Scope & constraints of local AQ management in tackling NO_2 and PM_{10}: the example of Berlin

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Air quality

☞ Berlin‘s compliance in relation to EU limit/target values

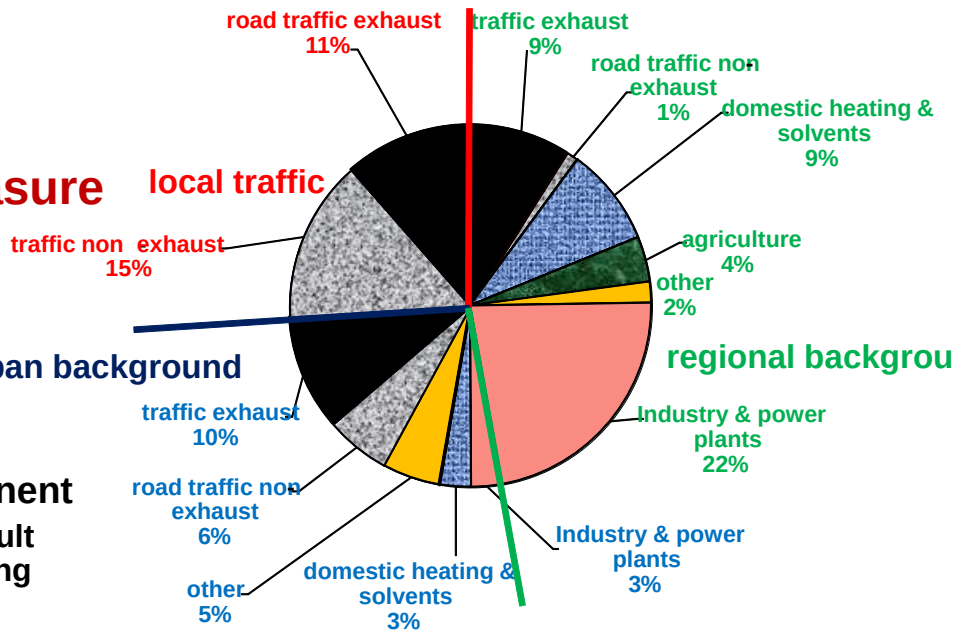
pollutant	main source	Status
SO2	power plants, industry, domestic heating	☺ problem solved 20 years ago ☞ switch to clean fuel & control technology
CO, HM	Traffic, heavy industries	☺ never a problem
Benzene	traffic	☺ problem solved 10 years ago
PAH	traffic, domestic heating	☺ problem solved 5 years ago ☞ switch to clean fuel & control technology
Ozone	long-range transport, traffic	😐 diminishing problem, to be solved at national & EU level
PM2.5	*long-range transport, traffic*	☺ *Problem (seemingly) solved*
PM10	*long-range transport, traffic, residential heating*	☺ *Largely solved, shrinking local share* ☞ *switch to clean fuel & control technology*
NO_2	Road traffic (Diesel)	☹ serious problem, national court verdicts & law suit filed by EU, traffic bans impending

Air quality management in Berlin

Senate Department for Environment, Transport and Climate Protection
Berlin

☞ 15 years ago need for action to tackle PM10!

- **Berlin has had serious problems with particulate matter (PM) pollution 15 years ago**
  - Widespread excess of EU air quality standards for PM10
  - Significant contribution of vehicle tail-pipe (soot) emissions to PM non-compliance problem
- **Focus on city-wide measures with priority on Diesel UFP**
  - cost-efficient Diesel particle filter (DPF) technology existed
  - DPF-retrofit in buses since 1999
  - LEZ scheme most important measure to attain the PM10/PM2.5 limit values
  - Side arguments:
    - ☞ health benefits strong as ultra-fine soot particles were considered the most toxic PM component
      - ☹ Quantification of health benefits difficult as dose-response functions are missing
    - ☞ soot particles contribute to climate change



PM10 source apportionment for Berlin in 2002

LEZ in Berlin & Germany

☞ Summary of impact analysis

Pollutant emissions

- Smaller, most harmful PM metrics: **-60%**
- PM10: **-20%**
- NOx: **<20%**

AQ concentrations

- Smaller, more harmful PM metrics: **-50%**
- $PM_{2.5}$: **-10 to -15%**
- PM_{10}: **-7 to -10%**
- NO_2: **< 5%**

Climate Change

- Black carbon emissions: **-60%**
- CO_2

noise

- Yet larger change
- Larger change
- Small change
- No measureable change

Source: L. Sadler, modified

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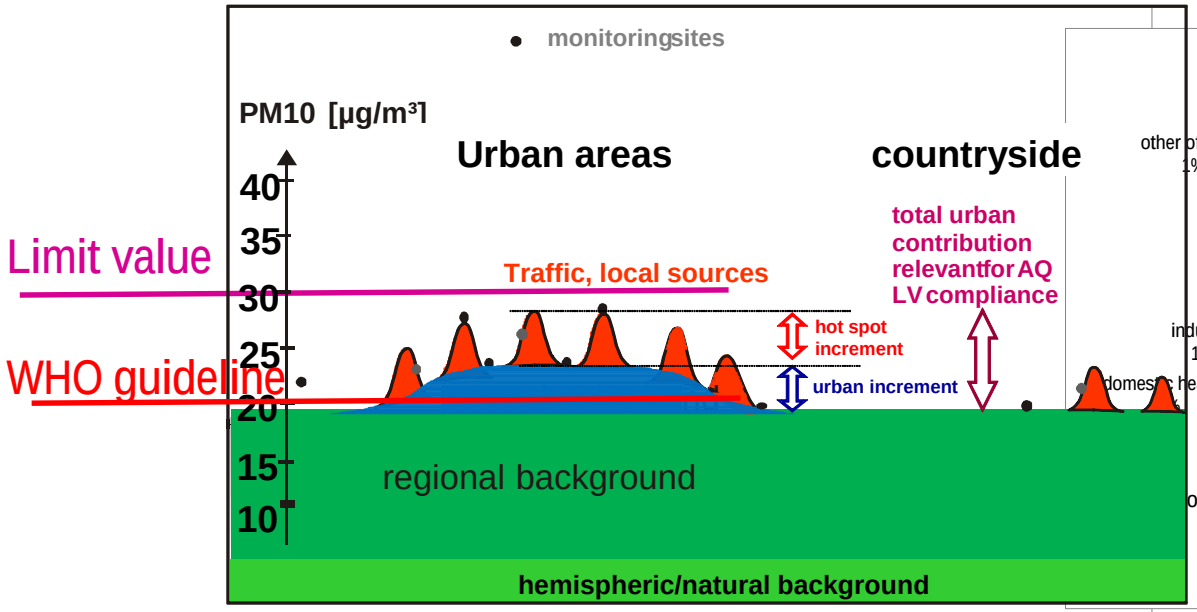
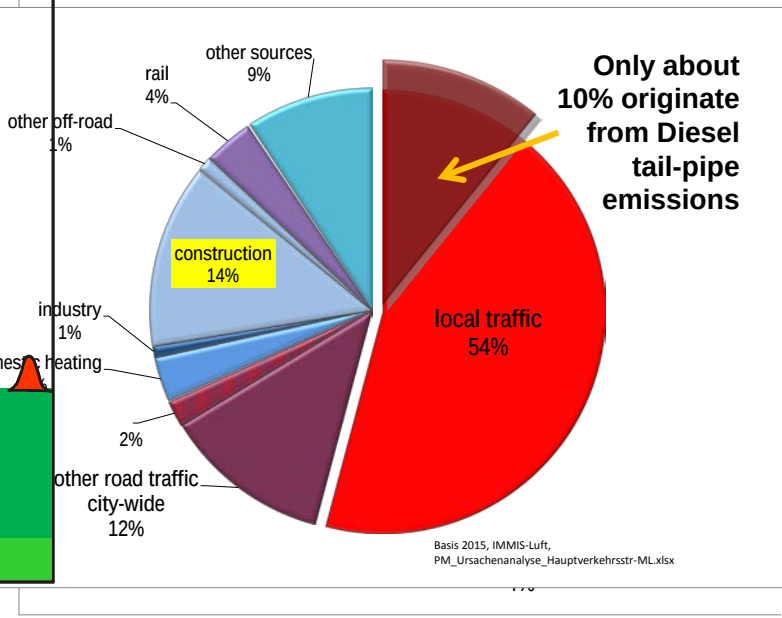
☞ sources of PM10 in 2017



Contribution of Berlin‘s sources to kerbside PM10 in Berlin



- **Shrinking** share of Berlin’s sources,
- LVs for PM10/PM2.5 are met, but WHO guidelines still **exceeded**
- Local road traffic **tailpipe** contribution only 4%,
- **non-exhaust**, mileage-dependent part still **important**
- **Construction**, incl. tail-pipe emissions of **NRMM** important
- What about **wood** combustion?

PM East source apportionment project

☞ case study Berlin

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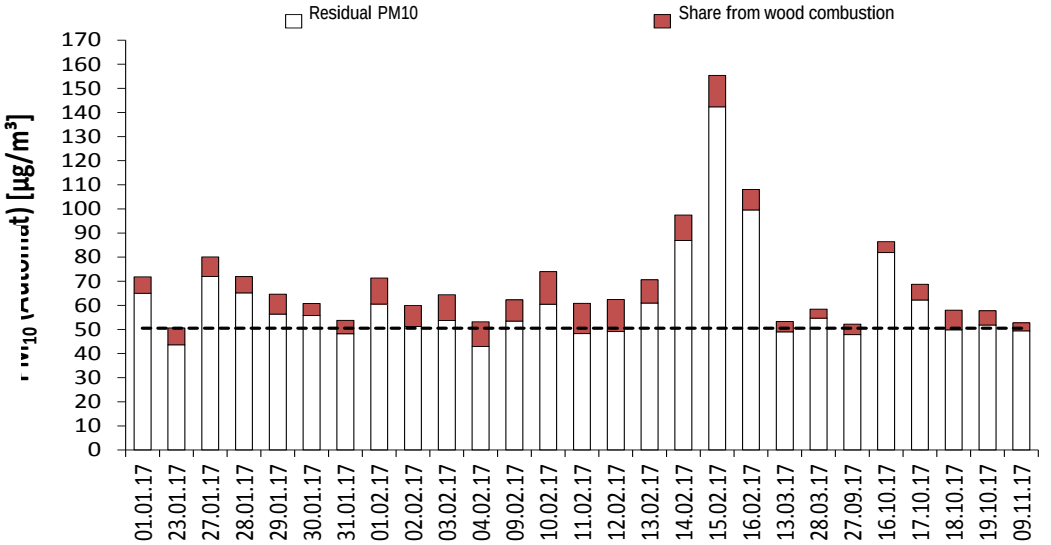
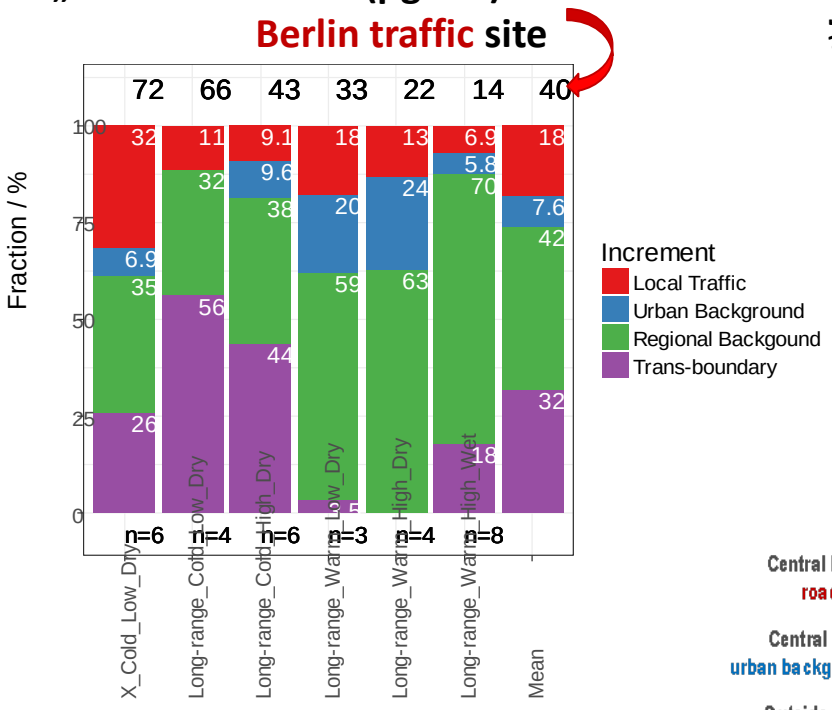
Berlin

☝ Visible biomass (=wood) combustion signal from Aethalometer measurements…

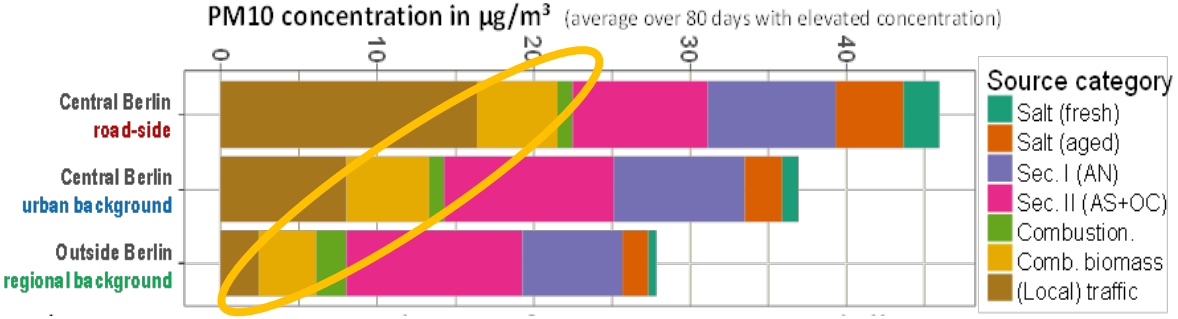


☝ Significant regional & transboundary contribution

„Increment East“ (µg m^{-3}) at Berlin traffic site



from PMF analysis (80 days with higher PM)….



☝ … and traffic signal (abrasion & re-suspension, plus secondary PM as ammonium nitrate)

Interim conclusion
☞ PM pollution

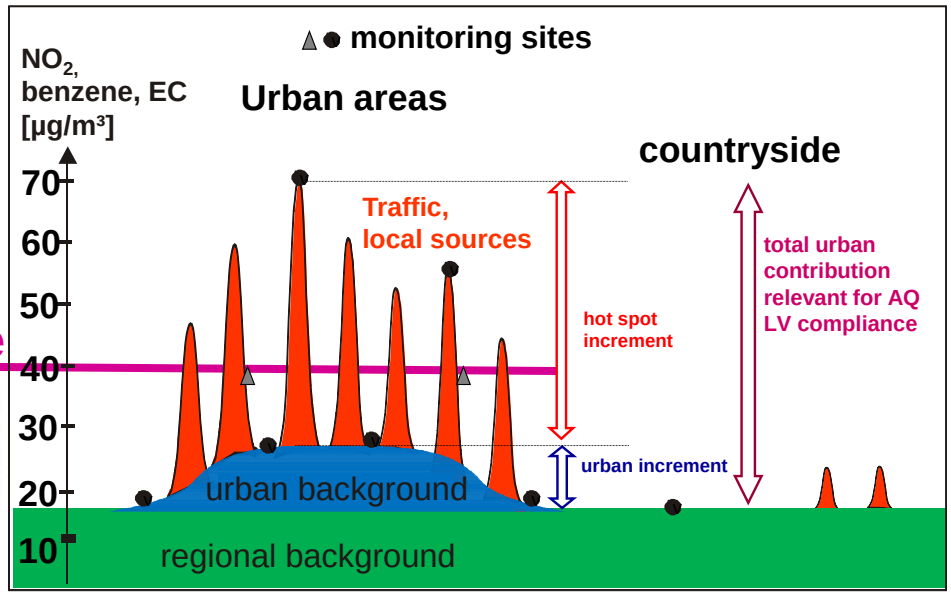
- 10-15 years ago: widespread exceedances resulted in effective local measures with city-wide effect (Low Emission Zone, DPF-retrofit)
  - Improvement also in urban background & population exposure
- Now: Full PM compliance, need for regulatory measures has faded away due to unambitious PM limit values
- Still large inter-regional & transboundary component
- Residential heating (wood combustion) gains (relative) importance
- Further measures useful to curb PM-emissions & yield health benefits
- Needs update of PM-standards in the AQ Directive
  - Which metric? Which component?
  - Hot spot approach (roadside compliance) insufficient, should be combined with a trigger to lower urban & regional background levels
  - Urban AEI for larger cities could be a useful driver for addition local action

In the meanwhile:

- Berlin is to set up a strategy to approach WHO by 2030
  - Underpinned by health impact assessment of potential measures
  - IAM application planned

Air quality in Berlin

☞ Sources of NO2



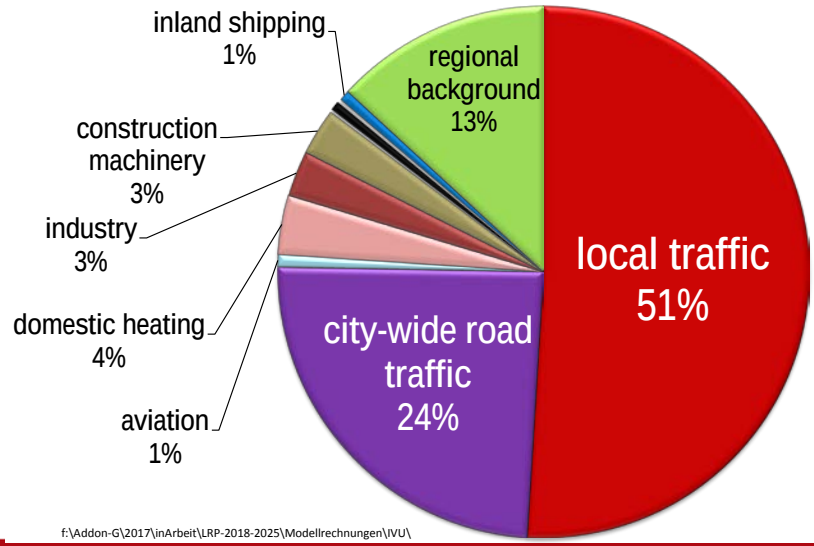
Limit value

- NO2 non-compliance in heavily trafficked main roads
- Road traffic (~80% Diesel) is the predominant source

NO2 pollution sources at roadside spots

NO_2-source analysis

average over main roads with measured pollution above limit value



f:\Addon-G\2017\inArbeit\LRP-2018-2025\Modellrechnungen\IVU\

Berlin AQ assessment

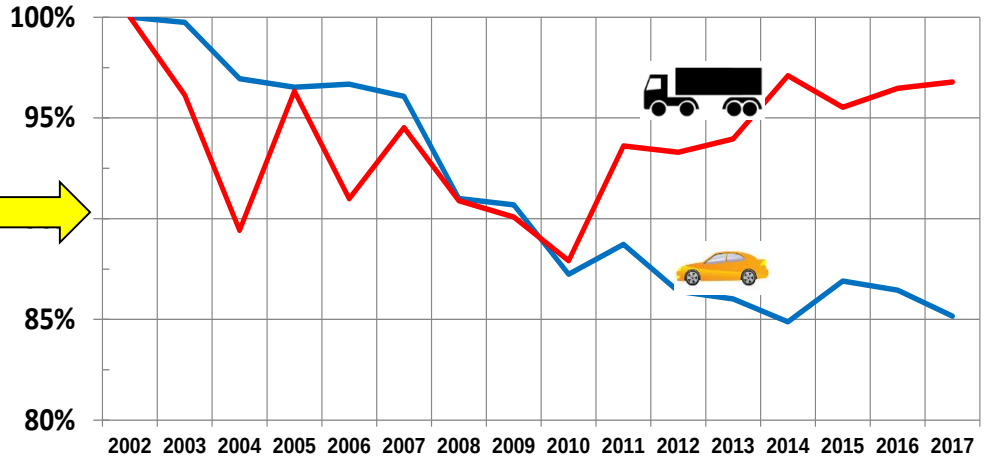
☞ NO_2 pollution & traffic trend

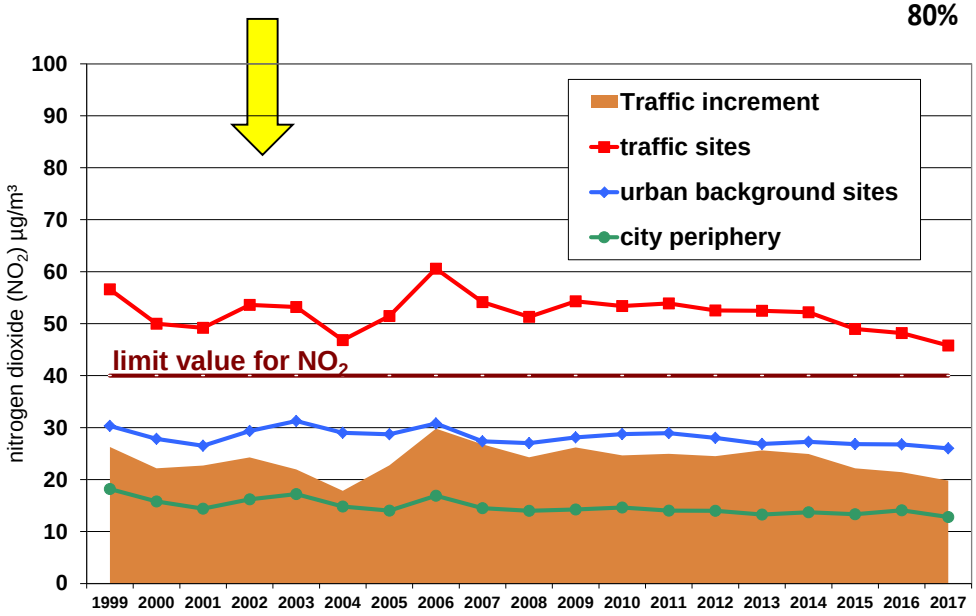
Despite of …

- **the LEZ**
- **decreasing traffic volumes**
  - ☞ **-14% passenger car traffic since 2002**

…NO_2 concentrations stagnate

- ☞ **In 2014: only -3% since 2002**





☝ **Extra measures badly needed**

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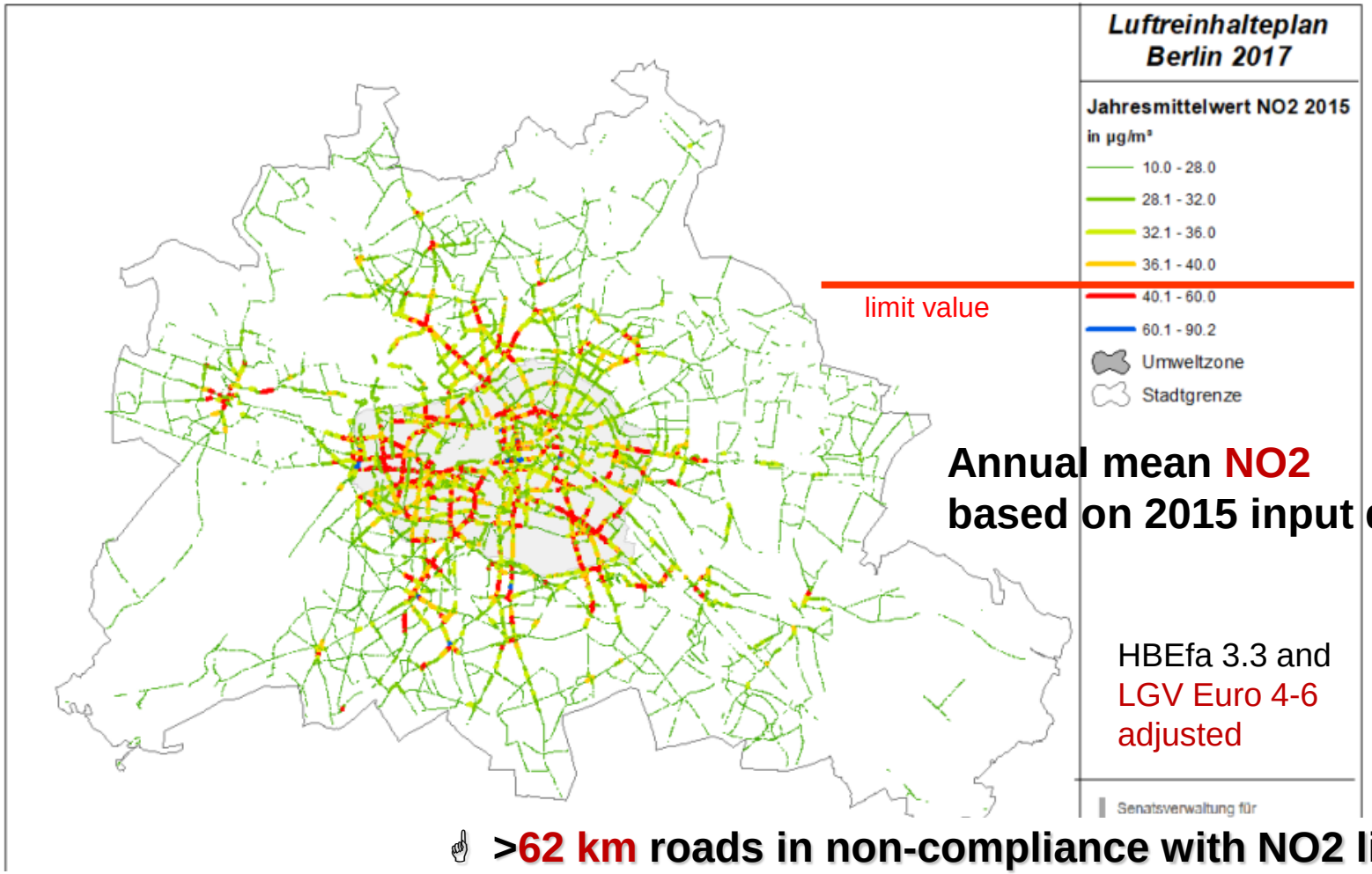
Berlin

☞ NO2 model results for base year 2015

Useful means: dispersion modeling of NO2 in every major road



Annual mean NO2 based on 2015 input data

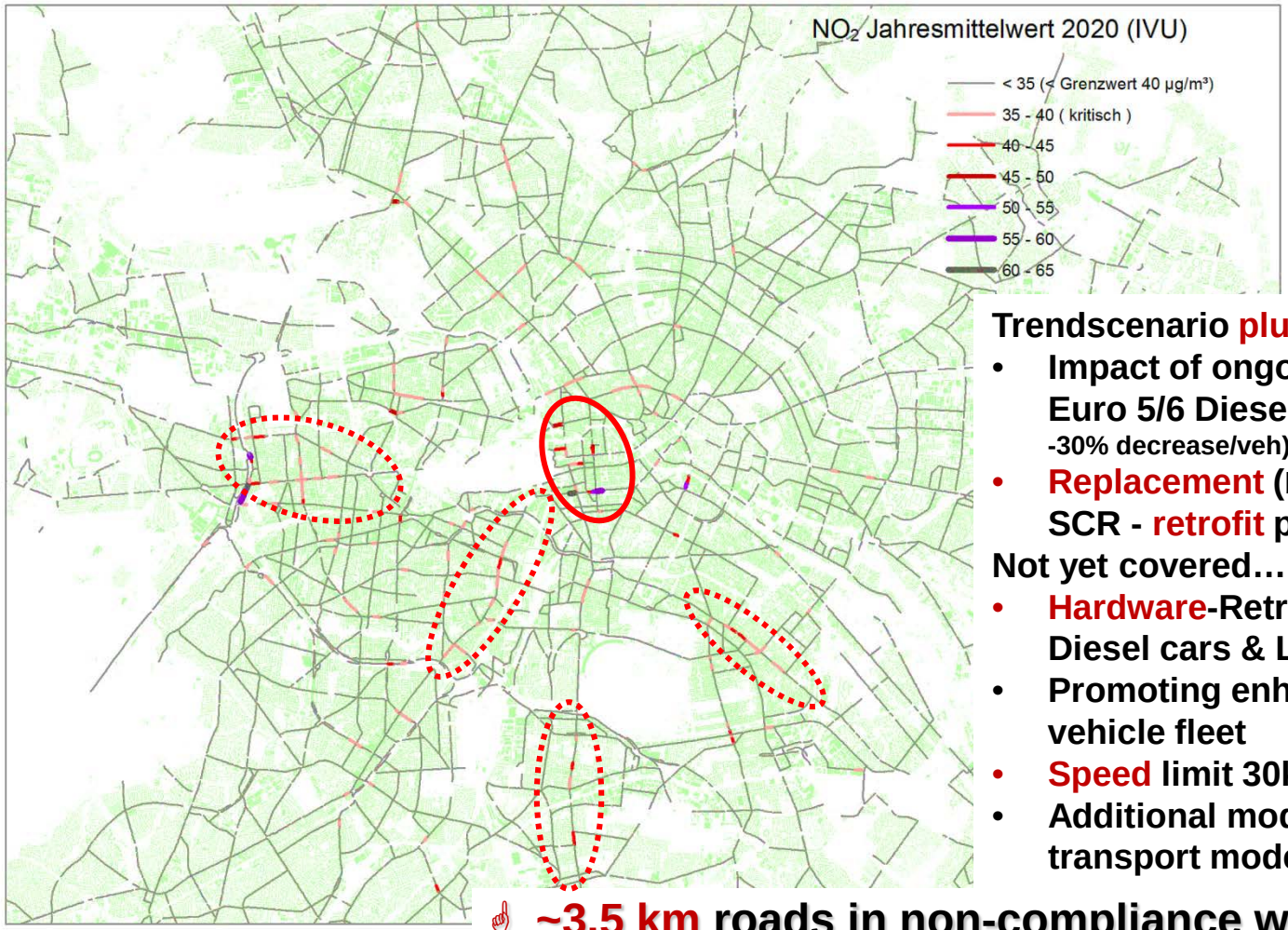
HBEfa 3.3 and LGV Euro 4-6 adjusted

☝ **>62 km roads in non-compliance with NO2 limit value**
1.8 km above 60 µg/m³, ca 50.000 effected residents

Air Quality management in Berlin

☞ Latest scenario run NO2 for 2020

Modelled annual mean concentrations of NO_2 in main roads



Trendscenario plus

- Impact of ongoing **Software**-Update of Euro 5/6 Diesel-cars (~50% of the fleet, -30% decrease/veh)=> - 1 µg/m³ for Berlin main road)
- **Replacement** (by Euro VI & E-buses) and SCR - **retrofit** programme of **bus fleet**

Not yet covered…

- **Hardware**-Retrofit (**SCR**) of Euro 5-Diesel cars & LGVs with high RDE
- Promoting enhanced **electrification** of vehicle fleet
- **Speed** limit 30kmph in polluted roads
- Additional modal split **shift** to **clean** transport modes (SUMP revision)

☝ **~3.5 km roads in non-compliance with NO2 limit value**

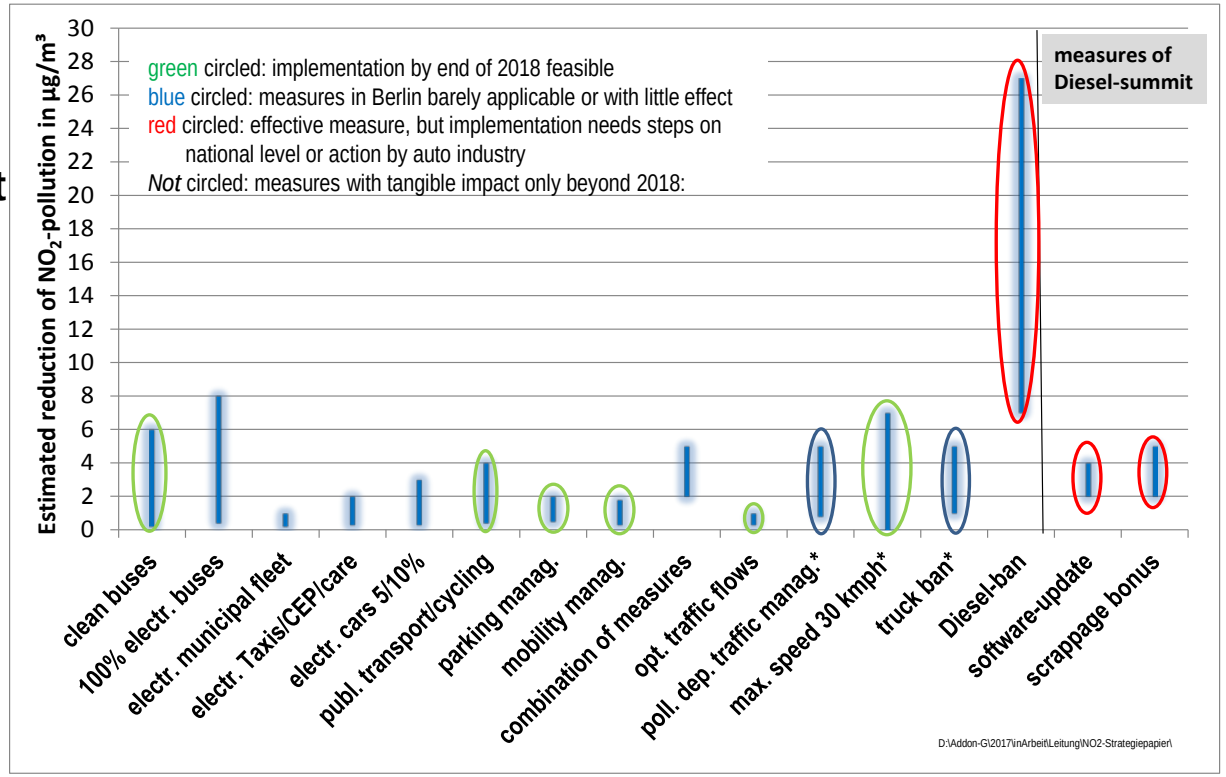
NO2 – non-compliance

☞ Modelled impact range of different local measures

…based on AQ plans of Stuttgart & Hamburg and experience in Berlin

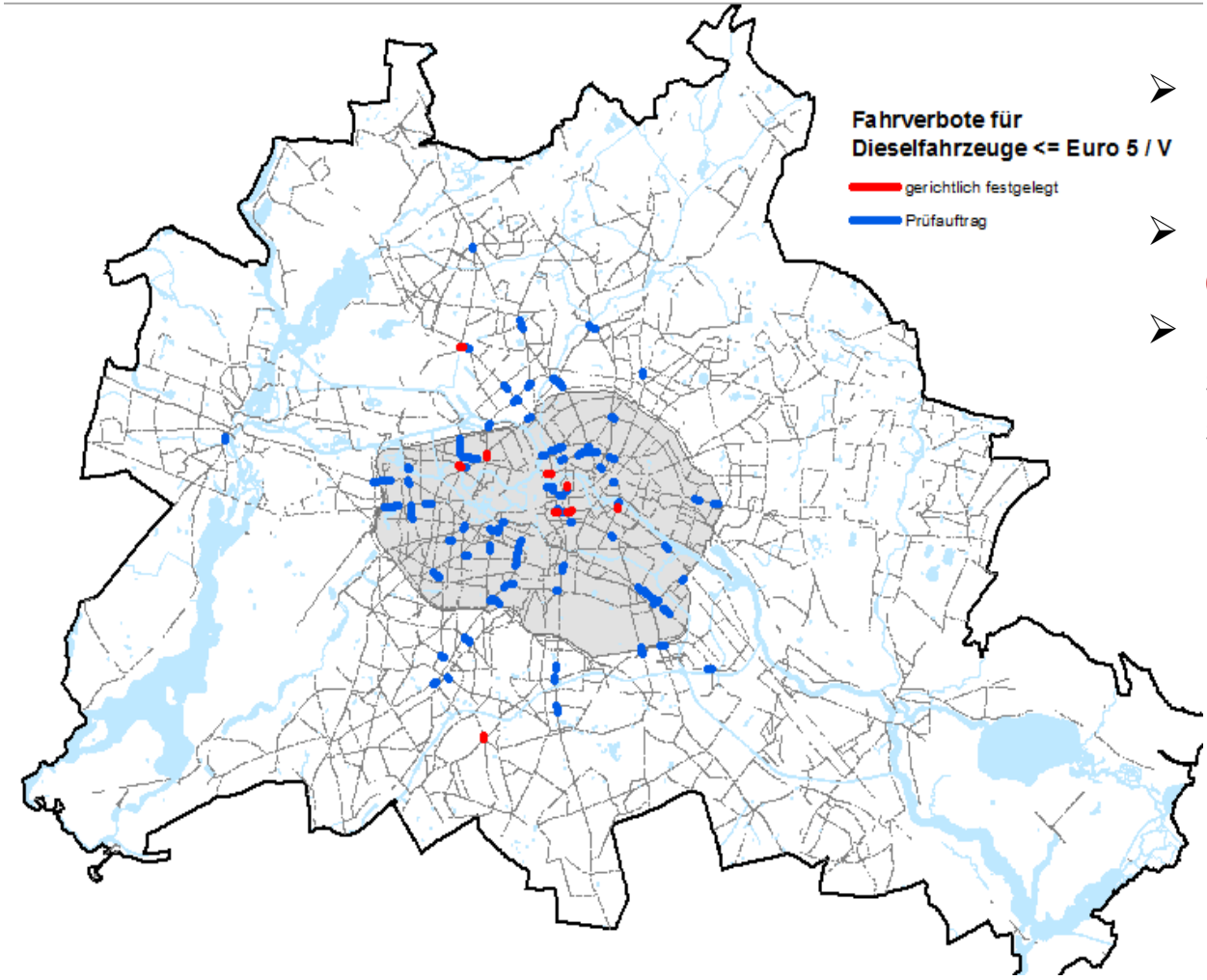
Challenges:

- we need to bring down NO2 by up to 25 µg/m³ by 2020
- E-Mobility, city- and transport planning measures mostly of medium-/long-term nature
- Ban of Diesel with high real driving emissions indispensible at least in some polluted roads
- Need to model effect of traffic re-routing and potential pollution increase
- Hardware-retrofit would ease the pressure, but comes too late



The current problem of excessive NO2

☞ consequences of recent court verdict



- Diesel bans **essential** for 8 NO2-hot spot roads
  - ☞ 11 street sections, 1 km in total
- Bans in whole **LEZ disproportionate**
- Measures for another 106 roads sections (14 km) need to be seriously **scrutinised**
  - ☞ alternative measures (**parking management**, modal split shift, cleaner vehicles)
  - ☞ Speed limit **30km/h** **-5 µg/m³** reduction can be assumed
  - ☞ or **Diesel bans** as a last resort
  - ☞ **uncertainty** margin (underestimation) of the forecast model **of 4 µg/m³** to be accounted for

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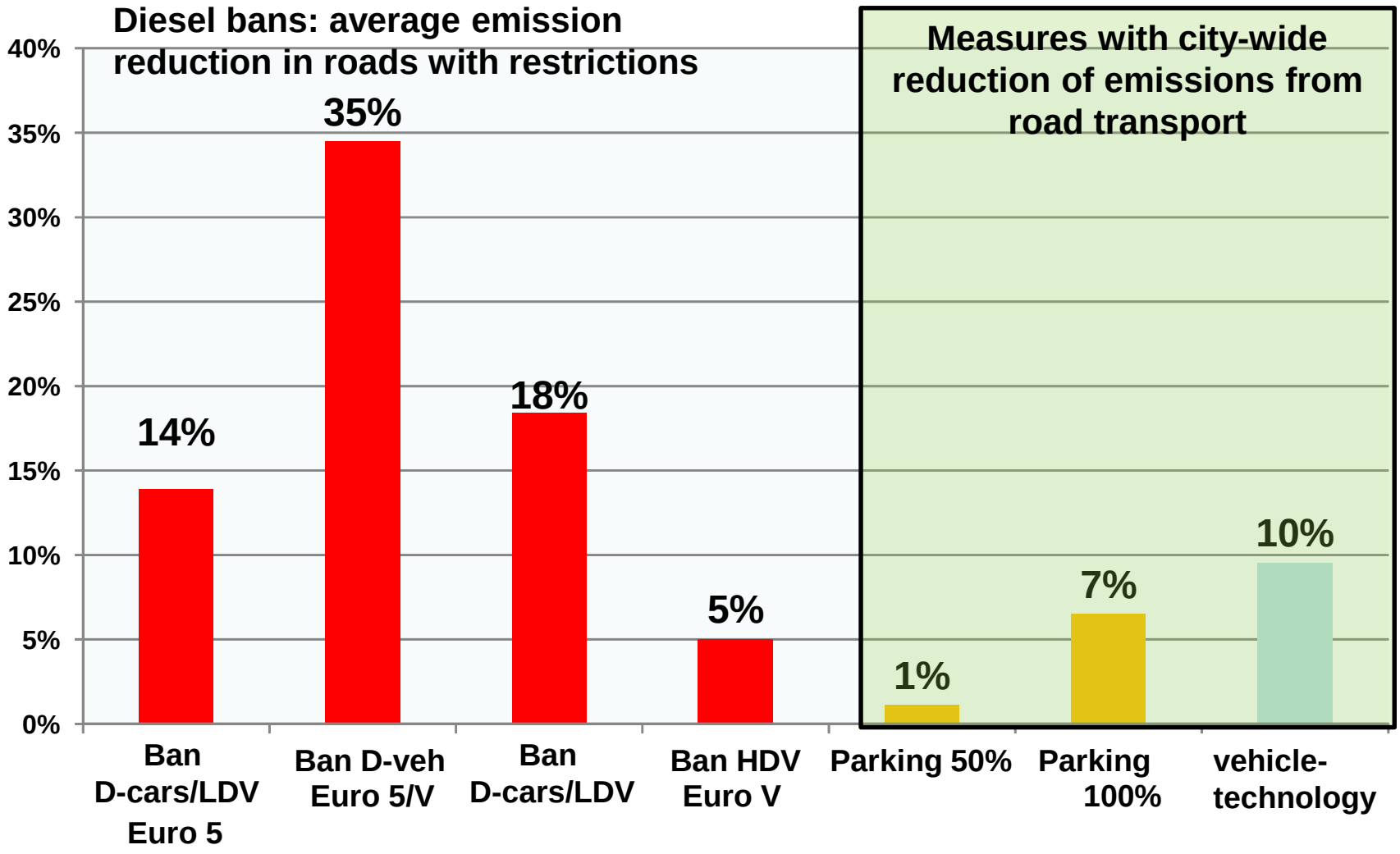
Berlin

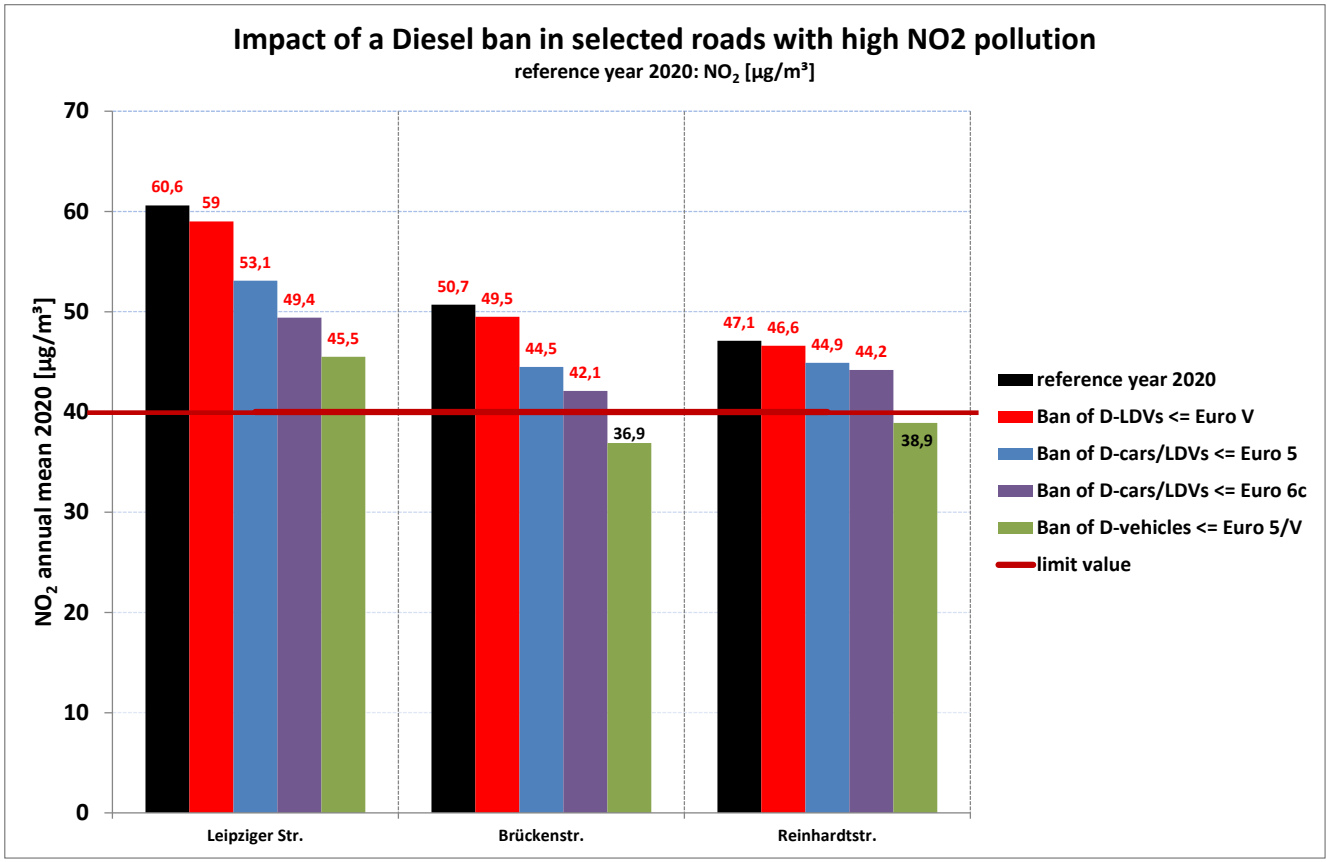
☞ emission reduction of traffic measures by 2020



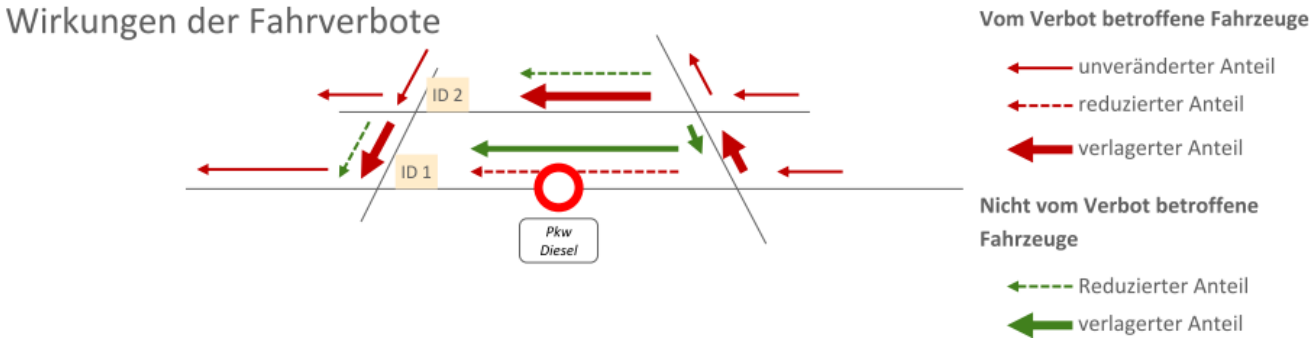
Diesel bans in single roads
☞ impact on NO2 - concentration

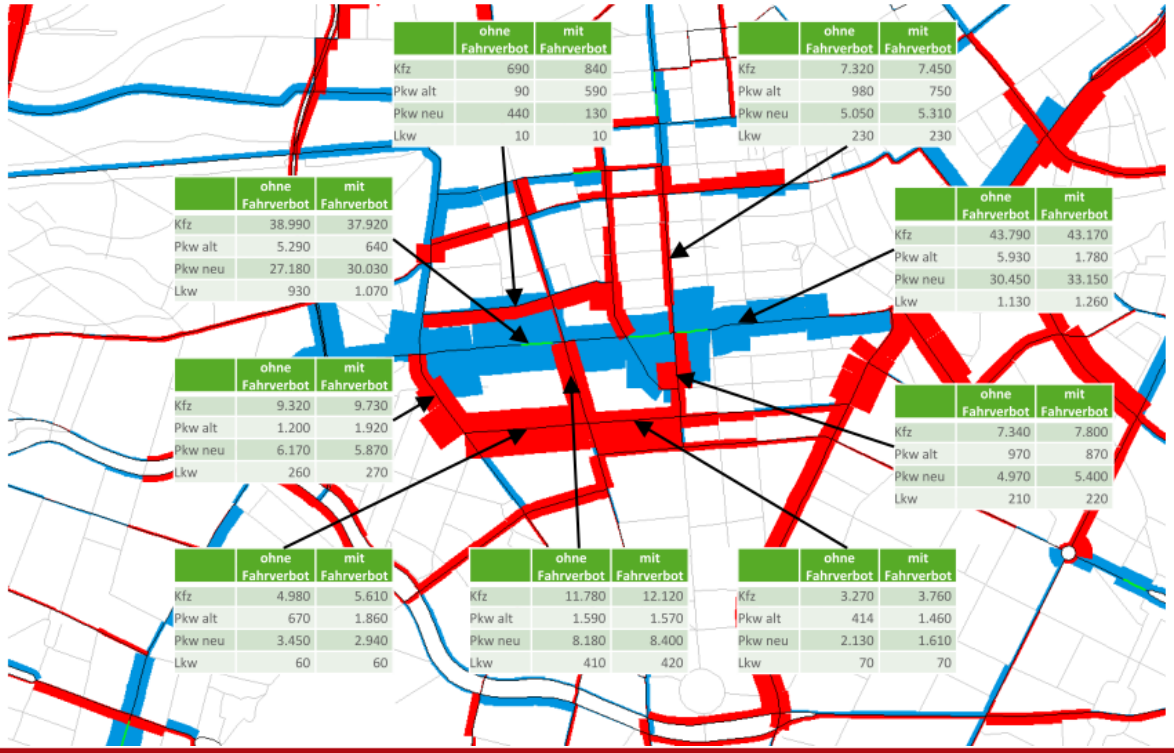
- **Dispersion** of the problem in other roads & hence **little effect** on the **fleet** emission
- Only very **few problems** with exceedances of the NO2-LV elsewhere
- Need to ban **all Diesel** up to Euro 5/IV

☝ Assumption: 80% of banned vehices don‘t drive



Diesel bans in single roads
☞ impact on traffic flows





	ohne Fahrverbot	mit Fahrverbot
Kfz	690	840
Pkw alt	90	590
Pkw neu	440	130
Lkw	10	10

	ohne Fahrverbot	mit Fahrverbot
Kfz	7.320	7.450
Pkw alt	980	750
Pkw neu	5.050	5.310
Lkw	230	230

	ohne Fahrverbot	mit Fahrverbot
Kfz	38.990	37.920
Pkw alt	5.290	640
Pkw neu	27.180	30.030
Lkw	930	1.070

	ohne Fahrverbot	mit Fahrverbot
Kfz	43.790	43.170
Pkw alt	5.930	1.780
Pkw neu	30.450	33.150
Lkw	1.130	1.260

	ohne Fahrverbot	mit Fahrverbot
Kfz	9.320	9.730
Pkw alt	1.200	1.920
Pkw neu	6.170	5.870
Lkw	260	270

	ohne Fahrverbot	mit Fahrverbot
Kfz	7.340	7.800
Pkw alt	970	870
Pkw neu	4.970	5.400
Lkw	210	220

	ohne Fahrverbot	mit Fahrverbot
Kfz	4.980	5.610
Pkw alt	670	1.860
Pkw neu	3.450	2.940
Lkw	60	60

	ohne Fahrverbot	mit Fahrverbot
Kfz	11.780	12.120
Pkw alt	1.590	1.570
Pkw neu	8.180	8.400
Lkw	410	420

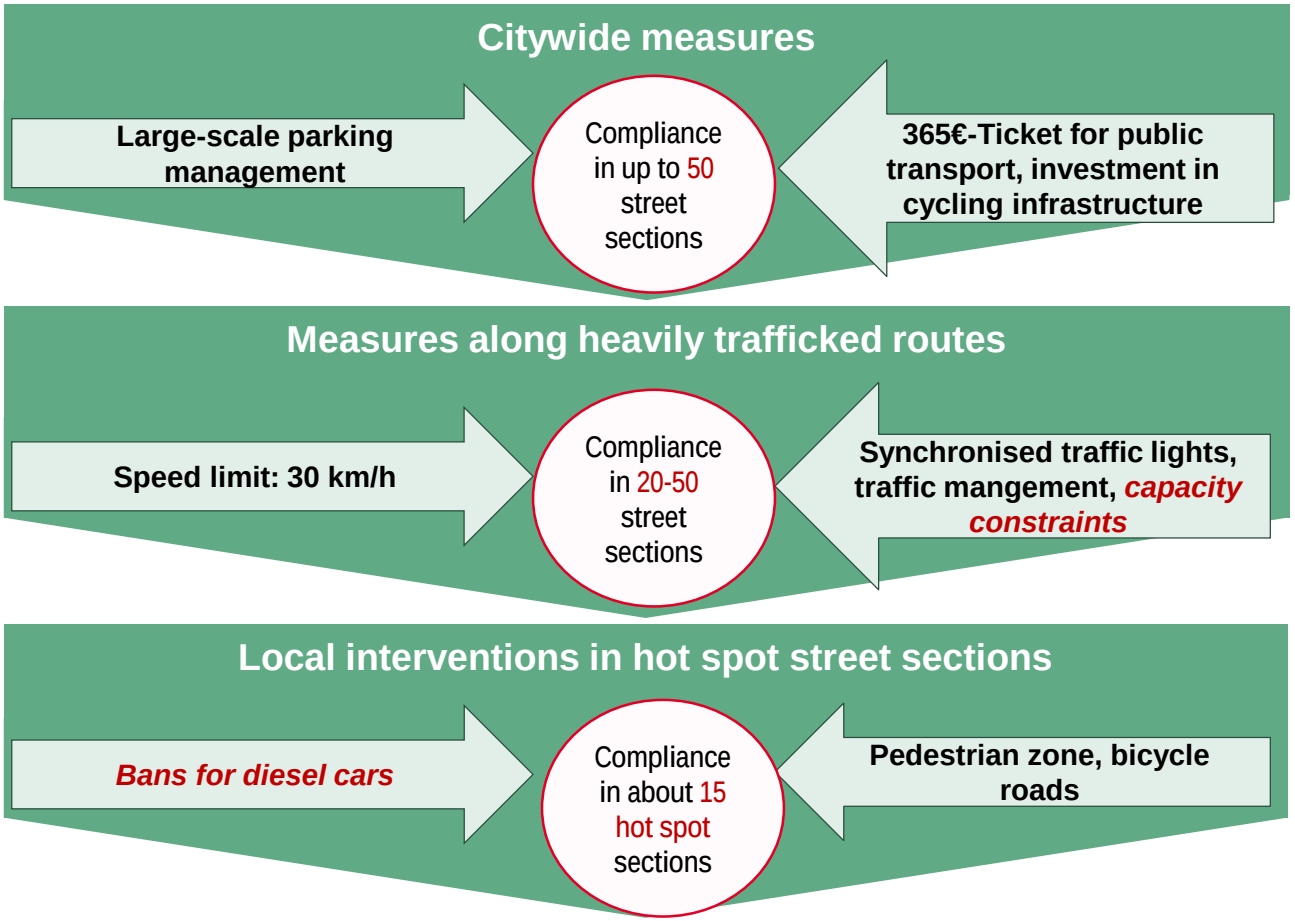
	ohne Fahrverbot	mit Fahrverbot
Kfz	3.270	3.760
Pkw alt	414	1.460
Pkw neu	2.130	1.610
Lkw	70	70

Impact of Sz 1

Ban of D-cars/LDVs <=E 5:

In/Decrease of traffic volumes in roads in and around the hot spot Leipziger Straße

Holistic approach for 117 road sections to swiftly attain NO_2-limit value



- ☞ less car traffic
- ☞ Shift to cleaner transport modes
- ☞ Slower & smooth traffic flows
- ☞ less air & noise emissions
- ☞ less accidents, support Vision Zero
- ☞ Traffic calming
- ☞ *Cleaner vehicles?? Little effect on fleet composition*

- ✓ Strategic contribution to strategic urban mobility change (Mobility Law)
- ✓ Local Diesel bans in polluted roads as a last resort to ensure compliance asap
- ☹ Shift of polluting Diesel traffic in other roads
- ☹ Little to no net health benefits

Conclusion ☞ NO2 pollution

- NO2 non-attainment since 2010:
  Huge judicial pressure by all courts for action to meet NO2 asap
- Forced to consider drastic measures, including speed limits 30 km/h and traffic (Diesel) bans (up to Euro 5

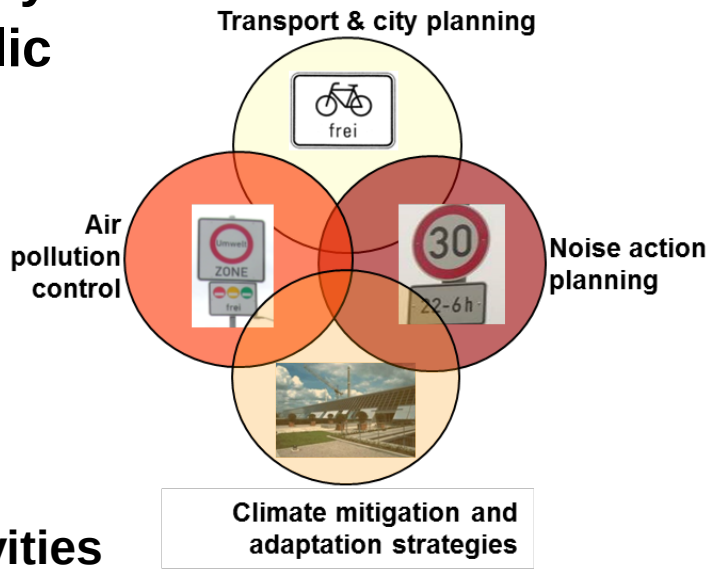
- Delay until supreme court clarified in Feb 2018 how/whether access restrictions could be enforced without a blue sticker (denied by German gov.)
- NO2 downward trend in Berlin requires to limit Diesel bans to single polluted roads
  - Area-wide LEZ scheme would be disproportionate
  - Will push traffic in adjacent roads as long as limit value is still met
  - Will have no net health benefit
- Exploit city-wide & durable measures to the extent possible
  - Extend parking management by 2020 & 20% higher fees
  - More attractive ticket fares & enhancing capacity of public transport
  - Huge investments (50 Mio €/a) in cycling infrastructure

😐 Problem: quite a few measures need longer time frame

Air quality management in Berlin

☞ Scope & constraints

- Local city-wide measures to curb PM emissions (LEZ, "no Diesel without DPF") were successful
- Health impact assessment of measures still missing
- Gains importance as legal pressure for measures to lower PM pollution has faded away – despite of evidence for health effects of current PM pollution
- City-wide approach (LEZ stage 3) largely failed with regard to NO2 abatement due to hot spot focus of the AQD & delay of requisite legal framework & strong pressure to meet NO2 by 2020
- Revised Air Quality Plan is now out for public consultation
- Planned AQ Strategy with Berlin-specific objectives for 2030,
  - Based on health impact assessment & cost-effectiveness (IAM application)
  - Emphasis on population exposure reduction
  - Goal: approaching WHO guideline levels
  - Useful input for the AQD revision process
  - Stronger coherence with other planning activities



Verkehrssenatorin Regine Günther Berlin muss über eine City-Maut diskutieren

Inzwischen sind in der Hauptstadt ...r als 1,2 Millionen Pkw zugelassen.

Senator Günther:
"Berlin needs to talk about introducing a city toll

More more information

On Berlin's LEZ
www.berlin.de/umweltzone (also in EN)

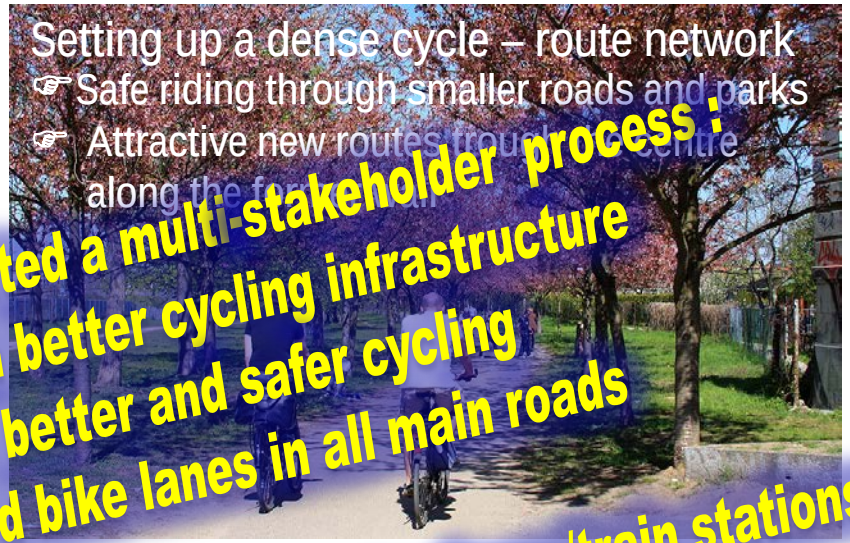
On Berlin's new Air Quality Plan see
www.berlin.de/luftreinhalteplan (soon also in EN)

On the underlying results of model and scenario runs in Berlin's Environment Atlas (also in EN)

https://www.stadtentwicklung.berlin.de/umwelt/umweltatlas/edinh_03.htm

UDP Transport exemplary measures

☞ bicycle strategy

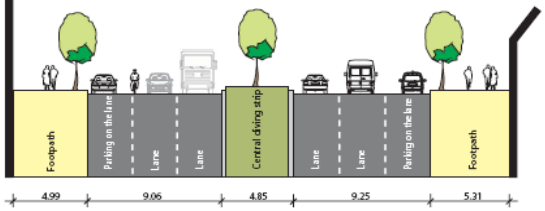


Setting up a dense cycle – route network
- ☞ Safe riding through smaller roads and parks
- ☞ Attractive new routes from the centre along the [illegible]

- Aims of Berlin's new mobility law, elaborated a multi-stakeholder process :
- Massive and accelerated investments in better cycling infrastructure
- 50 Mio Euro/year budget earmarked for better and safer cycling
- Network of dedicated cycling roads and bike lanes in all main roads
- 100 km of bike highways
- 200.000 additional bicycle parking stands, especially at subway/train stations

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

before



after