Innovation Days Efficient Dynamics.
Energy and Environmental Test Centre.
Energy and Environmental Test Centre (ETC).
Climatic and thermal wind tunnel. From road to testbed.
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Climatic wind tunnel.
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Background climatic and thermal wind tunnel.

**Intention:** Reproducible simulation of complex environmental and driving tests in a climatic wind tunnel in Munich – independent on specific seasons, weather and traffic conditions.

**Challenge:** To provide a testing method which allows the test engineers to work on their development programmes in a test bed without quality-related limitations.
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The test: Dynamic uphill driving with a vehicle/trailer combination.

Route profile
- Approx. 100 km on a motorway: engine and cooling system achieve thermal steady conditions
- Dynamic cross-country route: engine, transmission and all components close to the engine become increasingly hot
- Dynamic hill route: whole car is pushed to the limit both mechanically and in terms of temperature

Driving profile
- Moderate motorway driving style, max. 90 km/h
- Cross-country route: speeds between 60 km/h and 80 km/h, some sections at full throttle
- Uphill: max. 60 km/h, 40 km/h in corners, maximum acceleration
### Energy and Environmental Test Centre (ETC).
Free body analysis of relevant influences.

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<th>Type of approach to the hill</th>
<th>Humidity</th>
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<td>Air temperature</td>
<td>Air pressure</td>
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<td>Air conditioning setting</td>
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Test configuration of the car | What kind of trailer is the customer pulling?

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After a suitable test has been worked out offering significant potential, all the factors impacting on the car during the test are identified through “free body analysis”. These environment-related factors could also be described as “partial realities”, which together make up the conditions in which the road test is carried out.
Simulation of the hill
Forces acting on the car are transferred through the test bed roller dynamometers. The forces to be simulated include tyre friction, drag, inertial forces and grade resistance.

Simulation of environmental conditions
Thermally conditioned air is used for the simulation of the airflow around and through the car in the climatic wind tunnel. Isolated factors in the environmental conditions to be simulated include air temperature, humidity and wind speed.
Energy and Environmental Test Centre (ETC). Climatic and thermal wind tunnel. Simulation of artificially recreated realities.

- BMW database
- Driving resistance components
  - Drag
  - Engine and transmission
  - Tyres

Driving resistance simulation in the test bed

Engine, transmission, tyre and drag represented by a characteristic curve
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Climatic and thermal wind tunnel. Simulation of artificially recreated realities.

Depiction of grade resistance using a synthetic inclination profile.
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Depiction of the speed of the vehicle/trailer combination using a synthetic speed profile.
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Climatic and thermal wind tunnel. Creating a synthetic route profile.

Duration of road test: 120 minutes
Duration of simulation: 75 minutes

Motorway: 20 min shorter
Cross-country route: 25 min shorter
Synthetic gradient profile
Creating a new testing method “Dynamic uphill driving with a vehicle/trailer combination” using a schedule in the test bed management system.

The test bed management system controls all the subsystems, each of which reproduces one of the artificially recreated realities previously simulated.
Energy and Environmental Test Centre (ETC).
Climatic and thermal wind tunnel. Validation – the test is examined.

The validation compares the responses of relevant components between the road test and the “artificial” test in the test bed.

If the result is within the target tolerances, the new testing method can be approved for all test engineers.
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Thank you for your attention.