

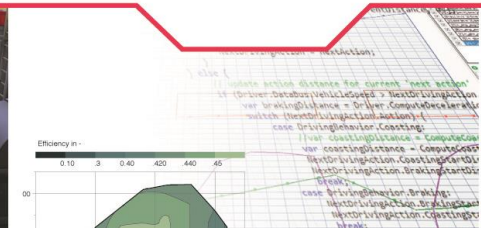
NRMM emissions

Overview on recent measurement data and current activities

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Content

- Overview on current activities
- Emission standard stage V
- Recent measurement data
- Main findings

Overview on current activities

- Further research activities in the area of NRMM due to the introduction of emission standard stage V
- Common project of TUG and Ifeu funded by the UBA Germany and the BMU Germany
- Main project goals:
 - Assessment of the real world emission behaviour of stage V machines
 - Elaboration of representative emission factors
 - Principal evaluation of emission standard stage V with focus on the ISM part

Emission standard stage V

Stage IV



Measurements on the engine test bed

- NRSC (stationary test cycle)
- NRTC (transient test cycle)

Stage V



Same as stage IV

+

test of the real world emission behaviour according to regulation 2017/655 - ISM

Summary of regulation 2017/655

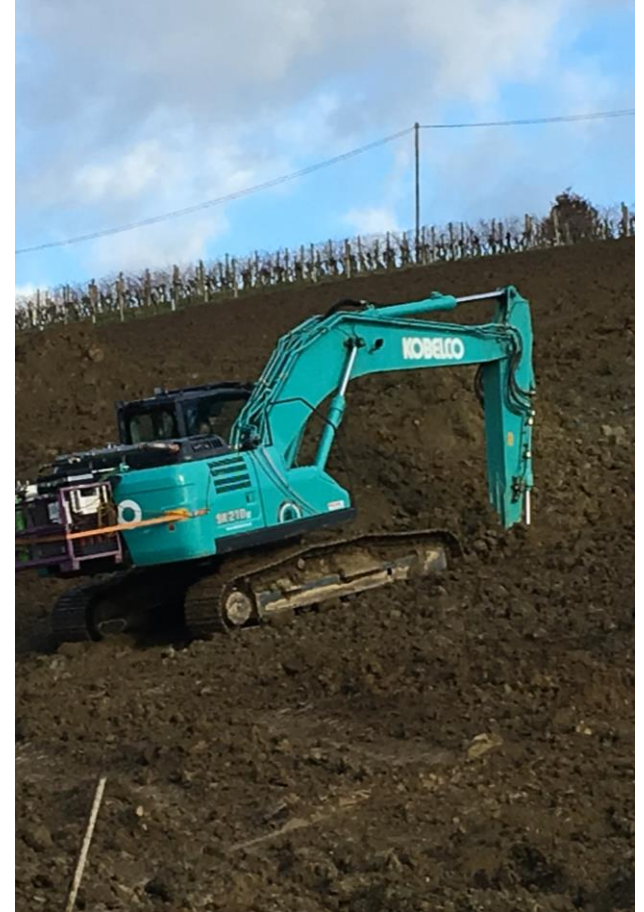
- Regulation on the monitoring of gaseous pollutant emissions from internal combustion engines in non-road mobile machinery using portable emission measurement systems
- The test is carried out during the entire (or partial) actual working operation
- Monitoring during operation shall be carried out in a single operating cycle or may be combined by several operating cycles
- The test duration must be long enough to perform 5 to 7 times the work done during the NRTC
- The measured values in non-working events shall be excluded of the evaluation

Procedure to determine non-working events

- Events with an engine power below 10 % of the rated engine power
- Events corresponding to engine system cold conditions (cold start)
- Non-working events shorter than 2 minutes shall be considered as working events and merged with the surrounding working events
- The take-off phase following long non-working events > 10 minutes shall also be considered as a non-working event until the exhaust gas temperature reaches 523 K. If the exhaust gas temperature does not reach 523 K within 4 minutes, all events after 4 minutes shall be considered as working events.
- For all non-working events, the first 2 minutes of the event shall be considered as working event

Recent measurement data

- Real world measurement of
 - 1 excavator stage IV
 - 1 excavator stage V
 - 1 bulldozer stage V (measurement last week, test data not yet available)
- Results divided in working and non-working events
- MAW evaluation with Emroad

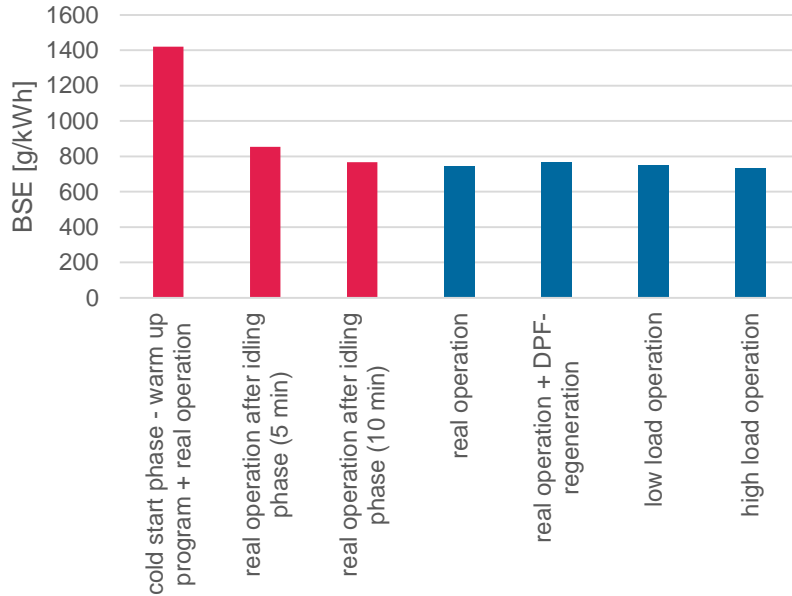


Recent measurement data



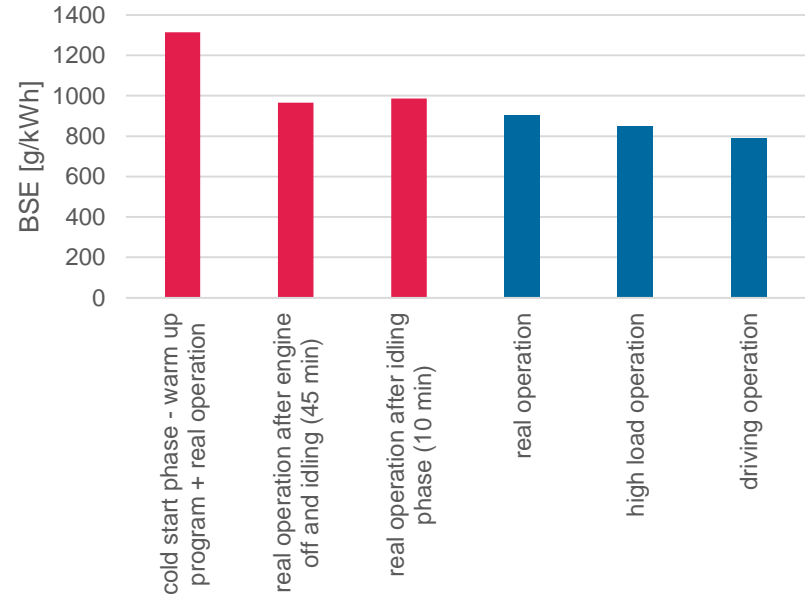
Test results – CO2

CO2 - stage IV



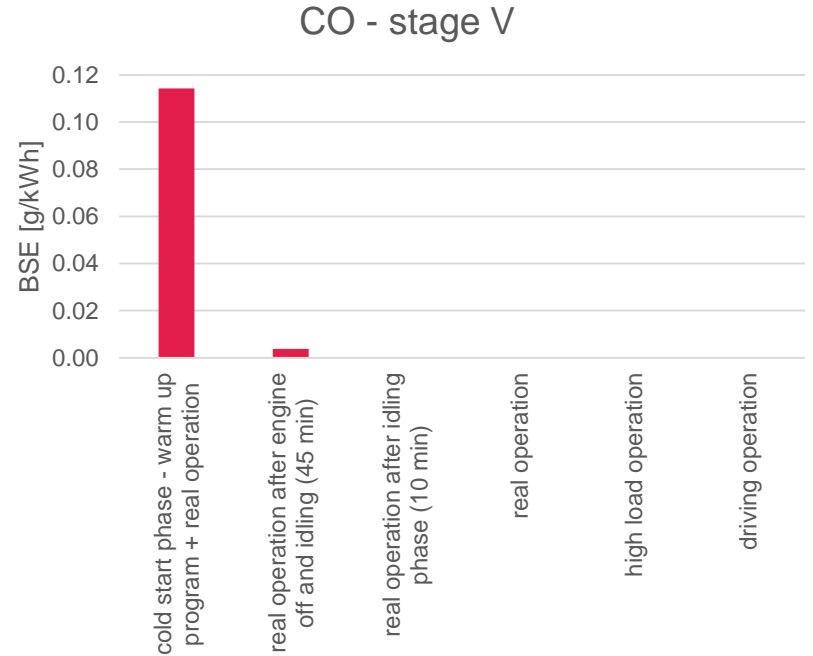
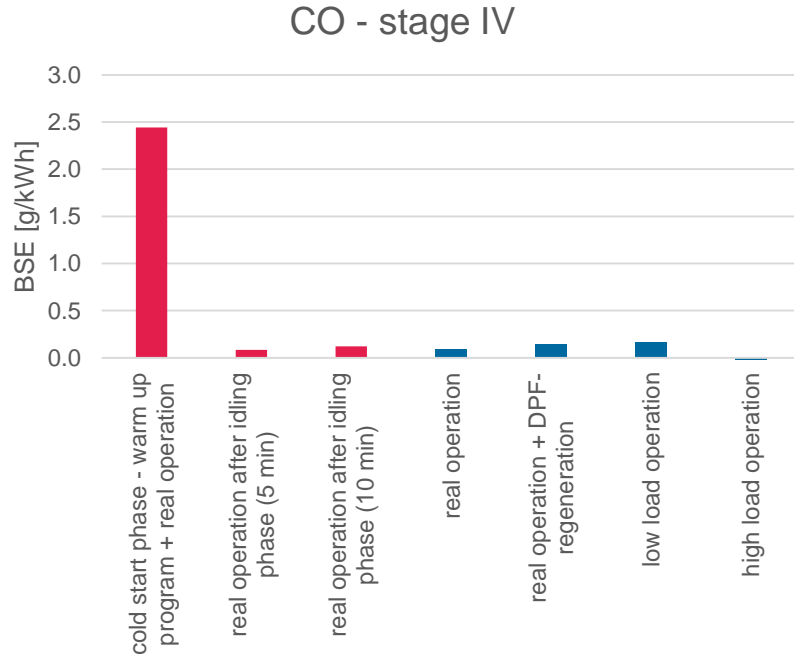
Non-working events

CO2 - stage V



working events

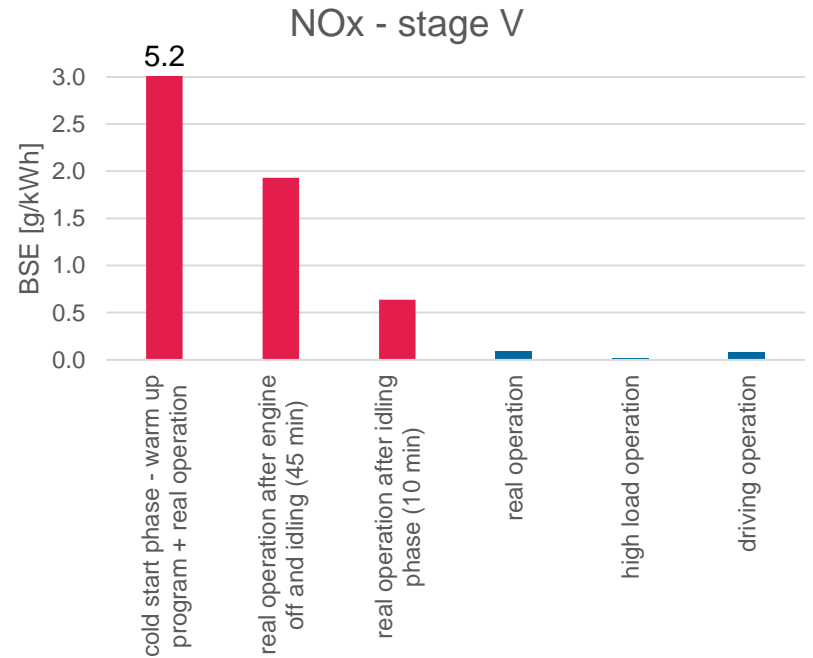
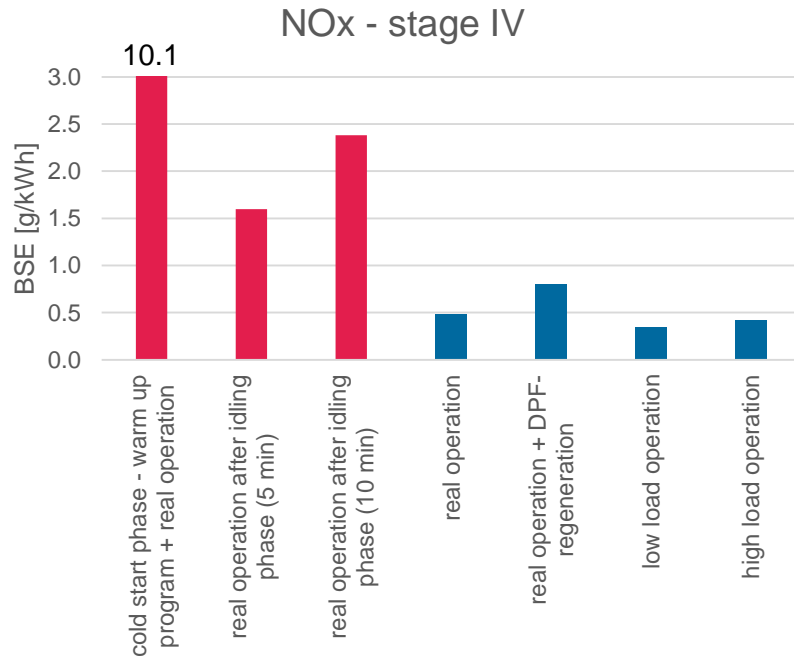
Test results – CO



Non-working events

working events

Test results - NOx

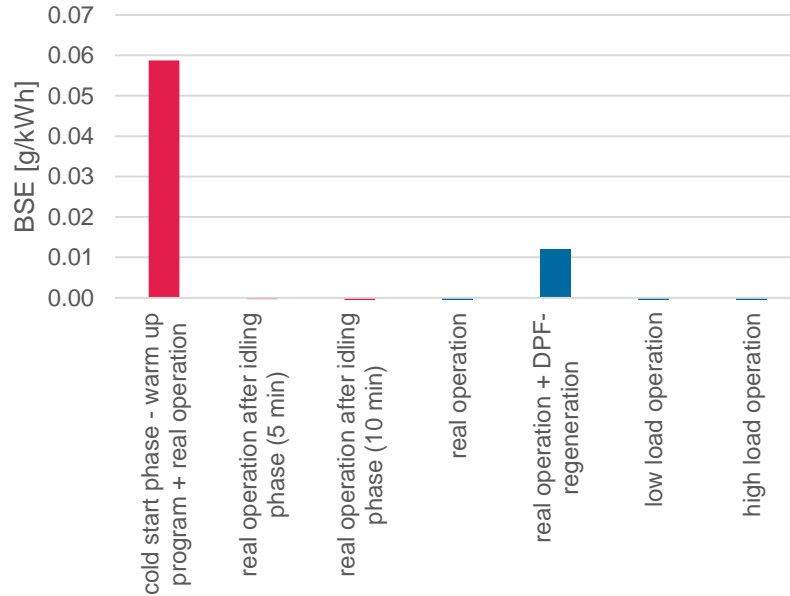


Non-working events

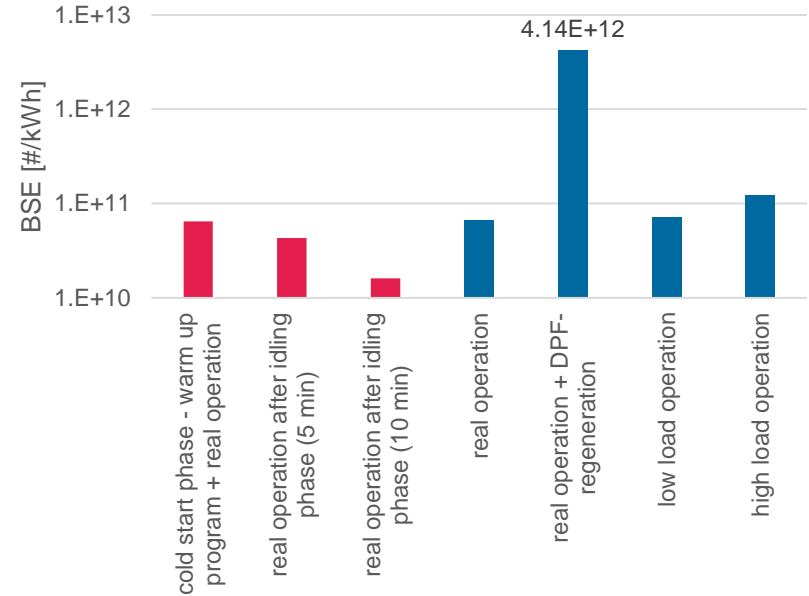
working events

Test results – THC and PN

THC - stage IV



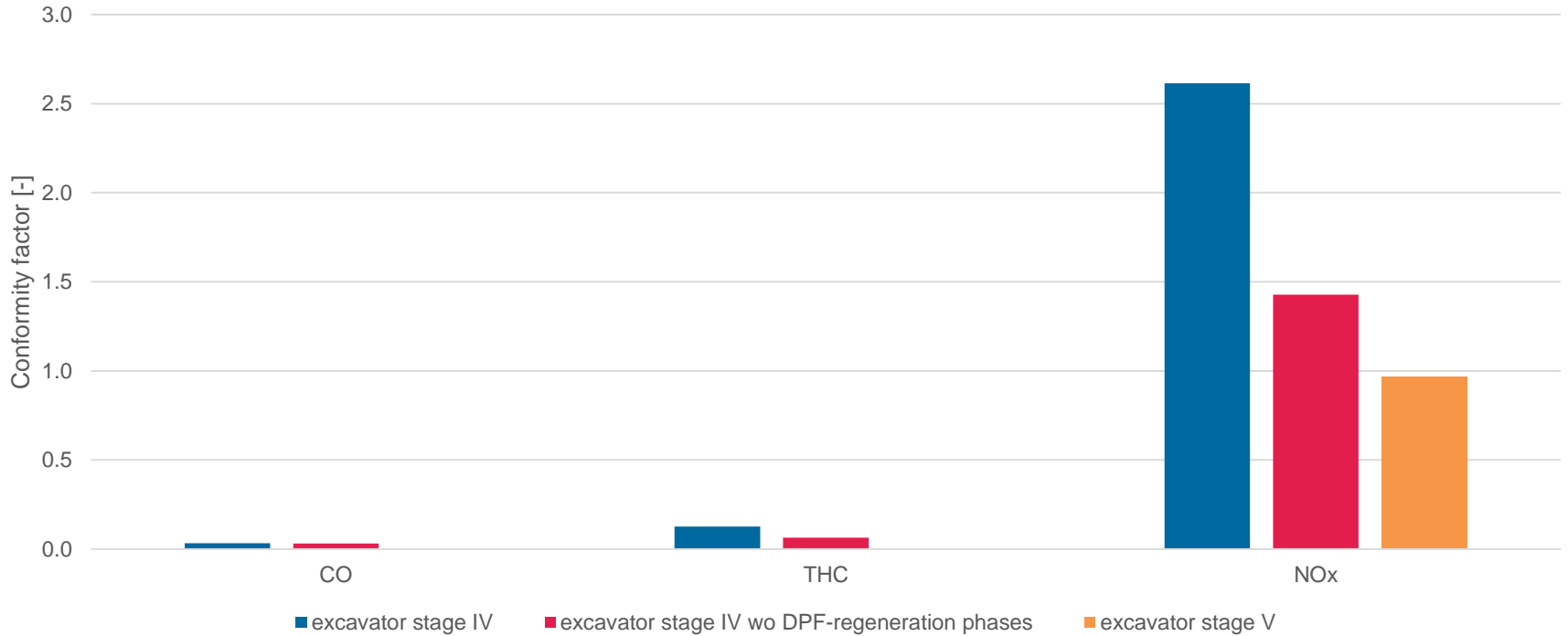
PN - stage IV



Non-working events

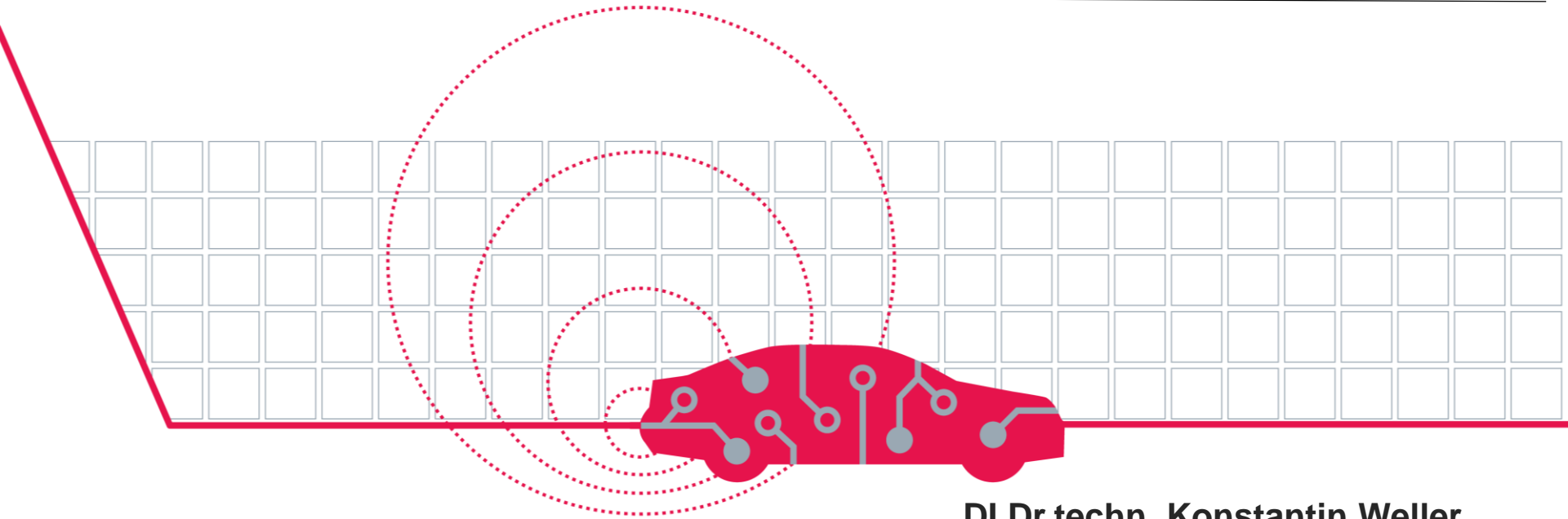
working events

MAW evaluation with Emroad – 90 percentile results



Main findings

- Real world emissions
 - on a low level in working events (stage IV and V)
 - Increase in non-working events like cold start, longer idling periods and DPF-regeneration → not considered in Emroad
- Amount of stage V data low especially with regard on the creation of representative emission factors
- Measurements of NRMM according to regulation 2017/655 works in principle
 - Vibrations of the PEMS → impact on accuracy?
 - Installation of PEMS equipment is challenging especially for small machines → bigger PEMS not mountable



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