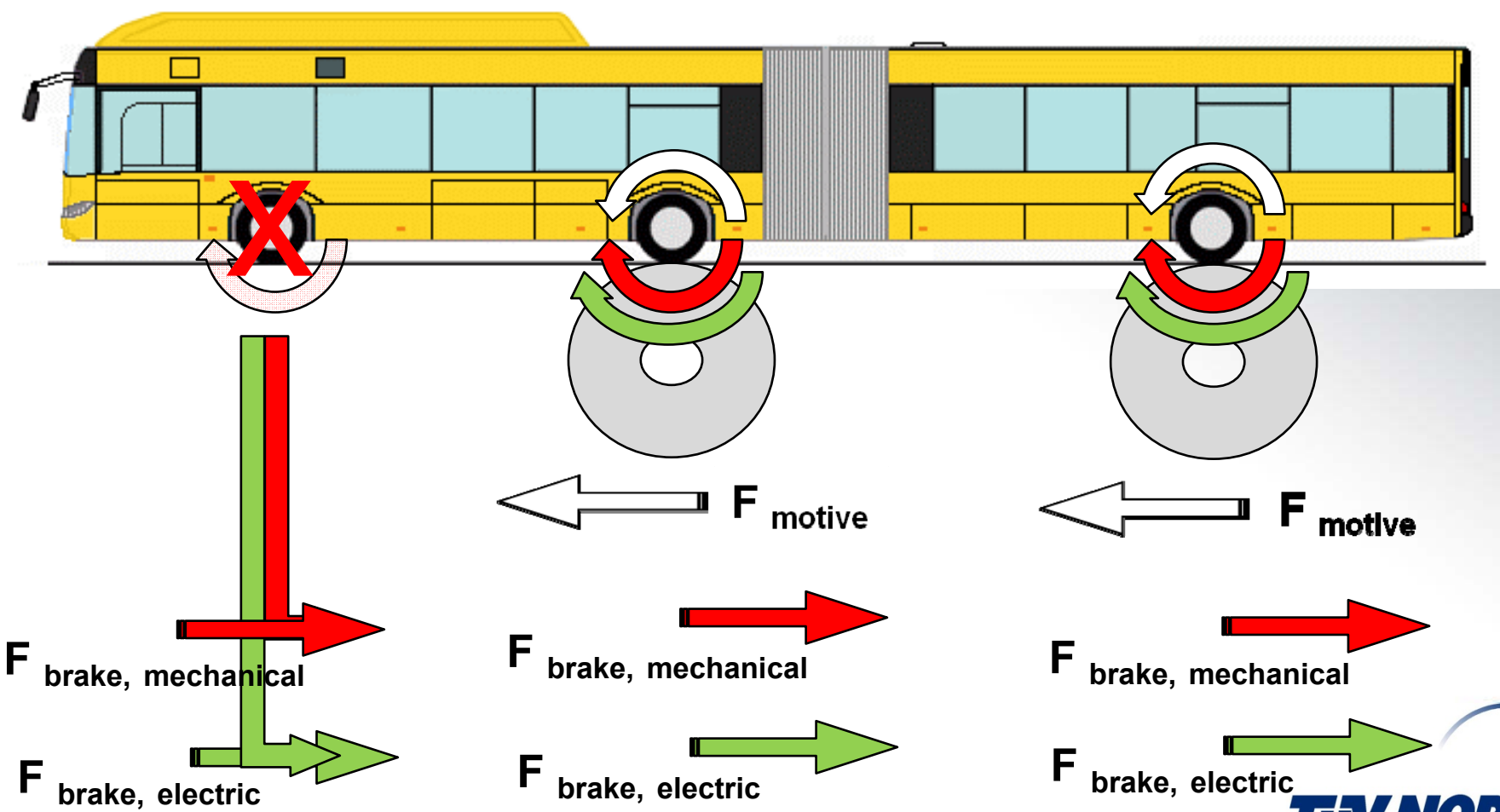
$F_{\text{brake, electric}}$

$F_{\text{brake, electric}}$

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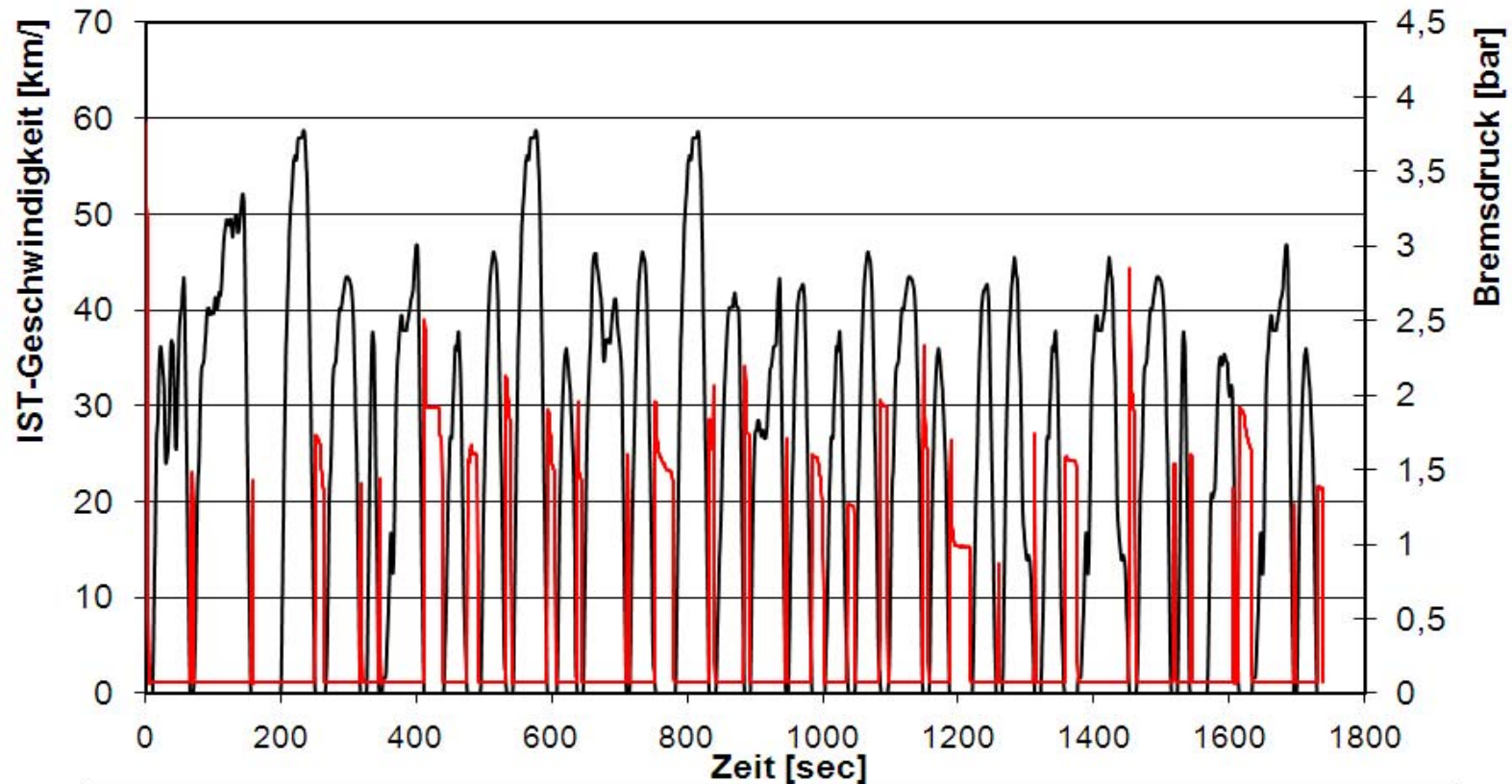
Driving and brake force / 18m articulated bus chassis-dyno



Recuperation Correction

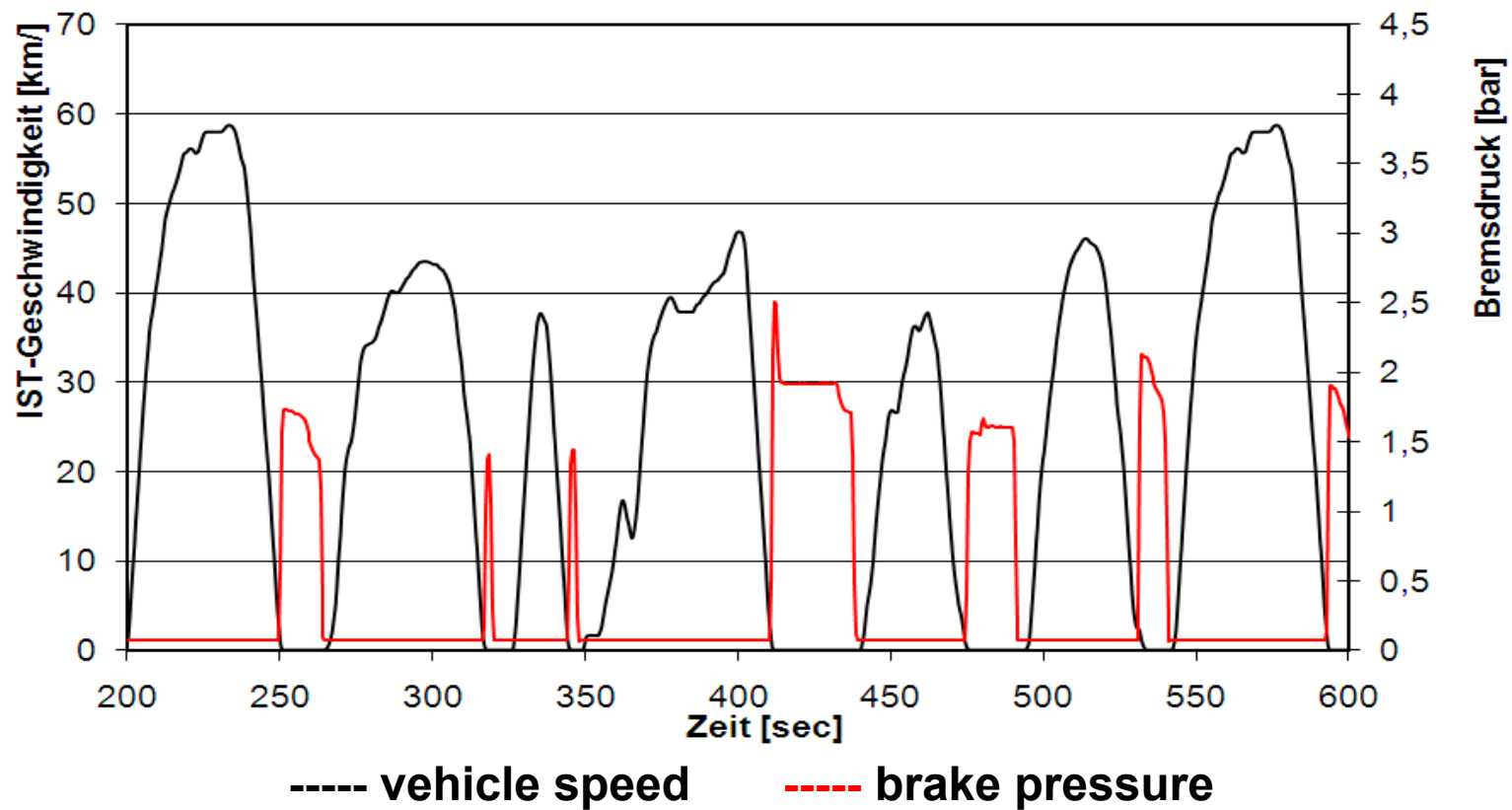
- In case of parallel activation of the mechanical and electrical (recuperation) brake system it can become possible that the brake forces of the axle(s) not in operation / rotation on the chassis-dyno are „over“ recuperated by the axles in operation / rotation. This gives an positive effect to the HDH. The effect itself depends on the HDH design and vehicle strategy.
- Due to the non-existing dynamic axle load distribution this effect is moderately increased on the chassis dyno. The propulsion axle(s) is (are) not load balanced on the dyno; for that reason the slip is lower.
- In case of serial activation of the brake systems (recuperation followed by mechanical braking system) the above mentioned effect will not appear as long as maximum recuperation can be observed. No additional energy will be recaptured.
- In order to verify the HDH strategy in relation to the above mentioned cases additional testing of the mechanical brake forces of the HDH vehicle becomes necessary.

Recuperation Correction

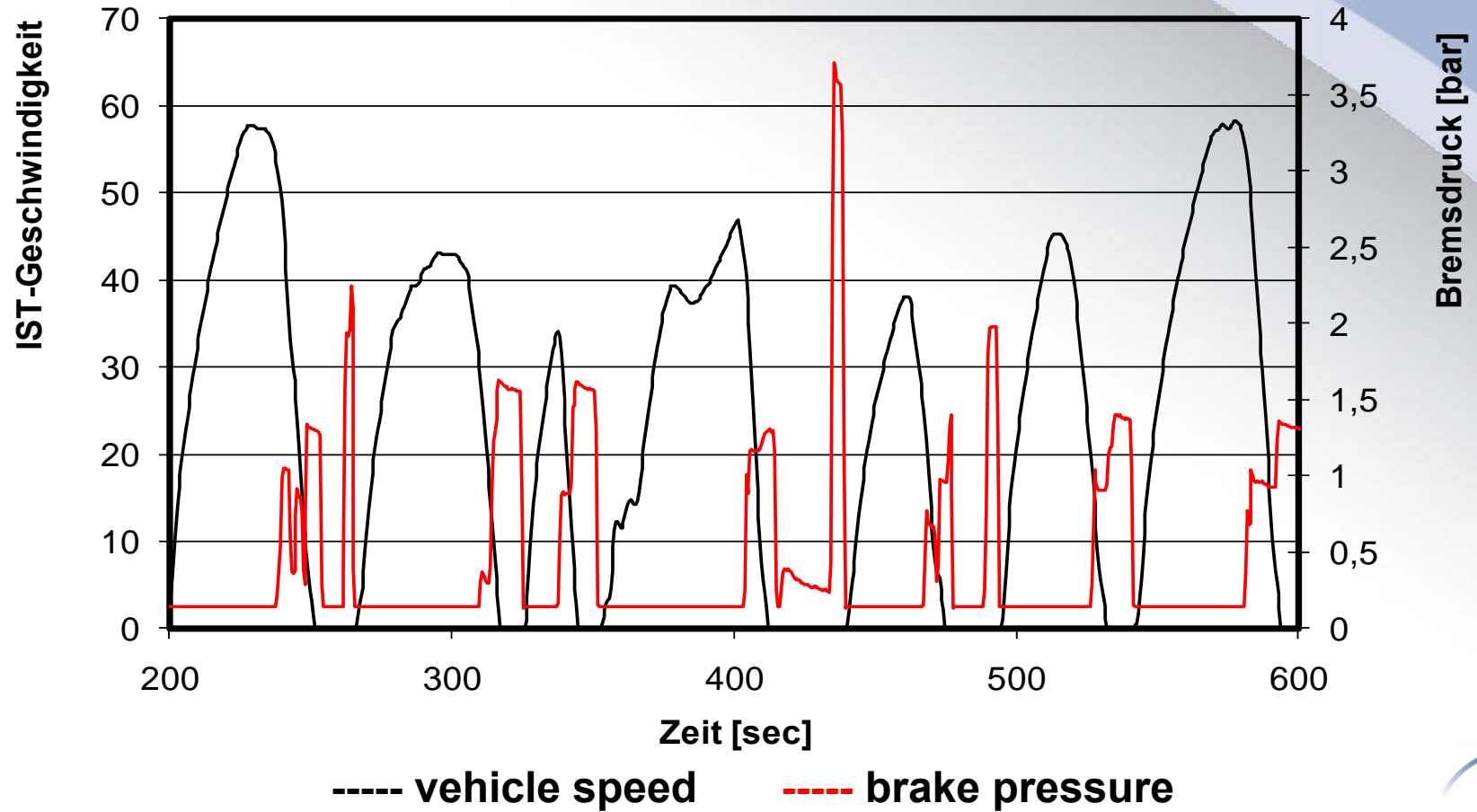


----- vehicle speed ----- brake pressure

Recuperation Correction



Recuperation Correction



Evaluation of state of charge / Correction

- Δ SoC – State of Charge at the start / at the end of a test cycle
- If Δ SoC \neq 0 correction is needed

$$\Delta \text{ SoC} = (W_{\text{in}} - W_{\text{out}}) * \text{Eta} = [\text{Eta}_{\text{lade}} * (U * I * t)_{\text{in}} - \text{Eta}_{\text{entlade}} * (U * I * t)_{\text{out}}]$$

W_{in} = stored work

W_{out} = released work

Eta = efficiency

=> Evaluation of the charge / discharge characteristic over the applicable test cycle necessary.

Necessity of coast-down measurements vs. HDH strategy

Depending on the HDH strategy and lay-out it is may not possible to perform coast down measurement.

Cooling of power electronics / converter / energy storage

Chassis dyno ambient conditions simulation important for HDH performance (e.g. air flow).

Additional measurement systems necessary

The HDH vehicle needs to be equipped with additional measurement systems for electrical values in high-voltage environment.



**Thank you for
your kind attention**