Dealing with the notorious NO2 problem in Germany: Current deliberations about diesel bans, speed limits and other nasty measures

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- Compliance situation
- Pressure for measures
- Example: Low emission Zone & options for ULEZ
- Other measures being discussed
- Prospects for full attainment
- résumé
Closing the NO2-gap in Berlin

max NO2-level

-15% fleet renewal, incl LEZ
-3% modal shift
-5% speed limit 30 km/h
-x% Euro 6/VI incentives
-x% SCRT retrofit buses & HGVs
-x% ???????

mean NO2-level

gap -28%

gap -50%

EU limit value

modelled NO2- levels at traffic site Stuttgart Neckartor

-15% LV excess even in 2020 and even if all vehicles were Euro 6/VI

source: Udo Lambrecht
IFEU Institute 2010
AQ assessment Germany

NO2 trend & compliance situation 2014

Still 1/3 of all traffic stations above limit value

Source: UBA Germany
AQ assessment Berlin

NO₂ pollution trend

Long-term trend of nitrogen dioxide levels in Berlin

限值 for NO₂
NO₂ annual mean 2014 in µg/m³
annual limit value of 40 µg/m³ widely exceeded
Berlin compliance assessment

modelled NO2 concentration

NO2 annual average 2013

- unter 38
- 38 bis unter 40
- 40 bis unter 42
- 42 bis unter 44
- 44 bis unter 60
- über 60

almost 50 km exceeded

Grenzwert NO2: 40 µg/m³
NO2 non-compliance

pressure for further action

From court rulings in Germany

- More than 30 court trials initiated by NGOs,
- most of them ruled in favour of more measures and ambition...
  - Non-attainment period needs to be kept as short as possible
  - Health protection got much stronger weight when assessing proportionality of measures
  - Current AQ plans insufficient in that respect
  - Traffic restrictions are legal, except if impact is very small or would result in traffic re-location and risk for non-compliance elsewhere
  - Very strong justification needed, if effective measures were neglected
  - Compensation needed through other measures if traffic restrictions not taken
NO2 non-compliance

pressure for further action

From the Commission

- Rejected a time extension for about 40 zones (incl. Berlin)
- launched an infringement procedure due to persistent non-attainment of NO2 in 33 zones (incl. Berlin)

- NO2 – LV need to be met asap, i.e. MS have a certain degree of freedom which measures to adopt, but authorities are responsible to achieve full compliance within a period „as short as possible“.

- Commission insists that MS take all appropriate measures to meet LVs asap, e.g. „access restrictions for Diesel in some urban areas“ despite the weaknesses of Euro 5 vehicle emission standards

- Measures taken so far in D are considered insufficient, if not counter-productive,
  - Example: fuel tax discount for Diesel, despite of known RDE problems of Euro 5

- Clear infraction of the AQD in zones, where attainment is envisaged only after 2020, i.e. more than 10 years after the initial attainment deadline

- In zones, where attainment is expected before 2020, the Commission assessed AQ plans in more detail and considered a breach of Art 23 of the AQD because
  - Projections deemed unrealistic, lack of convincing evidence for compliance before 2020
  - No LEZ was implemented
(Extra) Measures and their impact

Example: Low Emission Zone (LEZ)

Low Emission Zones

Stage 2: in Berlin since 1.1.2010

- Diesel vehicles: Particle emission Euro 4:
  - cars: Euro 3 + particle filter or better
  - goods vehicles: also retrofit of Euro 1-3 towards Euro 4_{particle}

Gasoline vehicles: at least Euro 1 by now in more than 60 german cities

Given the mess with NO2, should we go for stage 3? If so, how should that be framed? What would it deliver?
Impact analysis of current LEZ in Berlin

Emissions of PM

LEZ impact: change in particle exhaust emissions based on fleet composition at a busy main road (new emission factor data base HBEFa 3.2)
Impact analysis of current LEZ in Berlin

**Total carbon** air concentrations from traffic

Traffic related* total carbon concentration in Berlin

adjusted with traffic volume changes

low emission zone in force

- 98%
- 100%
- 100%
- 112%
- 104%
- 100%
- 82%
- 86%
- 81%
- 75%
- 50%
- 44%
- 54%
- 55%
- 43%
- 55%
- 47%
- 53%
- 42%

*traffic increment based on the difference between kerbside and urban background sites

data recalibrated Oct 2014

TC = EC + 1.2 * OC in µg/m³

Average TC over 12 mini sampler outside the LEZ

Average TC over 10 mini sampler inside the LEZ

*share of situations with low wind speed <2.4 m/s (2007=100%)

Impact analysis of current LEZ in Berlin

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Impact analysis of current LEZ in Berlin NOx emissions

based on fleet composition at Frankfurter Allee (new emission factor data base HBEFa 3.2)

emissions extrapolated to the entire main road network based on the fleet composition at Frankfurter Allee (with DPF-retrofit, only warm emissions, no cold start impact)
Berlin LEZ – impact analysis

**NO2** air concentrations **traffic** increment

Traffic related* NO2 concentration in Berlin
adjusted with traffic volume changes

![Graph showing NO2 concentrations over time in Berlin](image)

- **Average NO2 over 12 passive sampler outside the LEZ**
- **Average NO2 over 10 passive sampler inside the LEZ**

*Traffic increment based on the difference between kerbside and urban background sites

Data recalibrated Oct 2014
ULEZ impact projection **NOx & NO2**

Effect of banning certain vehicle categories in 2015

...on emissions

![Graph showing emissions comparison](image)

...on NO2 concentrations

![Graph showing NO2 concentration comparison](image)

calculated with HBEFa* 3.2

*Handbook Emission Factors, Vers. 3.2, latest available vehicle emission data base used in many MS, incl. Germany

Source: UBA Texte 26/2014
Impact analysis of current LEZ

Reason for the meagre LEZ effect on NO2

- Increasing share of Diesel cars in Germany
  - From 20% in 2005 up to 30% now

- Almost no improvement in real driving emissions (RDE)
  - for Euro 6 independent from the NOx control technology used

On-road emission results, by vehicle

Average NOx [g/km]

Average CO2 (as % of type-approval [g/km])
Real Driving Emissions (RDE) of NOx

Performance of Diesel cars

mg NOx/km

Source: Presentation by Lars Mönch (UBA) at TU Darmstadt, 2015, extended

PEMS measurement of 3 Euro 6 Diesel cars by Regional EPA (LUBW) Baden-Württemberg (2015)
(Extra) Measures and their impact

How to define a proper ULEZ scheme?

Dilemma:

- Current Euro 6 cars & LGV not much better than previous standards
  - current emission factor databases/models not appropriate
  - Assessment to be based on PEMS – need more such data! Quickly!
- Need benefit rather early given the huge pressure
- Diesel ban would be very effective, but Diesel cars still popular
- Charging (like London ULEZ) instead of banning would be easier to implement, but infrastructure (CCTV) lacking & difficult to realize

LEZ & sticker scheme currently proposed by City of Paris

Ban proposed 07/16
Ban proposed 07/17
Ban proposed 07/18
Ban proposed 07/19

Source: Olivier Chrétien, Paris 2015
(Extra) Measures and their impact

How to define a proper ULEZ scheme?

Current deliberations on ULEZ/sticker schemes in Germany

- Define a clean vehicle category exempted from access restrictions in future ULEZ covering …
  - Electric vehicles, Hybrids, CNG, LNG and petrol cars Euro 4+
  - Euro VI HDV & buses as they are already type approved on RDE (NOx CF factor 1.5)

- How to treat Diesel cars & LGVs? Options currently discussed….
  - (1) One new category based on current Euro 6a for Diesel
    - ☝️ Could be imposed earlier (~2020, like London ULEZ plan)
    - ☹️ but difficult to justify (also in legal terms) given the relative small progress in RDE
  - (2) One new category based on future Euro 6c, incl. RDE conformity factor 1.5
    - ☃️ Enforcement rather late (2020+x), depends on Euro 6c introduction
    - ☃️ Large RDE improvement, easier to sell, more solid legal ground
    - ☃️ Sticker could be introduced early based on recently adopted RDE monitoring method, already incentivizing truly clean Diesel cars
  - (3) Both
    - ☹️ Difficult to communicate
    - ☝️ Awards manufacturers of bad Euro 6a cars
    - ☃️ Allows approach in 2 stages

- Any option will be tough given the heavy promotion of Diesel by car industry

- Potential impact of option(1) for Stuttgart:
  - ☃️ -40% exceeded street sections in 2020, but calculated with optimistic CF factors for Euro 6a
(Extra) Measures and their impact  
 kvm Means to reduce urban car traffic

Reason: Vehicle emission control technology won’t deliver the improvement sufficient “to keep non-compliance as short as possible”

Idea: Emission-dependent urban road pricing scheme in cities with NO2-problems

■ Aim  
- Awarding clean vehicle technology & clean modes of transport  
- Raising money to finance public transport & cycling infrastructure

■ Implementation options:
- Vignette system: 😊 easy to implement  
  😊 benefits frequent drivers
- Camera enforcement: 😊 trip/mileage dependent charging  
  😊 expensive, conflicts with data privacy law
- GPS-based enforcement: 😊 trip/mileage dependent charging  
  😊 expensive, but technical infrastructure applied on German motorway

■ Legal basis still lacking

■ Potential impact based on experience in London, Stockholm, Milan:
  - 14-28% less car traffic
  - 8-18% less NO2 and PM10 pollution

■ Politically sensitive issue, but could be sold by
- pointing to benefits for urban living quality  
- Investments in clean transport modes as a back-up measure
Means to reduce car traffic

- promoting bicycle use

- made bicycle use more attractive
  - share of bicycle trips doubled within 15 years from 6% to almost 15%
  - despite of tiny budget (~3€/capita)

Free ride on bus lanes

Setting up a dense cycle network

- Safe riding on extra bicycle lanes on the road
- Reduces noise levels at the building line

Re-allocation of road space in favour of cyclists & pedestrians:

- Safe riding on extra bicycle lanes on the road
- Reduces noise levels at the building line

3 City & Transport Planning Measures | Cycling
(Extra) Measures and their impact

Traffic management

- **Shift modal split** from motor traffic to clean transport modes
  - Berlin's planning objective:
    - -10% less motor traffic in 10-15 years
    - results in
    - up to -10% NO2
    - up to -4% PM10
  - ...based on modelling and source apportionment study results

- **Truck ban & re-routing:**
  - up to 20% less NO2, -7% PM, results based on monitoring data
  - Problem: local effect only in single roads, traffic shift to other roads, no net reduction

- **Optimizing traffic flows** (progressive signal systems):
  - impact difficult to quantify
    - local effect, traffic signal coordination works only in one direction, potentially negative effects on cross-roads
    - conflict with acceleration of bus/tram
    - risk that gained road capacities will attract more traffic
    - small net gain in pollution control

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Trend in traffic volumes 2002-2014 in Berlin (2002 = 100%)

- Inside LEZ
- Outside LEZ

<table>
<thead>
<tr>
<th>Year</th>
<th>Inside LEZ</th>
<th>Outside LEZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>100%</td>
<td>88,2%</td>
</tr>
<tr>
<td>2003</td>
<td>99,9%</td>
<td>89,5%</td>
</tr>
<tr>
<td>2004</td>
<td>95,9%</td>
<td>87,3%</td>
</tr>
<tr>
<td>2005</td>
<td>97,3%</td>
<td>88,2%</td>
</tr>
<tr>
<td>2006</td>
<td>97,6%</td>
<td>88,5%</td>
</tr>
<tr>
<td>2007</td>
<td>98,2%</td>
<td>85,2%</td>
</tr>
<tr>
<td>2008</td>
<td>92,1%</td>
<td>86,1%</td>
</tr>
<tr>
<td>2009</td>
<td>91,1%</td>
<td>88,2%</td>
</tr>
<tr>
<td>2010</td>
<td>86,1%</td>
<td>86,0%</td>
</tr>
<tr>
<td>2011</td>
<td>88,2%</td>
<td>86,0%</td>
</tr>
<tr>
<td>2012</td>
<td>86,0%</td>
<td>84,1%</td>
</tr>
<tr>
<td>2013</td>
<td>88,2%</td>
<td>85,7%</td>
</tr>
<tr>
<td>2014</td>
<td>95,9%</td>
<td>86,1%</td>
</tr>
</tbody>
</table>
(Extra) Measures and their impact

Means discussed to reduce urban car traffic

Idea: Emission-independent traffic bans during peak episodes

■ Aim
   Reducing car traffic volumes & emissions during stagnant atmospheric dispersion conditions

■ Implementation:
   Based on alternating number plates, focusing on car traffic
   Triggered by forecasted stagnant meteo conditions
   Option: additional pollution threshold as a trigger
     simple to enforce, but no long-term impact on fleet composition
     Pushes commuter traffic into cleaner transport means, but
     Could be circumvented by buying cheap inefficient second cars
     Trips are often shifted to next day without access restriction
     Commercial traffic (Diesel!) largely exempted, to ensure supply of essential goods
     Alert management needs extra ressources

■ Appropriate trigger criteria still to be discussed

■ Potential impact on days with bans based on experience in Paris:
   car traffic and NOx emissions dropped by ~20%
   NO2 pollution decreased by about 10%
(Extra) Measures and their impact

- speed limits

Speed limit 30 km/h (instead of 50 km/h) can deliver...

- about 5% less (total) PM
  - derived from a 25-30% drop of local PM increment
- 6-10% decrease of total EC
  - derived from a 14-21% drop of local PM increment
  - Depends on share of Diesel vehicles
- 7-12% less total NO2
  - derived from a 15-25% drop of local NO2 increment

- Enforcement is key
- Results are not fully coherent with speed-dependent emission measurements
- Effect depends on keeping a smooth traffic flow
- Impact is site specific, difficult to extrapolate
- Generates wind-fall profit for road safety and noise (-2 dBA)
- Berlin: 17% of main road network limited to 30 km/h, 7% whole day because of air quality problems
Measures and their impact

Economic measures under discussion

■ Eliminating the Diesel fuel tax differential of 19 ct/l (28%)
  ❍ Would gain 7 billion additional tax revenue if Diesel tax raised to petrol
  ❍ Likely result: simultaneous deduction of petrol tax
  ❍ Fast implementation, but long-term impact:
    halving Diesel car share would mean 13% drop of NO2 concentration
  ❍ (regional/local) freight transport on the road becomes more expensive
    ❍ Rail road transport more competitive
  ❍ Strong resistance from transport business

■ Economic incentives for electric vehicles & plug-in hybrids
  ❍ current proposal by State of Hesse given the low number of currently 25,000 e-vehicles in D
  ❍ one time premium of 5000 € per purchase
  ❍ no vehicle tax for 10 years
  ❍ additional capital allowance of up to 50% costs for commercial e-vehicles & charging infrastructure
  ❍ Means 140 Mio €/a lower tax revenues
  ❍ Too early to heavily invest in charging infra-structure given the current uncertainty on future e-vehicle technology
  ❍ Better spend money for public transport & (e-)cycling infrastructure
Anticipating NO2 attainment

(very) preliminary scenario run for 2020 without extra measures

Lenght and number of road sections exceeding NO2-LV in Berlin

<table>
<thead>
<tr>
<th>Year</th>
<th>Lenght in m</th>
<th>Number of road sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>335</td>
<td>1</td>
</tr>
<tr>
<td>2014</td>
<td>314</td>
<td>1</td>
</tr>
<tr>
<td>2015</td>
<td>258</td>
<td>1</td>
</tr>
<tr>
<td>2016</td>
<td>209</td>
<td>1</td>
</tr>
<tr>
<td>2017</td>
<td>102</td>
<td>1</td>
</tr>
<tr>
<td>2018</td>
<td>80</td>
<td>1</td>
</tr>
<tr>
<td>2019</td>
<td>49</td>
<td>1</td>
</tr>
<tr>
<td>2020</td>
<td>33</td>
<td>1</td>
</tr>
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Euro 6 ICCT
Dealing with NO2 non-compliance

Conclusions

- Envisaged time frame notified to the Commission to meet NO2 – LV with current AQ plans

<table>
<thead>
<tr>
<th>Federal State</th>
<th>Expected compliance in non-attainment areas</th>
</tr>
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<tbody>
<tr>
<td>Baden-Württemberg</td>
<td>2030 In Stuttgart agglomeration, elsewhere 2016-2024</td>
</tr>
<tr>
<td>Bavaria</td>
<td>2030 in Munich agglomeration, elsewhere before 2020</td>
</tr>
<tr>
<td>Berlin</td>
<td>2020</td>
</tr>
<tr>
<td>Hamburg</td>
<td>2020</td>
</tr>
<tr>
<td>Hesse</td>
<td>2025 in Darmstadt, Limburg, elsewhere in 2020</td>
</tr>
<tr>
<td>Northrhine-Westphalia</td>
<td>By 2015 for Bielefeld and Münster, After 2020 for Rhine-Ruhr Area</td>
</tr>
<tr>
<td>Rhineland-Palatinate</td>
<td>2018 - 2022</td>
</tr>
<tr>
<td>Saxony-Anhalt</td>
<td>By 2020</td>
</tr>
<tr>
<td>Thuringia</td>
<td>2016/17 for Gera and Weimar, after 2020 for Mühlhausen</td>
</tr>
</tbody>
</table>

- Too long a way to go! Need to speed up!
**progress towards compliance**

arguments vis-à-vis Brussels...

- **NO2 attainment 2020/current measures in Berlin:**
  - ✓ full impact of LEZ stage 2 (⊗ fading away by 2015)
  - ✓ SCRT retrofit program buses & perhaps for some HGVs
  - ✓ speed limits, traffic light coordination, etc
  - ✓ modal split change due to transport strategy
  - ✓ local (HGV) traffic bans (⊗ barely feasible in Berlin)
  - ✓ Euro 6/VI incentives (⊗ need to wait for the Federal Gov.)
  - realistic scope for improvement up to <<30%

- **full compliance by 2020 only realistic, if**
  - ↪ EU sets ambitious CF-factors for RDE-based type approval of Euro 6c
  - ↪ Our Federal Government
    - Comes up with a sticker scheme for truly clean vehicles
    - Sets the legal ground for city toll schemes
    - Stops the subsidies for Diesel
  - ↪ Länder and city governments
    - have the courage to exploit the given potential of measures
Thanks for listening!

For more information on

- Berlin’s LEZ see www.berlin.de/umweltzone (also in EN)
- Berlin’s Air Quality Plan see www.berlin.de/luftreinhalteplan (also in EN)
- LEZ in Germany see http://www.umweltbundesamt.de/umweltzonen/index.htm
- LEZ-cities in Europe visit www.lowemissionzones.eu, the website of the European Network of LEZ-cities (LEEZEN)