Further experience with low emissions zones in Germany: will the next stage do the job?

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Introduction and Status Quo

High concentrations of NO_2 and PM10 prevail (see Fig. 1) mainly in street canyons, with local road traffic as main reason (see Fig. 2).

Low Emission Zones (LEZ) are one measure to reduce the burden.

So far: First stage (SG 1 excluded, see Tab. 1) implemented, first LEZ in 2008

Even though air quality improved (see Tab. 2 and 3), still too high concentrations remained:

Time for 2nd stage (SG 1, 2,3 excluded, see Tab. 1) of LEZ

But will that be enough?

Type (SG)	1	2	3	4
Sticker	none	red	yellow	green
Diesel engine	Euro 1 or worse	Euro 2 or Euro 1 plus particle filter	Euro 3 or Euro 2 plus particle filter	Euro 4 or Euro 3 plus particle filter
Petrol engine	No controlled catalytic converter			Euro 1

Table 1: Classification of vehicles in emission groups (SG).

Effect of LEZ stage 1 First implemented in 2008	Cities with LEZ	Studies showing the effect of LEZ
Increase of pollutants	None	
Decrease of pollutants	Munich, Cologne, Ruhr Area (8 cities with LEZ)	[4], [5], [6]
Inconclusive	London, Berlin, Mannheim, Stuttgart, Tübingen, Ludwigsburg, Hannover	[1], [2], [3]
Effect of LEZ stage 2	Cologne, Ruhr Area, probably more	Only model calculations, will be implemented in 2012

Table 2:Effects of LEZ in Europe. Stage 1: field observations.

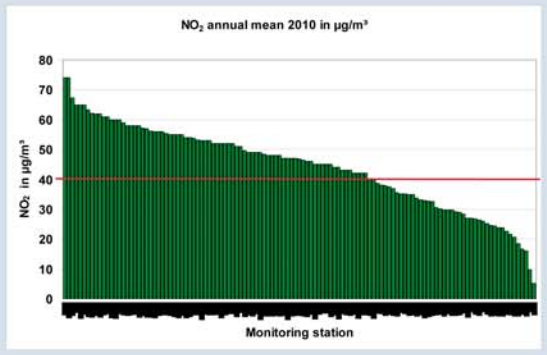


Figure 1: Measurements of annual average NO_2 2010 in NRW 2.

	Average difference measurements 2009 - 2007			
	All traffic exposed sites	Traffic exposed sites in LEZ	Traffic exposed sites outside LEZ	Background stations
	PM10 annual average (µg/m³)			
# of sites	12	7	5	26
Average	-2,6	-3,3	-1,6	-1,1
Standard dev.	2,5	2,9	1,6	1,6
	Number of PM10 exceedance days (> 50 µg/m³)			
Average	-15	-21	-6	-3
Standard dev.	12	13	5	5
	NO_2 annual average (µg/m³)			
# of sites	34	18	16	20
Average	-1,1	-1,7	-0,8	1,7
Standard dev.	3,1	3,7	2,1	1,3

Table 3: Effects of LEZ stage 1 in NRW. Field observations.

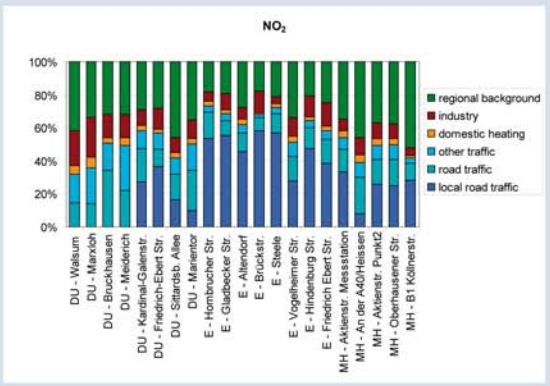


Figure 2: Source apportionment for NO_2 for stations in Duisburg, Essen, and Muelheim (Ruhr area west).

Figure 3: Dashed areas: LEZ in the Ruhr District.

LEZ stage 2: Example Ruhr Area

2nd stage = only green sticker vehicles allowed

Reduction in burden due to local traffic calculated within the existing LEZ (see Figs. 4 and 5 and Tab. 4)

Model simulation with Immis[Luft] [7] for impact: assumption all vehicles with SG1 and SG2 replaced by vehicles with SG4 (see Tab. 1).

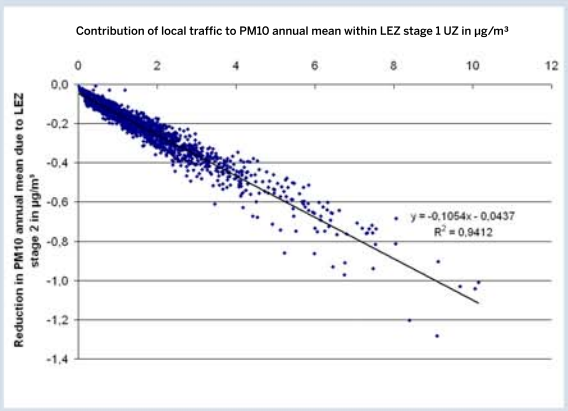


Figure 4: PM10. Impact of LEZ stage 2. Model results.

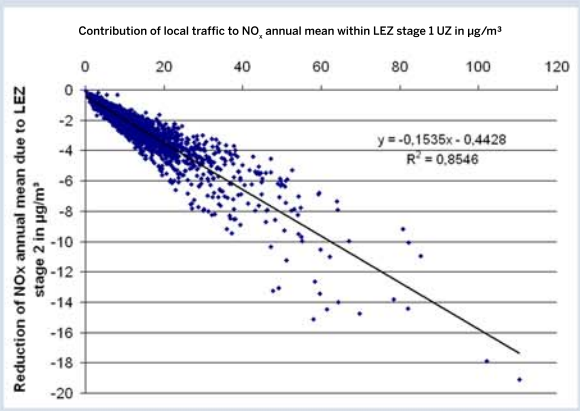


Figure 5: NO . Impact of LEZ stage 2. Model results.

Impact of LEZ stage 2:

LEZ stage 2 leads to an additional reduction of air pollution (see Tab. 4 and 5).

The reduction is proportional to the contribution of local road traffic to the immission load (see Figs. 4 and 5).

Highest reduction is obtained in heavily trafficked street canyons.

Delta LEZ	PM10 µg/m³	PM10 exceedance days	NO_2 µg/m³
Max.	1.3	~ 4	19
Mean	0.2	~ 1	1

Table 4: Impact of LEZ stage 2. Model results.

Place	Measured 2010	Contribution of local road traffic	Reduction owing to LEZ stage 2
Alfredstraße at Essen	58 µg/m³ NO_2 162 µg/m³ NO_x	69 µg/m³ NO_x	11 µg/m³ NO_x
Gladbecker-straße at Essen	54 µg/m³ NO_2 139 µg/m³ NO_x 31 µg/m³ PM10	87 µg/m³ NO_x 13 µg/m³ PM10	14 µg/m³ NO_x 1 µg/m³ PM10

Table 5: Impact of LEZ stage 2. Example roads.

Will LEZ stage 2 do the job?

LEZ is one way to reduce the burden of NO_2 and PM10

2nd stage of LEZ can help to meet the limit values.

It is very promising for PM10.

But still more than the half of stations remain above the limit value for NO_2

Further measures are needed:

Example: Essen, Gladbecker Straße: reduction in total traffic to about 20 % needed to meet limit values (see Fig. 6)!

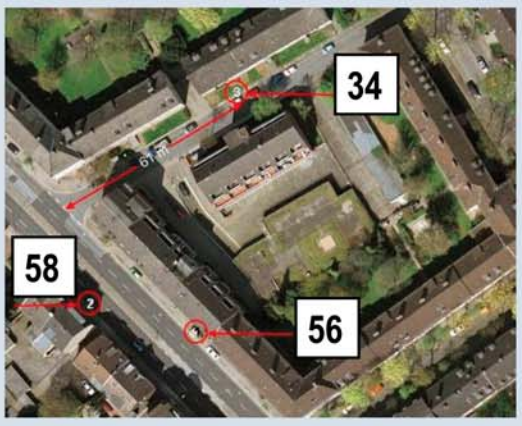
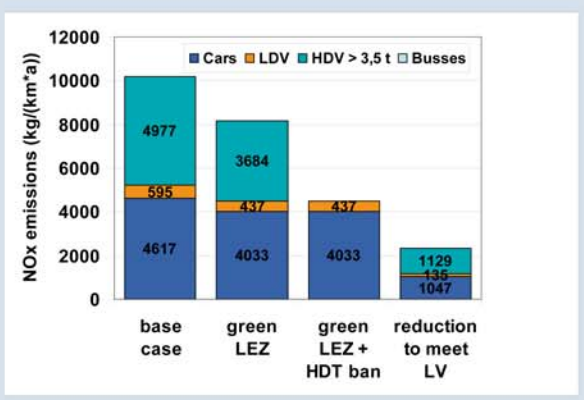


Figure 7: Essen, Gladbecker Straße,
Measured annual mean concentrations 2009 in µg/m³ in the street canyon and urban background.



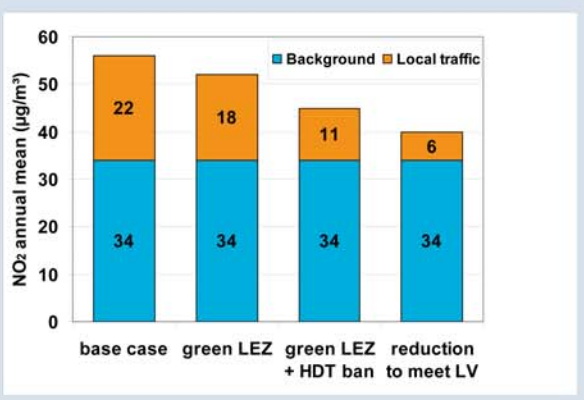


Figure 6: Example Essen Gladbecker Straße: Total burden for different scenarios.

Some essentails about the Gladbecker Straße:

Urban distributor in the Ruhr District

Street canyon

41.300 vehicles per day

HDT (> 3,5 t) 5.2%

No busses

Traffic situation: URB/Distr./50/*

* = Level of service (Freeflow, Heavy, Saturated, Stop&Go) according to traffic density with hourly update.

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[6] Bruckmann, p., A. Brandt, S. Wurzler, K. Vogt, 2011: Verbessern Umweltzonen die Luftqualität? Do Low Emission Zones Improve Air Quality?

[7] IVU UMWELT (2007): Bestimmung der aktuellen gebietsweiten Schadstoffbelastung in den besiedelten Hauptstraßen des Ruhrgebiets. Auftraggeber: Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen (LANUV

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