

Berlin: the most efficient low-emissions zone (?) and **other measures** to tackle **NO₂** and **PM₁₀**

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- Taking stock of 15 years **PM abatement** in Berlin
- Success through **LEZ**, but remaining issues
- **Current NO₂** dilemma and emerging pressure
- Portfolio of **measures** and their **impact** by **2020**
- Conclusions, caveats & **Outlook**



Environment

Less pollutants. More quality of life.

The Air Quality Plan of Berlin: 2nd revision 2019

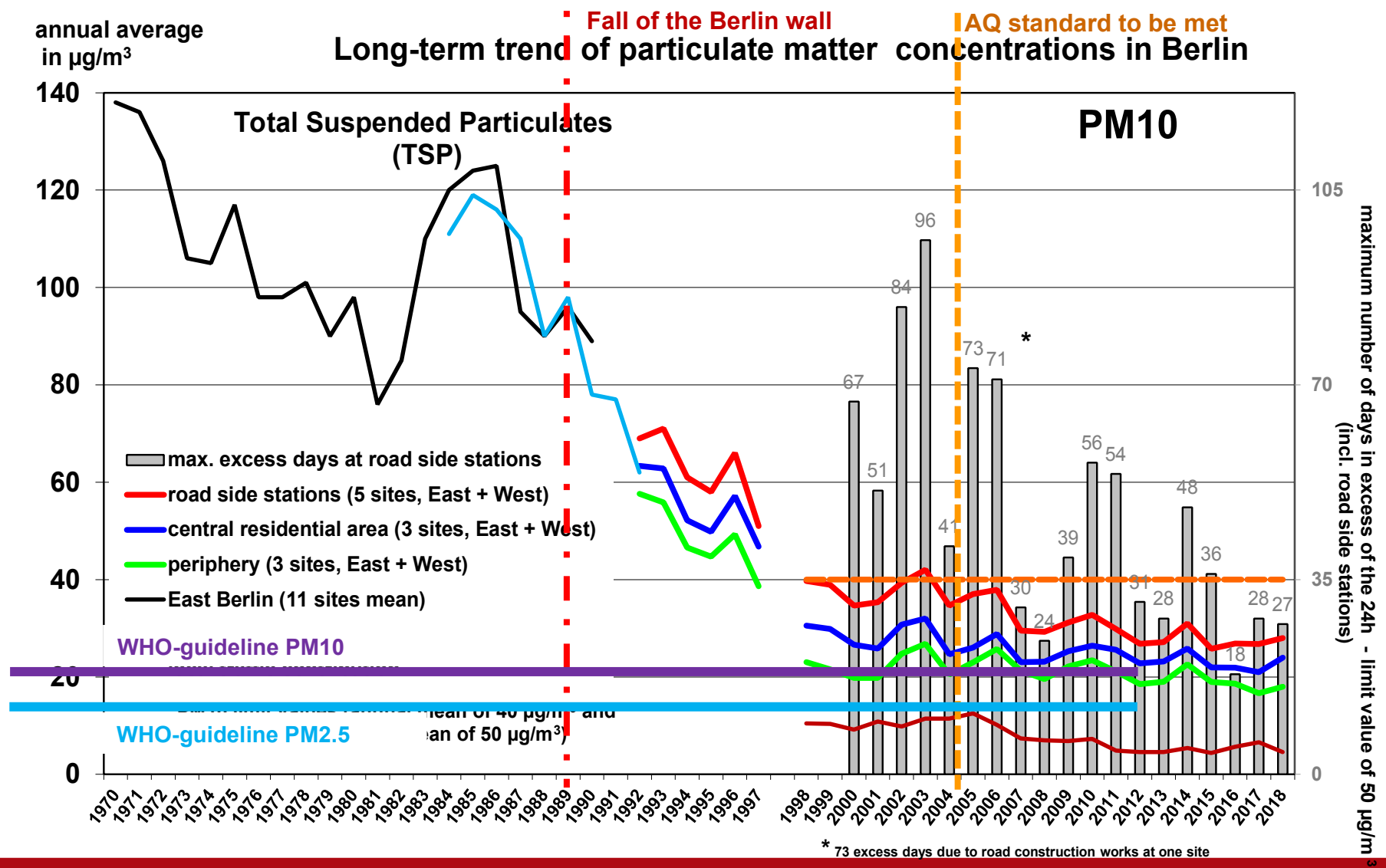
Air quality

◦ 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 <u>clean fuel</u> & 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 <u>clean fuel</u> & control technology
Ozone	long-range transport, traffic	⚖ diminishing problem, to be solved at national & EU level
PM2.5	long-range transport, traffic	≡ <i>Problem (seemingly) solved</i>
PM10	long-range transport, traffic, residential heating	😊 Largely solved, shrinking local share ◦ switch to clean fuel & control technology
NO₂	Road traffic (<u>Diesel</u>)	⚠ serious problem, national court verdicts & law suit filed by EU, traffic bans impending

Particulate matter (TSP/PM10)



Air quality management in Berlin

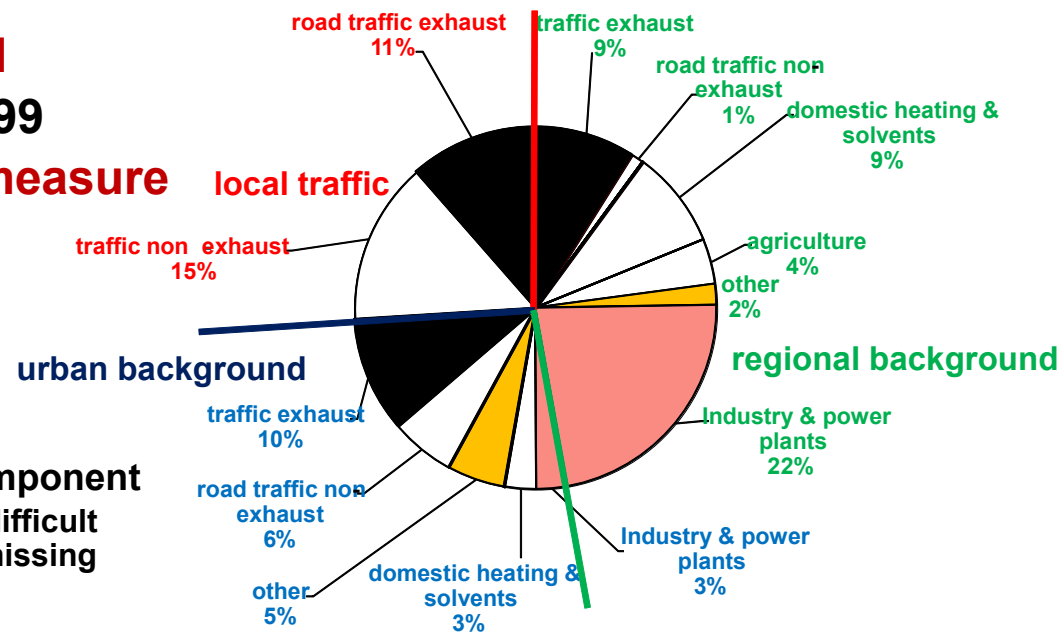
15 years ago **need** for action to **tackle PM10!**

- 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

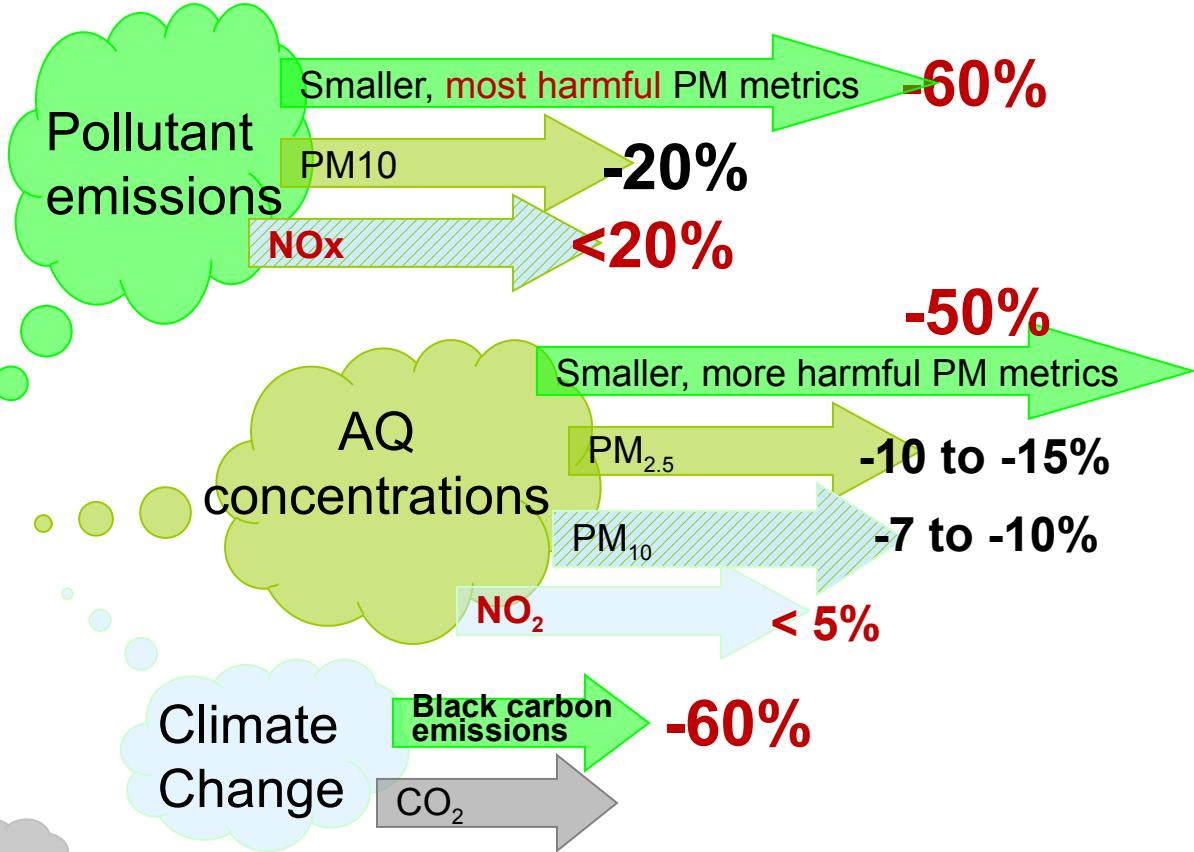
LEZ in Berlin & Germany

Summary of impact analysis



- Yet larger change
- Larger change
- Small change
- No measurable change

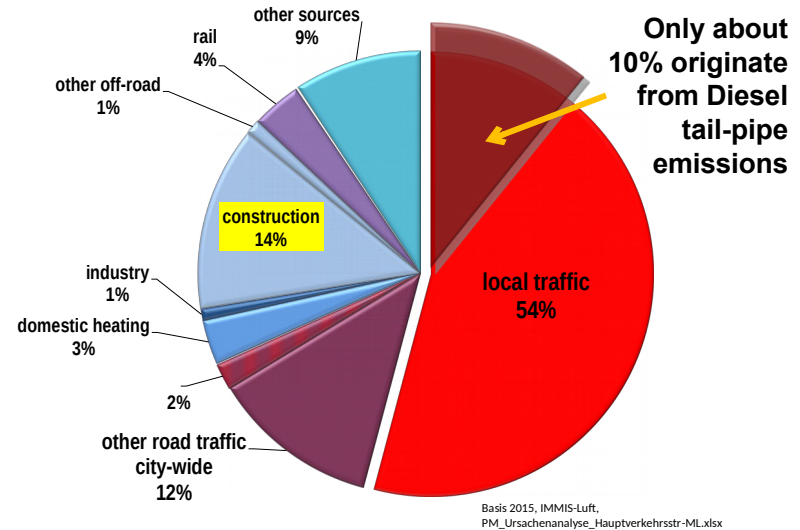
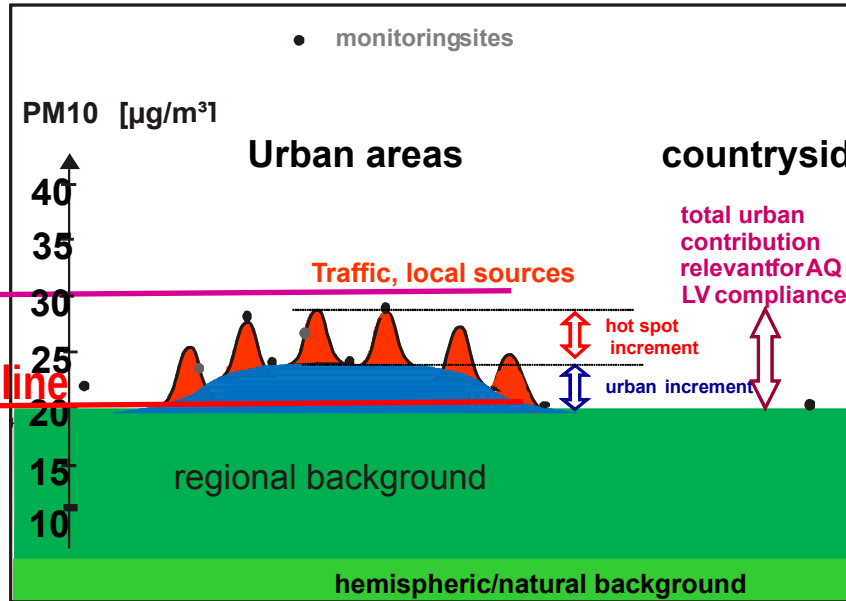
noise



Source: L. Sadler, modified

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?

Basis 2015, IMMIS-Luft, PM_Ursachenanalyse_Hauptverkehrsstr-ML.xlsx

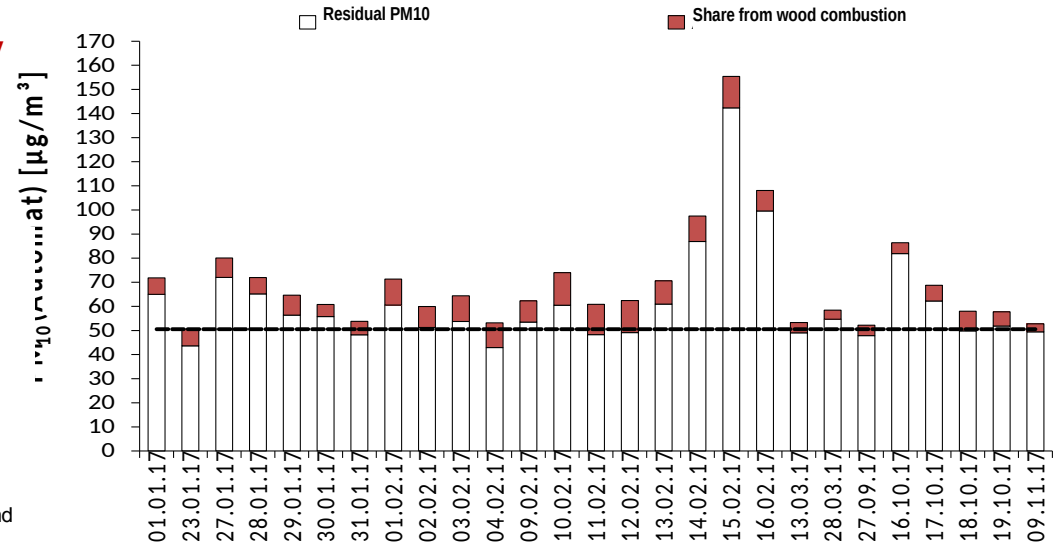
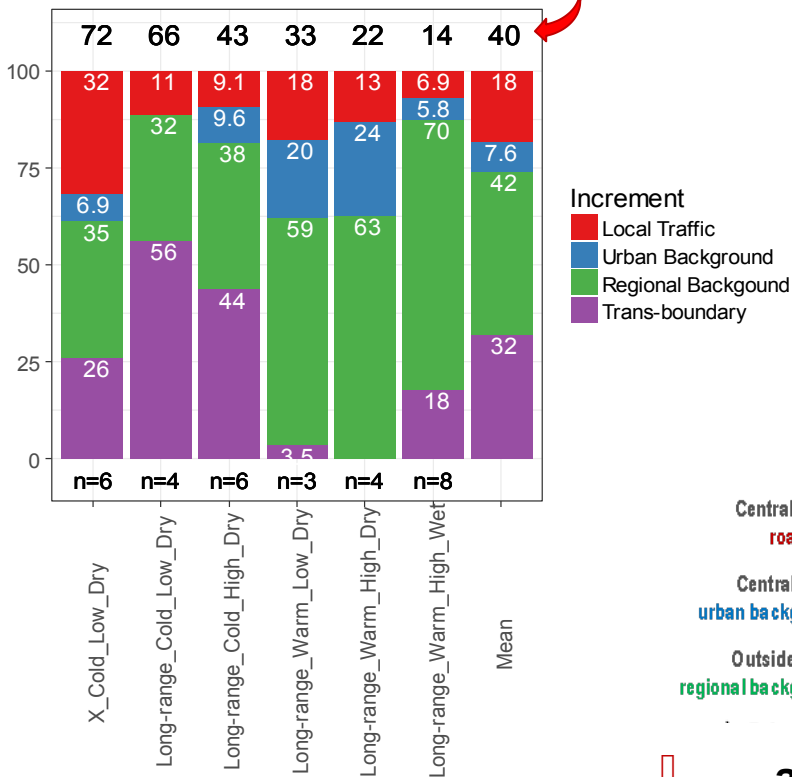
PM East source apportionment project

case study Berlin

Visible biomass (=wood) combustion signal from Aethalometer measurements...

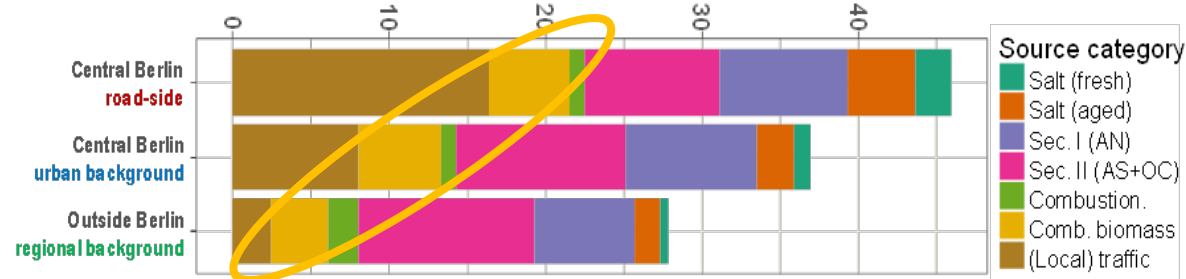
Significant regional & transboundary contribution

„Increment East“ ($\mu\text{g m}^{-3}$) at Berlin traffic site



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

PM10 concentration in $\mu\text{g}/\text{m}^3$ (average over 80 days with elevated concentration)



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

o PM pollution

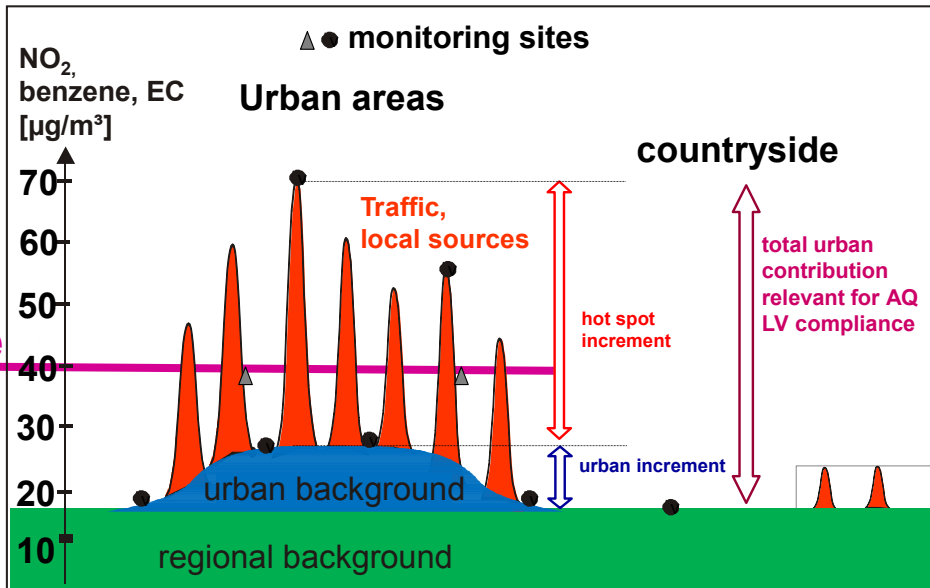
- 10-15 years ago: **widespread** exceedances resulted in **effective** local measures with **city-wide** effect (**L**ow **E**mission **Z**one, DPF-retrofit)
 - ↳ Improvement also in urban background & **population exposure**
- Now: Full PM **compliance**, need for regulatory measures has faded away due to unambitious PM limit values
- Still large **inter-regional** & **transboundary** component
- Residential heating (**wood** combustion) gains (relative) importance
 - ↳ **Stricter** requirement for new heating systems stipulated in the new AQ plan
- **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

Air quality in Berlin

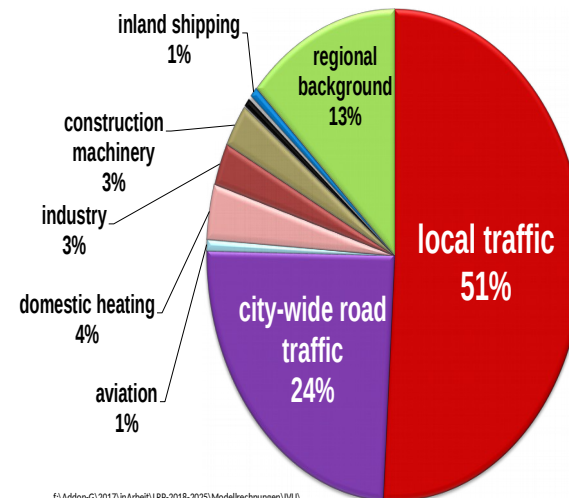
Sources of NO₂



NO₂ pollution sources at roadside spots

NO₂-source analysis

average over main roads with measured pollution above limit value



F:\Addon-GI\2017\inArbeit\LRP-2018-2025\Modellrechnungen\WU\

Limit value



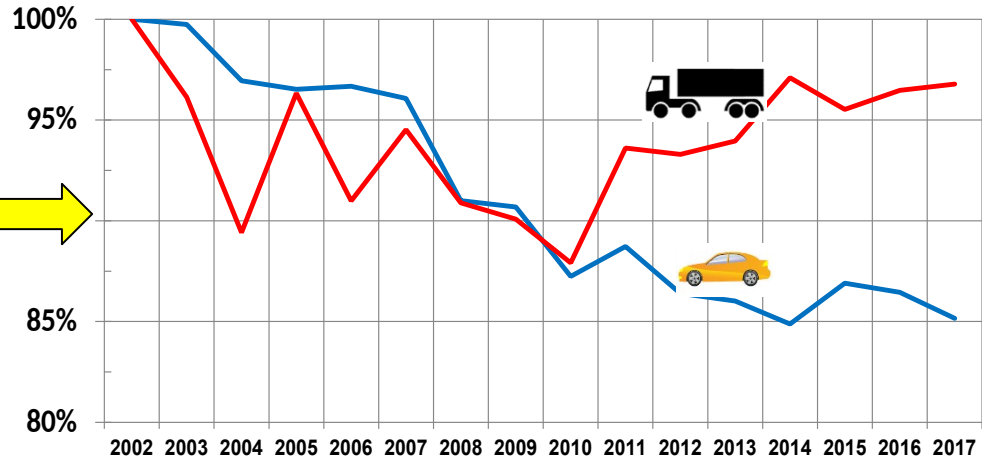
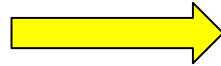
- NO₂ non-compliance in heavily trafficked main roads
- Road traffic (~80% Diesel) is the predominant source

NO₂ pollution & traffic

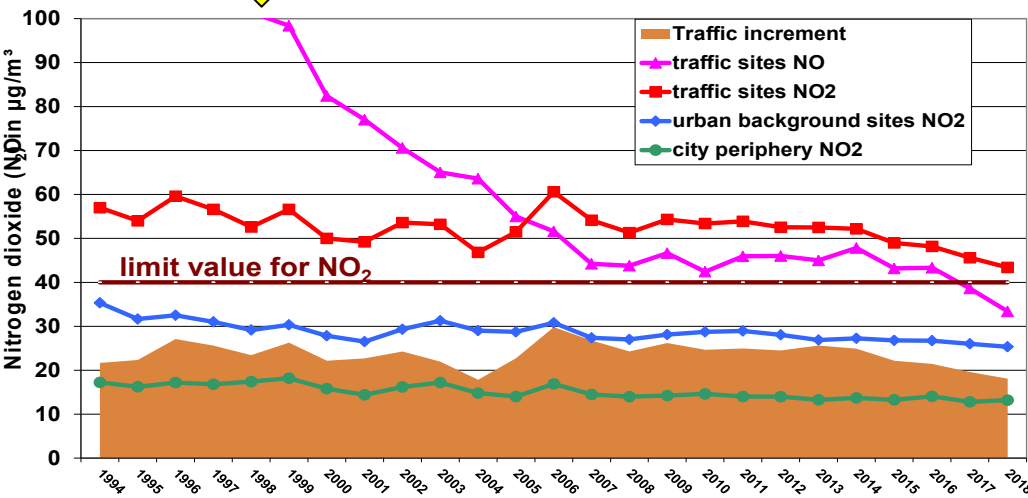
trend

Despite of ...

- the LEZ
- decreasing traffic volumes
 - -14% passenger car traffic since 2002
- ...NO₂ concentrations stagnate
 - In 2014: only -3% since 2002



Trend of nitrogen oxide levels in Berlin

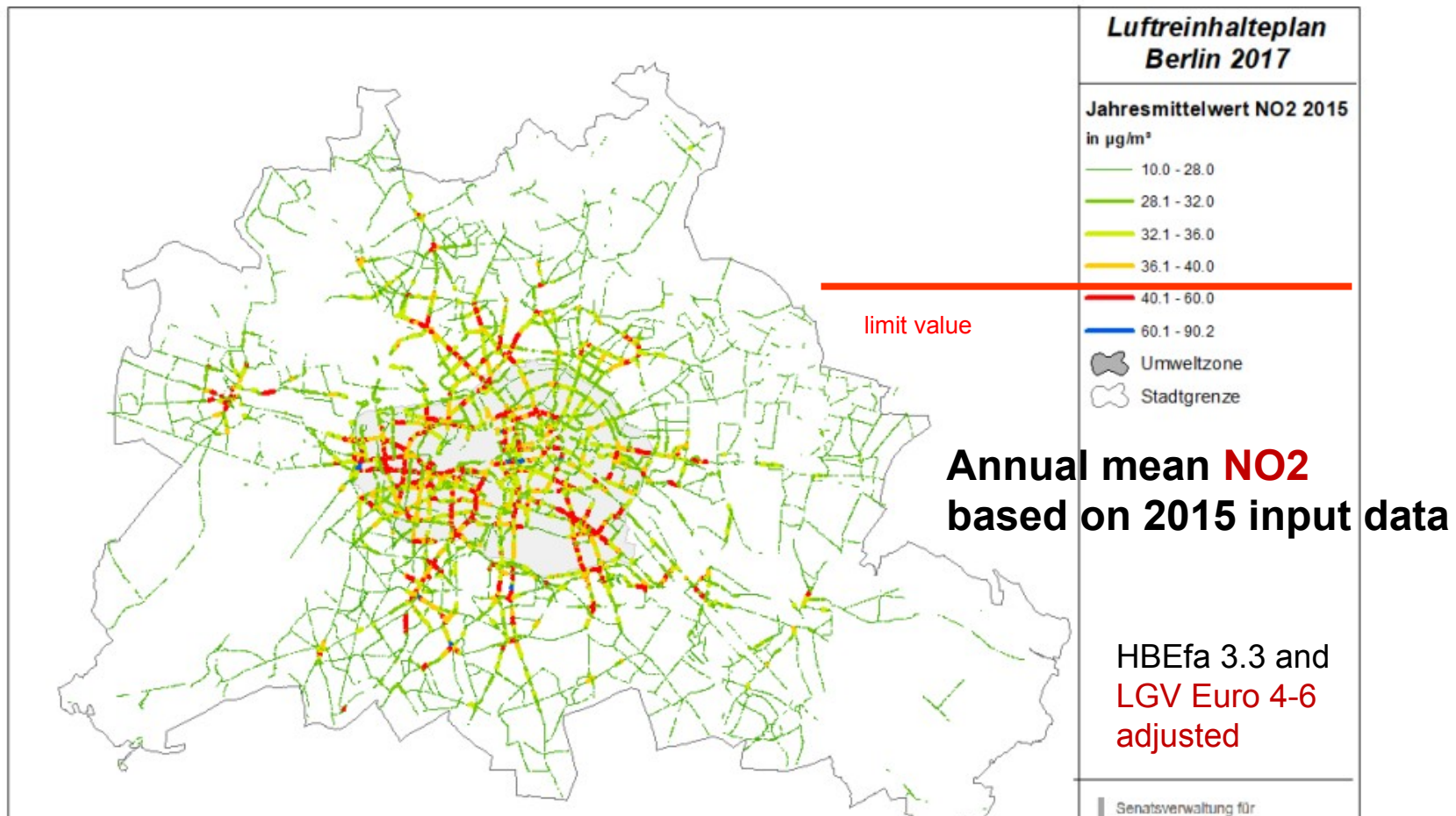


⚡ Extra measures badly needed

Air Quality in Berlin

° NO₂ model results for base year 2015

Useful means: dispersion modeling of NO₂ in every major road

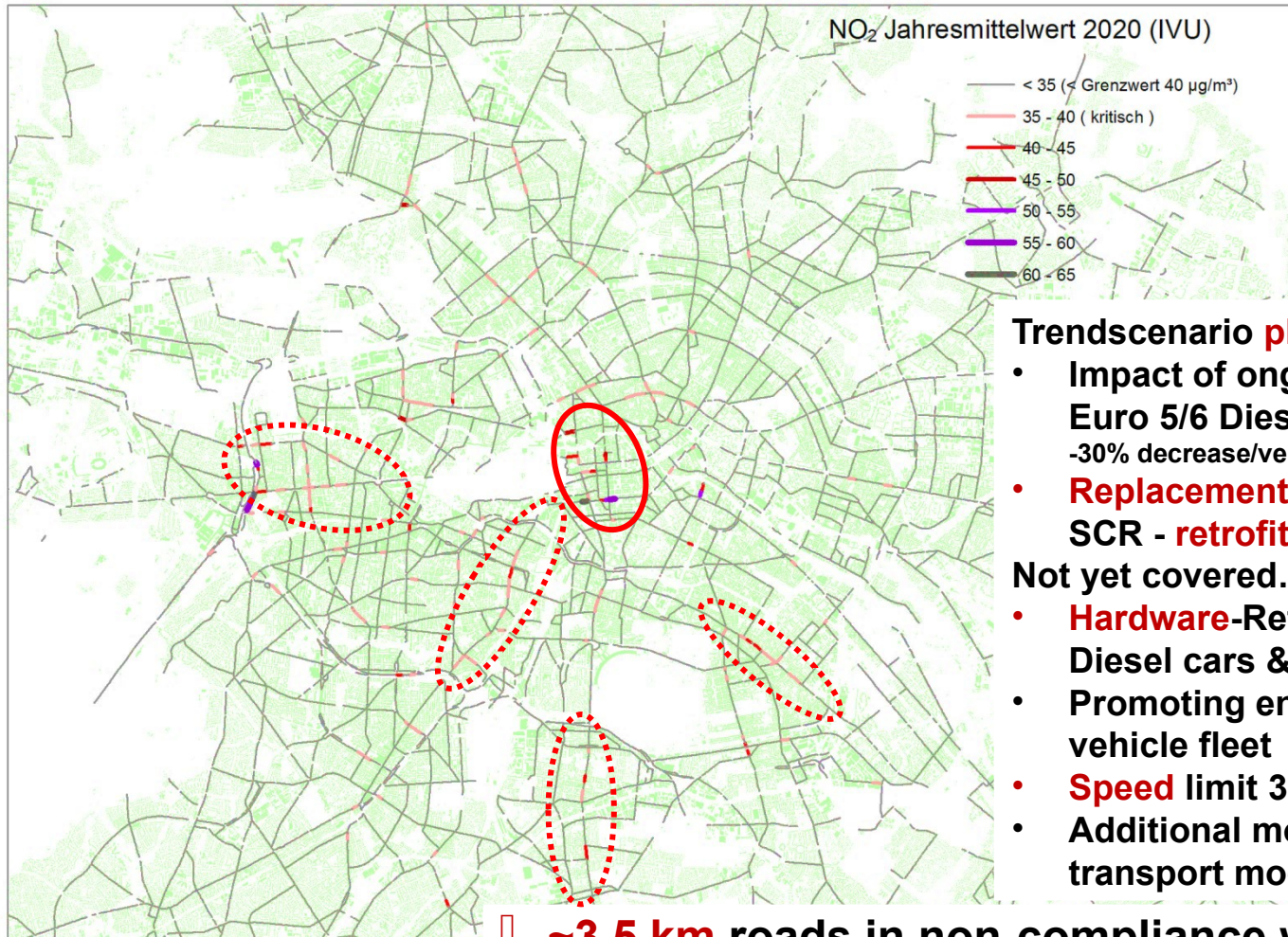


□ **>62 km** roads in non-compliance with NO₂ limit value
1.8 km above 60 µg/m³, ca **50.000 effected** residents

Air Quality management in Berlin

Latest scenario run **NO₂** for **2020**

Modelled annual mean concentrations of NO₂ 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)

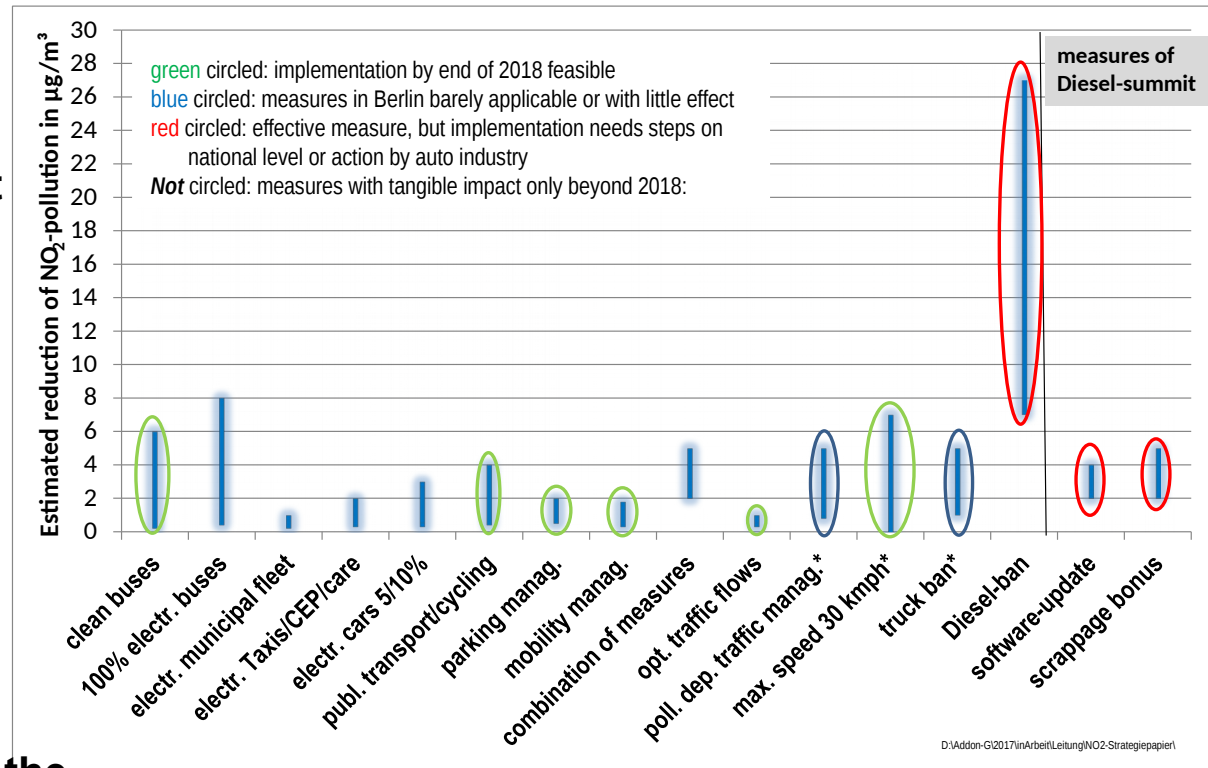
NO₂ – non-compliance

○ Modelled **impact** range of different local measures

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

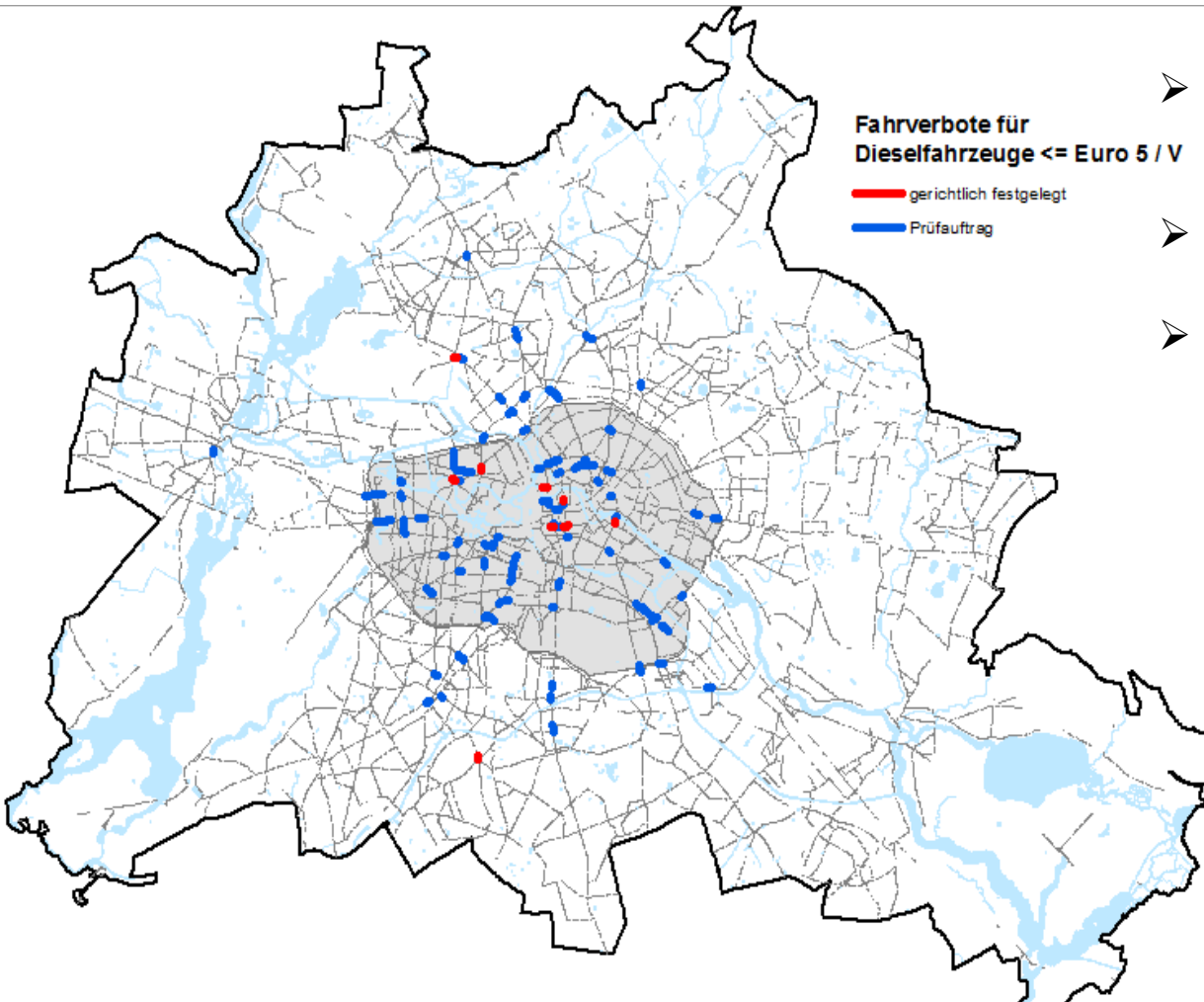
Challenges:

- 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 indispensable 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**



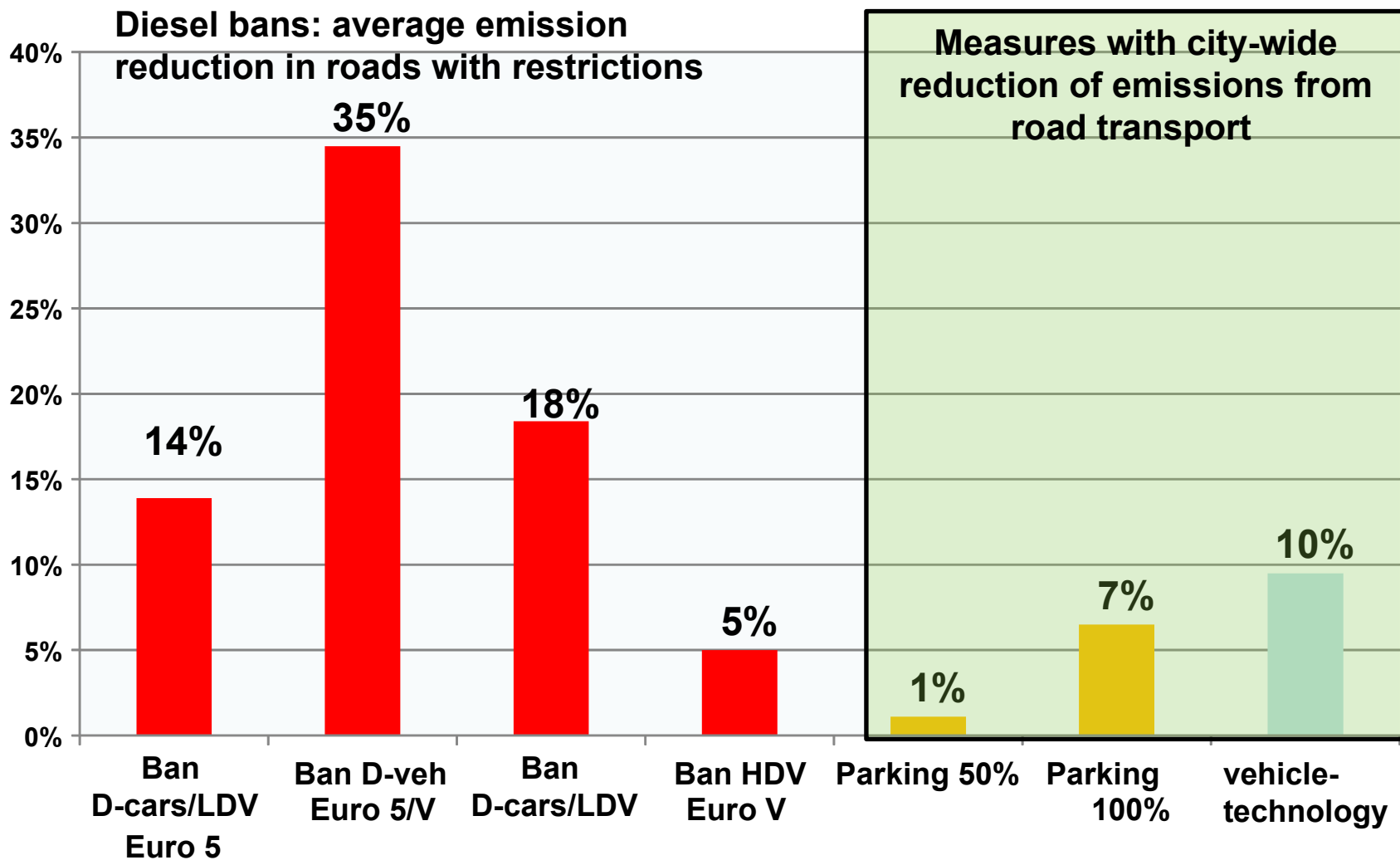
The current **problem** of excessive **NO₂**

° 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

emission reduction of traffic measures by 2020

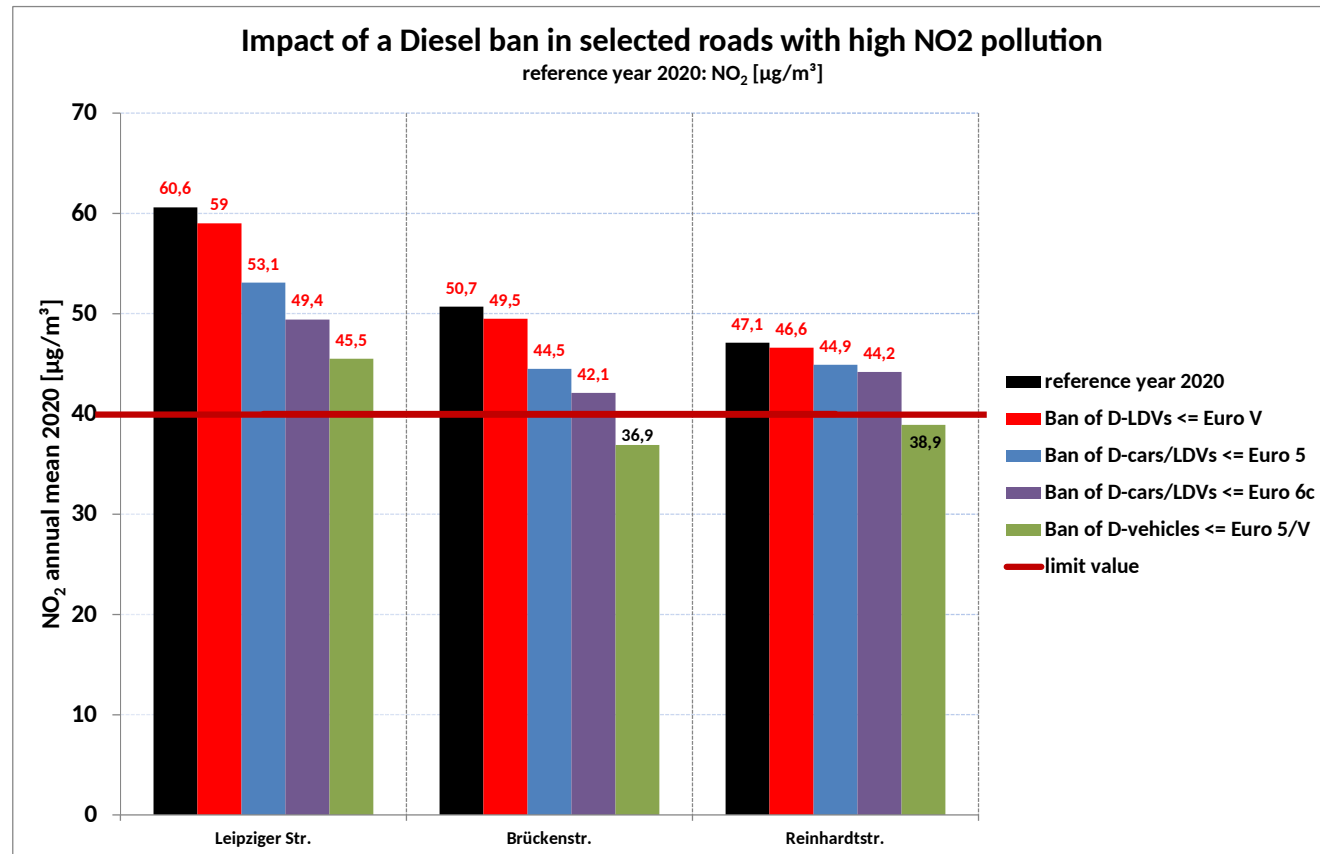


Diesel bans in single roads

◦ 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**

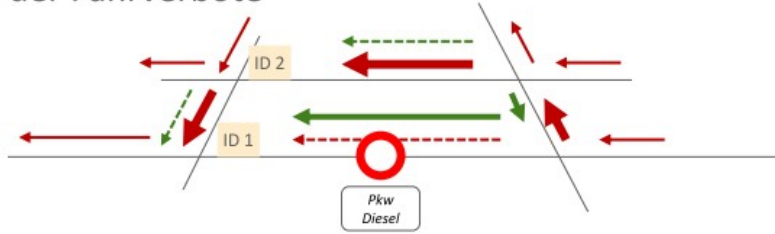
□ **Assumption:**
80% of banned
vehicles don't drive



Diesel bans in single roads

◦ impact on traffic flows

Wirkungen der Fahrverbote

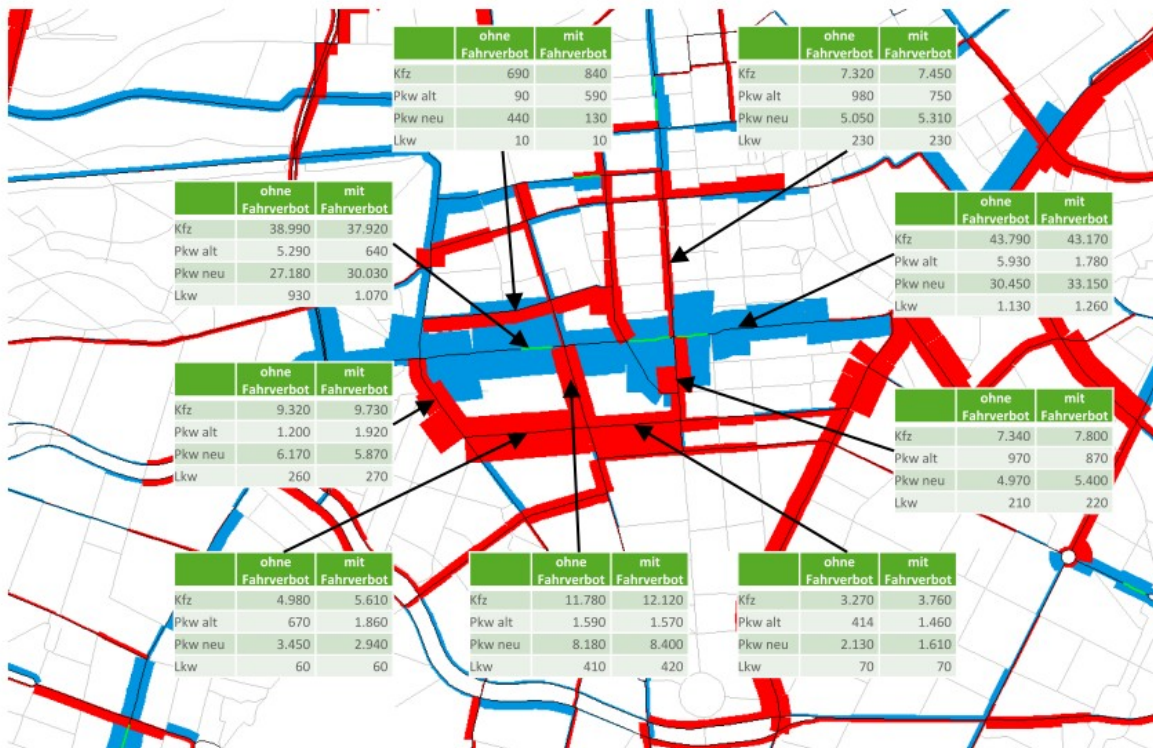


Vom Verbot betroffene Fahrzeuge

- ← unveränderter Anteil
- ← reduzierter Anteil
- ← verlagerter Anteil

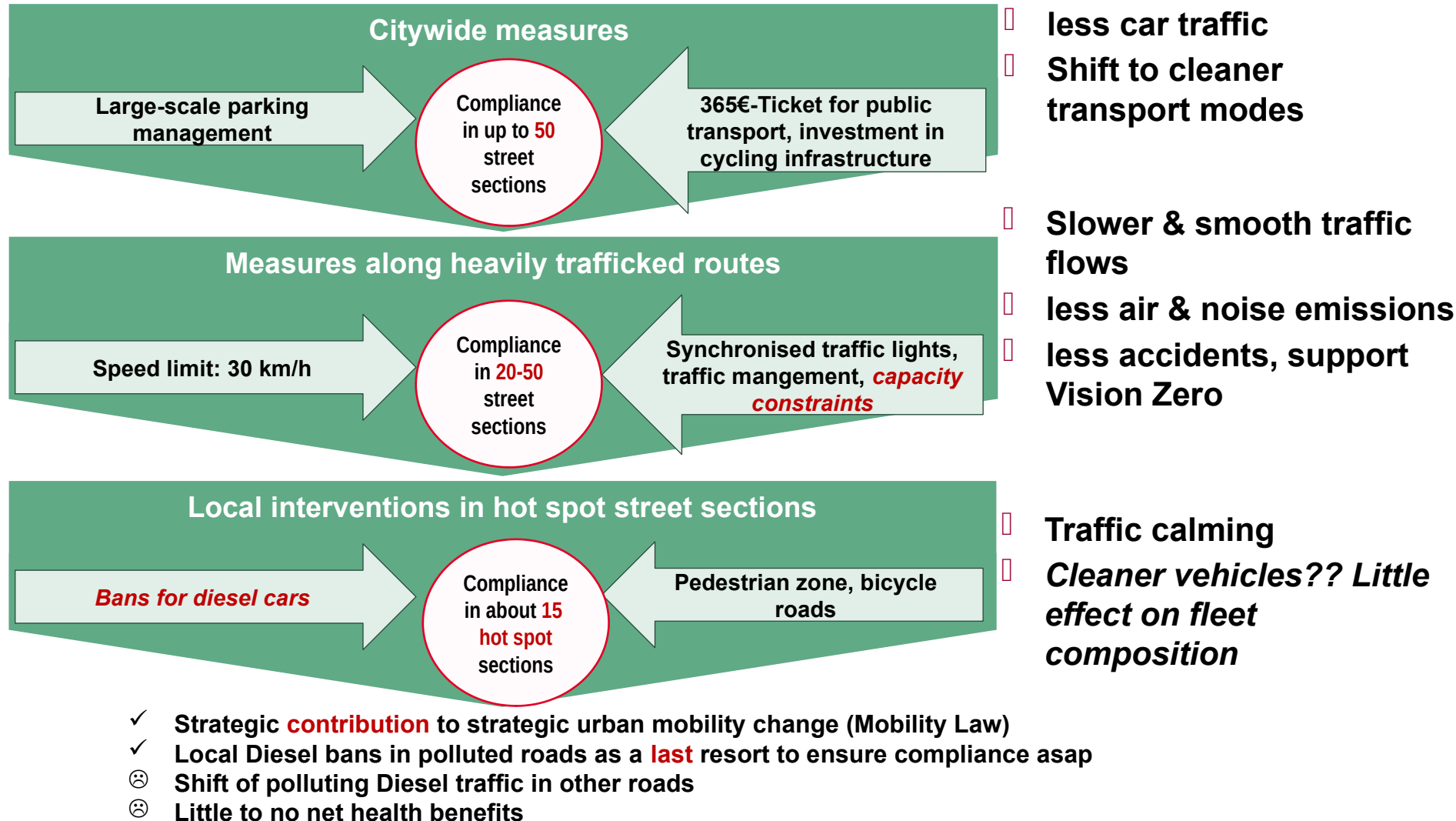
Nicht vom Verbot betroffene Fahrzeuge

- ← Reduzierter Anteil
- ← verlagerter Anteil



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 NO₂-limit value



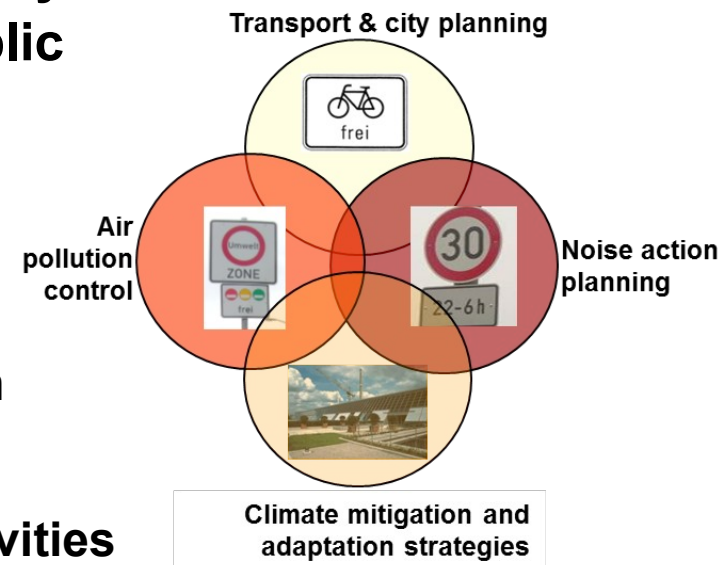
Conclusion ^o NO₂ pollution

- 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



° 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



Conclusions

Result: Better Balance between City, Transport and Environment



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



Verkehrssenatorin Regine Günther Berlin muss über eine City-Maut diskutieren

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

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