Air pollution issues from the perspective of the Federal Environment Ministry of Germany

2020 EUFJE Annual Conference

9th/10th October 2020

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Presentation is my personal view

Emissions vs Immission

Emissions

National: NECD
Source-based: IED, MCPD,
Euro standards etc.

Transmission
Chemical reactions

Immission

AAQD

Responsibilities of national, regional and local authorities in Germany

Level	Type of authority	Responsibilities
Federal government	Federal Ministry for Environment, Nature Conservation and Nuclear Safety	– policy-making and **implementation** (political framework, **legislation**)
	Federal Environment Agency	– **reporting** to European Commission – calculating emissions (except agricult.)
	Thünen institute	– calculating agricultural emissions
State level	chief emission control authorities, higher/intermediate/lower state authorities	– involvement in federal legislation – state-based policy-making/legislation – **enforcement** (air quality **monitoring** and **air pollution control planning**)
Towns and municipalities		**enforcement**

NEC Directive and NAPCP

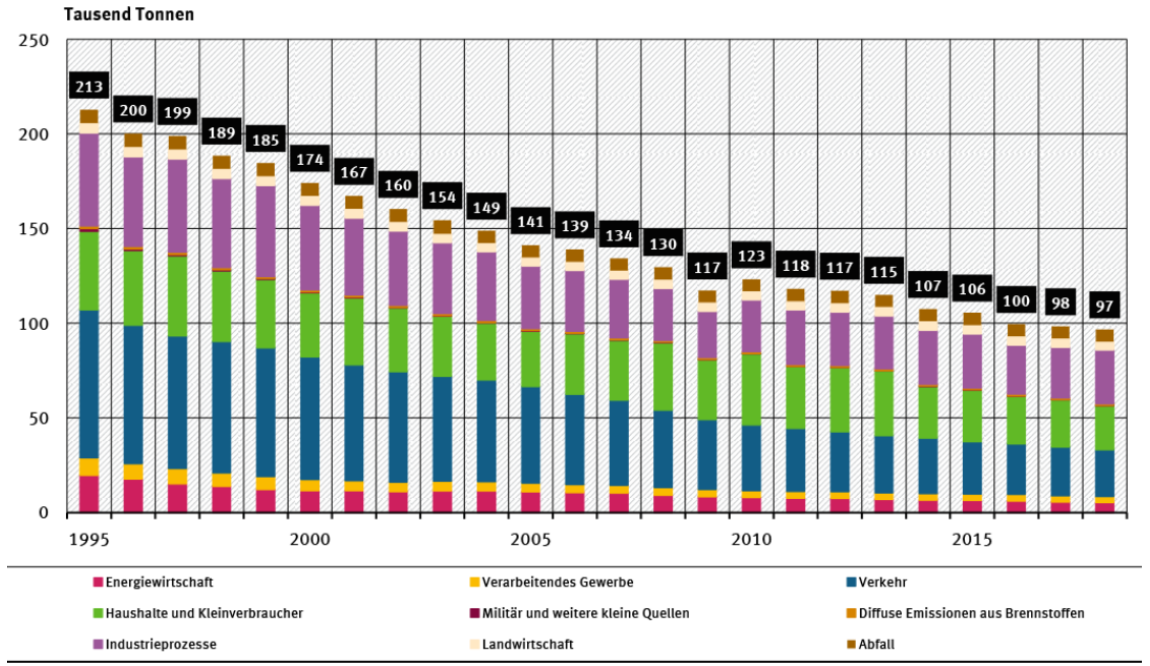
New NEC Directive

- National implementation in the 43rd BImSchV (in force since 31st July 2018)
- NEC covers **sum of national emissions** of pollutants
- Reduction obligations relative to **base year 2005**
- Federal Government adopts a **National Air Pollution Control Programme** (at least) every four years
- NAPCP adopted on 22 May 2019

Reduction obligations for Germany

	SO_2	NO_x	NMVOC	NH_3	$PM_{2,5}$
2020-2029	- 21 %	- 39 %	- 13 %	- 5 %	- 26 %
2030	- 58 %	- 65 %	- 28 %	- 29 %	- 43 %

Primary $PM_{2.5}$ emissions since 1995 (in kt)



Source: NAPCP DE

Main content of NAPCP

- Development of national emissions in the past (2005-2016)
- Emission **projections** for 2020-2030 in two scenarios
  - With measures (WM scenario)
  - With additional measures (WAM scenario)
- list of **additional measures needed** for compliance with reduction obligations
- Assessment of **impact on background air quality** (modeling)

Calculation of national emissions

- Calculation explained in detail in guidance documents
- Principle:

$$\boldsymbol{Emission}\ [\boldsymbol{EM}] = \boldsymbol{Activity\ Rate}\ [\boldsymbol{AR}] \cdot \boldsymbol{Emissions\ factor}\ [\boldsymbol{EF}]$$

- Examples for activity rates:
  - fuel consumption in terajoules [TJ]
  - number of animals given in units [U]
  - quantity of product used in kilograms [kg]

- Emission factors:
  - measurement results
  - other sources as e.g. modelling, expert calculation/estimation on the basis of qualified assumptions

WAM scenario for compliance with NECD

NECD reduction commitments (from 2005 baseline)			2030				
			NO_x	SO_2	NMVOC	NH_3	$PM_{2.5}$
			65%	58%	28%	29%	43%
WM scenario		%	59%	51%	30%	9%	41%
		kt	603	231	785	570	80
Reduction potentials of c							
Climate change mitigation	a)	kt	-24.6	-26.6	-2.0		-1.6
	b)	kt	-32.3	-34.8	-0.9	-0.5	-1.5
Air pollution control	Combus						
	c)	kt	-31.2	-0.2			-0.1
	d)	kt					-1.3
	Transpc						
	e)	kt	-7.2		-5.5	-0.2	-0.3
	Agricult						
	f)	kt				-133.0	
	Combus						
	g)	kt		-8.2			
	h)	kt	-2.1				
WAM scenario		%	65%	66%	31%	30%	44%
		kt	506	161	776	436	75

a) climate change mitigation measures
b) phase-out of electricity generation from **coal and lignite**
c) implementation of the **MCP Directive**
d) retention of more ambitious **national rules** on **solid fuel boilers**
e) road transport measures (e.g. software update for cars; hardware retrofitting for buses; new CO_2 limits for cars)
f) package of **agricultural measures**
g) promotion of a fuel-shift used in industrial production in favour of lower-sulphur fuels or more efficient technology for exhaust gas cleaning
h) NO_x reduction for fuels except coal

Source: NAPCP DE

Reductions and source categories

Source groups (aggregated)	NO_x (as NO_2)			
	2005	Projection		
		2020	2025	2030
	kt	kt	kt	kt
1 Energy	1 353.0	739.8	564.5	418.8
A. Fuel combustion activities	1 351.9	738.7	563.4	417.7
1 Energy industries	289.1	232.7	206.2	144.2
2 Manufacturing industries	103.3	68.2	58.6	53.1
3 Transport	806.5	333.8	212.8	149.5
of which: road transport	*738.1*	*284.1*	*167.9*	*110.3*
4 Other combustion plants	142.0	99.6	82.0	67.4
of which: commerce, trade, services	*34.6*	*27.1*	*23.1*	*19.8*
of which: residential	*67.2*	*49.7*	*44.2*	*40.5*
5 Military and other minor sources	11.0	4.5	3.9	3.5
B. Fugitive emissions from fuels	1.2	1.1	1.1	1.1
2 Industrial processes	106.3	87.5	86.4	84.0
3 Agriculture	118.0	128.1	128.3	128.3
5 Waste and wastewater treatment	0.3	0.6	0.6	0.6
National total of source groups for which reporting is obligatory	1577	956	780	632
Total source groups for which reduction is obligatory	1459	830	653	506

Source groups (aggregated)	PM2.5			
	2005	Projection		
		2020	2025	2030
	kt	kt	kt	kt
1 Energy	93.2	53.3	45.1	40.2
A. Fuel combustion activities	92.1	52.3	44.2	39.2
1 Energy industries	10.7	6.7	5.9	4.1
2 Manufacturing industries	4.6	2.2	1.4	1.1
3 Transport	46.2	21.7	20.2	19.5
of which: road transport	*36.2*	*16.0*	*14.6*	*14.1*
4 Other combustion plants	30.2	21.6	16.5	14.4
of which: commerce, trade, services	*2.2*	*1.0*	*0.6*	*0.4*
of which: residential	*20.5*	*18.6*	*14.7*	*13.1*
5 Military and other minor sources	0.5	0.1	0.1	0.1
B. Fugitive emissions from fuels	1.1	1.0	1.0	1.0
2 Industrial processes	31.7	25.3	25.2	25.0
3 Agriculture	4.5	4.6	4.6	4.5
5 Waste and wastewater treatment	5.6	5.7	5.7	5.7
National total of source groups for which reporting and reduction are obligatory	135	89	81	75

Source: NAPCP DE

Phase-out of coal-based electricity production

- electricity generation from coal to end at the latest by 2038
- reviews in 2026, 2029 and 2032 planned
- major contribution to NO_x, SO_2 and $PM_{2.5}$ reduction

Energy scenario for phaseout (in TWh):

	2016	2025	2030
Nuclear energy	80	0	0
Lignite	138	82	**58**
Hard coal	103	64	**39**
Gas / oil / other	100	123	130
Hydropower	51	42	43
Wind onshore	68	128	163
Wind offshore	12	42	68
Photovoltaics	39	62	77
Bioenergy	43	44	34
Other renewables	8	8	8

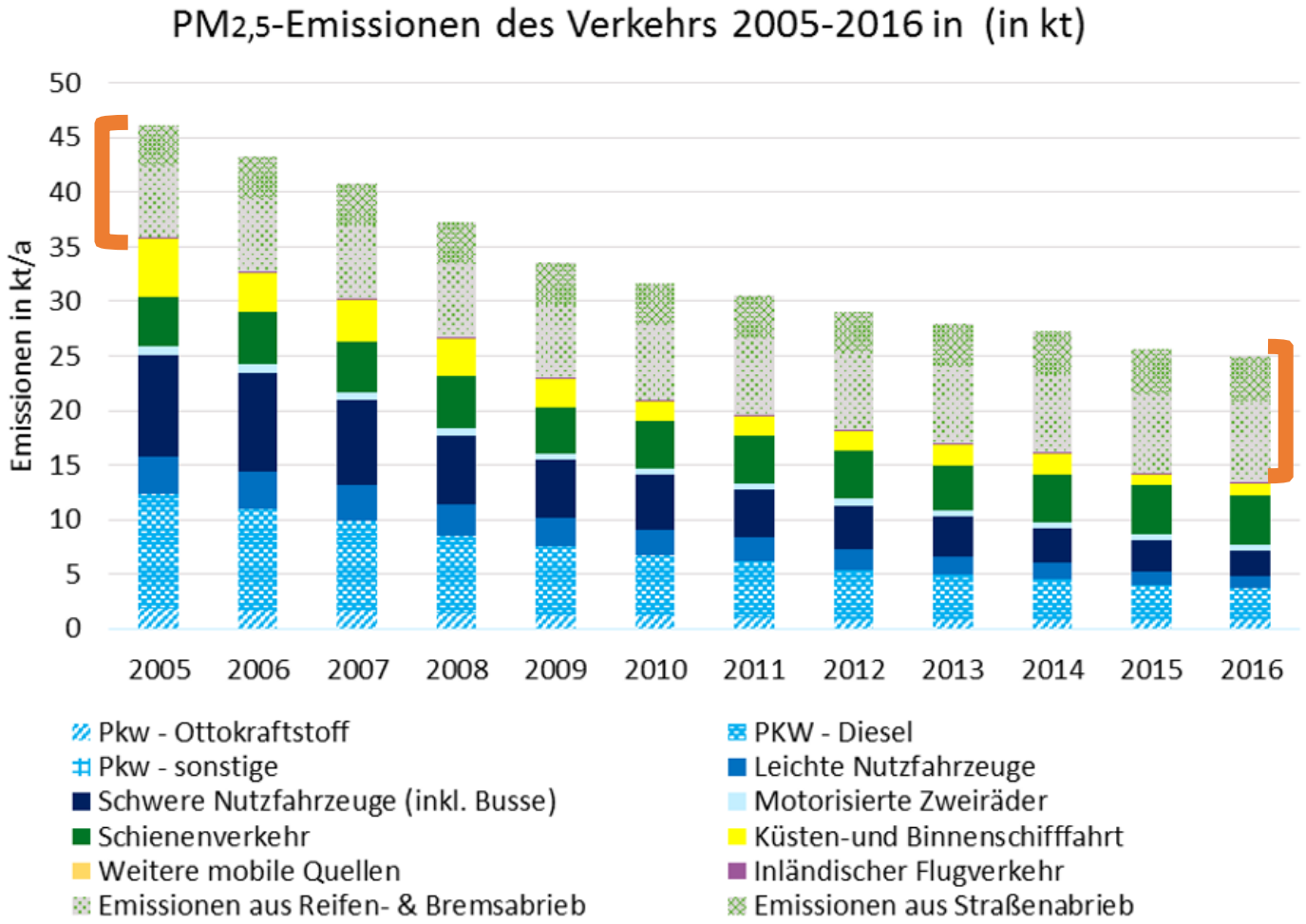
Biomass – air quality vs. climate change

- incentives for bioenergy as GHG reduction measure
- **Trade-off** with air pollution: **$PM_{2.5}$ emissions of biomass combustion about 500-800 higher compared to CNG** boilers
- COM approved that Germany can maintain its **more ambitious national standards** for **solid fuel boilers** (needed for compliance with NECD)
- continuous **monitoring** necessary ➔ large increase in number of solid fuel boilers could be a compliance risk for NECD
- Council conclusions Improvement of Air Quality:

  *"EMPHASISES that it is essential that **new** energy efficiency and **emission requirements** under the Ecodesign Directive, including for heaters and boilers, and […] **contribute to continued coherence** and synergies, while **avoiding trade-offs, such as in the case of biomass use for both residential heating and medium-sized combustion installations**"* (para 17, 5 March 2020)

$PM_{2.5}$ emissions of transport

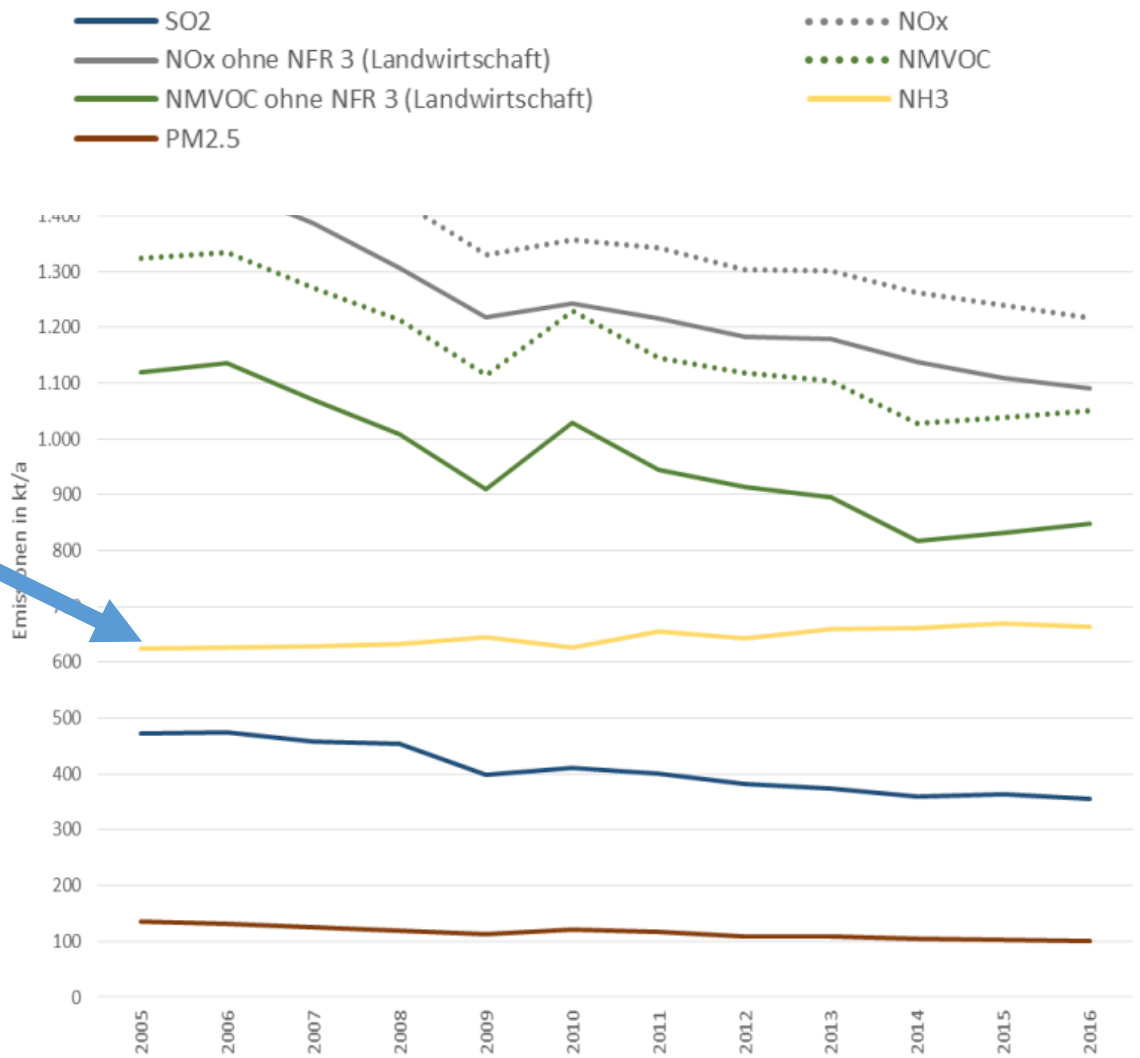
- Significant reduction of $PM_{2.5}$ exhaust emissions over the last decade
- Relative share of abrasive emissions (brakes, tires, street) increasing ➔ technical challenges



Source: NAPCP DE

Ammonia emissions

- decrease in emissions of all pollutants covered by NECD except Ammonia (NH_3)
- NH_3 important **precursor for PM** concentration (also in cities)
- 95 % of NH_3 emissions from agriculture (2016), e.g. from spreading of organic fertilisers, mineral fertilisers and fermentation residues
- agricultural measures include
  - low-emission storage of manure
  - low-emission application of manure and mineral fertilisers



Issues related to the AAQ Directives

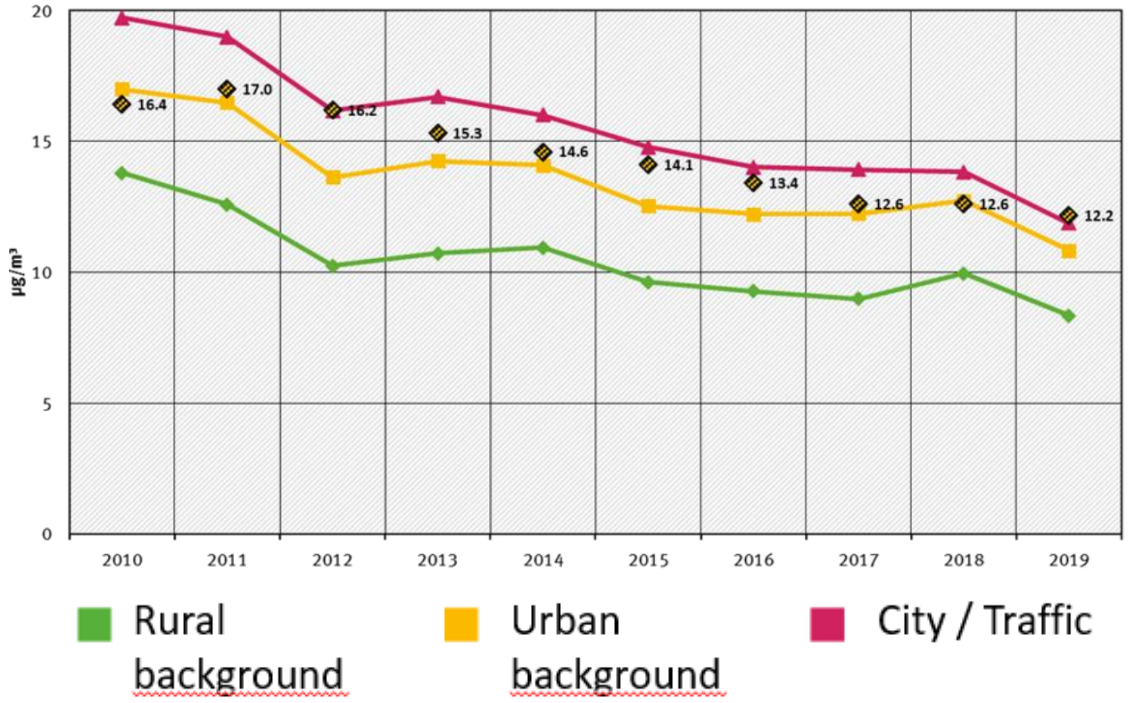
AAQ Directives

- Significant improvements of air quality have been achieved

- Air pollution is still a major health risk (also in Europe)
  - Pollutant concentrations affect i.a. burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases.

- Current situation in Germany
  - compliance with PM limit values since 2018
  - exceedances of NO_2 annual mean limit value (40 µg/m³)
    - limit value exceeded in 25 cities in 2019 (65 cities in 2017, 57 cities in 2018)
    - Main cause: high NO_x emissions of diesel passenger vehicles

Average $PM_{2,5}$ concentration (µg/m³) at selected stations

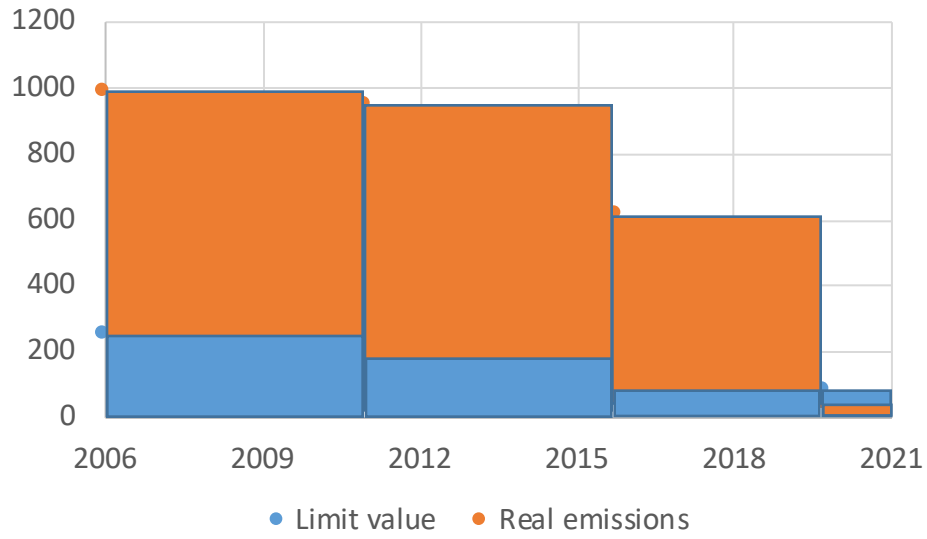


Source: UBA

NO_2 concentrations in cities

- Vehicle fleet
  - Share of diesel passenger cars in hot spot NO_2 direct emissions at ca. 72 % (UBA)
  - Share of diesel cars in Germany at 33 % (Eurostat, 2016)
- Real driving emissions of diesel passenger cars:

Emission standard	Date (first registration)	Limit value (mg NO_x/km)	Real world emissions (mg NO_x/km)	Deviation (factor)
Euro 4	Jan 2006	250	989	3,96
Euro 5	Jan 2011	180	**950**	**5,27**
Euro 6a-c	Sep 2015	80	**614**	**7,68**
Euro 6d-TEMP	Sep 2019	*168*	46	



Source: HBEFA 4.1

NO_2 reduction measures

- Numbers indicate that RDE requirements are a very **effective** and **proportionate** measure
  - **EU-wide harmonization due to the common vehicle market**
  - **fleet renewal on-going** (lower share of new Euro 6a-c high-emitting diesel cars since Oct 2018)

- necessary reduction can only be achieved in a **joint effort**

  *„[…] it is **particularly important to combat emissions of pollutants <u>at source</u>** and to identify and implement the **most effective emission reduction measures <u>at local, national and Community level</u>**.“ (Recital 2, AAQD)*

- **further NO_2 reductions expected** due to measures adopted on all levels

EU level

- Real driving emissions (binding since 9/2019) ➔ fleet renewal

Federal level

- Software updates of diesel passenger cars
- Promotion of hardware retrofitting (LDVs, vehicles of regional authorities)
- Model city program
- ***Private sector:*** *Hardware retrofitting of diesel passenger vehicles (in / around cities >50 µg/m³; financed by two car manufacturers)*

Regional level (measures differ between cities)

- Promotion of alternative modes of transport
- Dedicated lanes limited to specific modes of transport
- Traffic lights limiting number of vehicles allowed to enter („gatekeeper traffic light“)
- Driving bans in cities

Green deal / WHO guidelines

- Green Deal Communication (Dec 2019):
  - COM intends to revise AAQ Directives
  - Aim: align it more closely to WHO guidelines
  - *"strengthen provisions on monitoring, modelling and air quality plans to help local authorities achieve cleaner air."*
- Update of WHO (outdoor) air quality guidelines on-going

Current WHO AQ guidelines and EU AQ standards

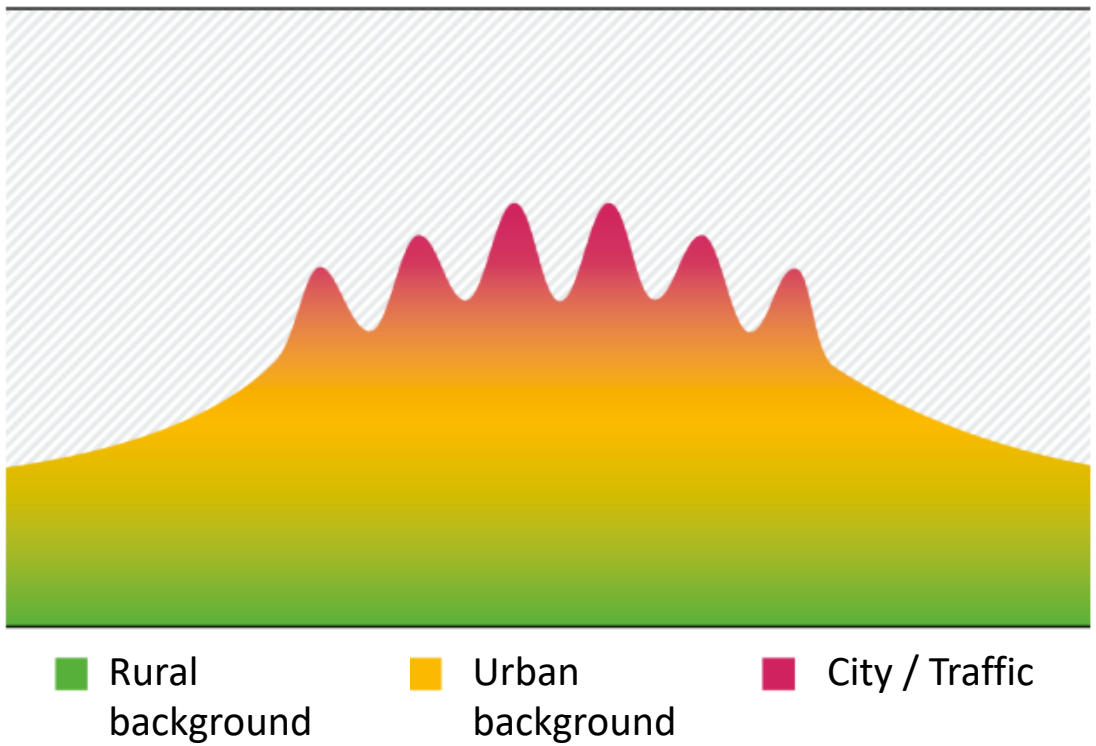
Pollutant	WHO Guidelines	EU air quality standards	'Permitted' exceedances
PM_{10} (annual LV)	20 µg/m^3	40 µg/m^3	-
PM_{10} (daily LV)	50 µg/m^3	50 µg/m^3	(35 days a year)
$PM_{2.5}$ (annual LV)	10 µg/m^3	25 µg/m^3	-
$PM_{2.5}$ (daily LV)	25 µg/m^3	-	-
NO_2 (annual LV)	40 µg/m^3	40 µg/m^3	-
NO_2 (hourly LV)	200 µg/m^3	200 µg/m^3	(18 hours a year)
SO_2 (daily LV)	20 µg/m^3	125 µg/m^3	(3 days a year)
SO_2 (hourly LV)	500 µg/m^3 (for 10 min)	350 µg/m^3	(24 hours a year)
O_3 (8-hour TV)	100 µg/m^3	120 µg/m^3	(75 days in 3 years)

Source: COM, Fitness Check

Governance – current Directive

- Current AAQD: MS/ regions responsible for compliance
- **But:** future reduction options of MS / regions more limited
  - pollutant **concentrations not only affected by local emissions**, but also by long range transport of pollutants

    ➔ Large share of relevant **emission sources outside jurisdiction of responsible entity** (extent varies depending on many factors such as type of pollutant, size of MS …)
  - emission **source legislation** mostly adopted on EU level
- considerations for future structure should include those aspects



Source: UBA (*modified according to Lenschow et al.: Some ideas about the source of PM10, Atmospheric Environment 35(2001) pp 23-33)*

Governance – examples for long range transport

- Relevant e.g. in terms of **ground-level ozone**:
  - ozone is not emitted, but a **product of complex chemical reaction** of ozone precursors like methane, CO, NO_x, NMVOCs (➔ secondary pollutant)
  - exceedances for ozone vary significantly, as concentrat**ions are sensitive to meteorological conditions**, in particular sunlight
  - **Long lifetime** of ozone (up to several weeks); can be **transported over very long distances**

- **Partculate matter**:
  - **fine particles** (< 1µm) can be **transported hundreds/thousdands of kilometers** (coarse particles are more easily deposited)
  - **substantial share** of fine particle concentration **due to NH_3 emissions**

Governance – Joint responsibility

- Emissions for relevant sources identified can be reduced by reduction of EF or reduction of AR
- EF mainly determined by **emission source legislation** (mostly **EU level**)
- Regional measures often come down to **reducing AR** (due to **lack of legislative power** on EF), e.g.
  - driving bans
  - ban of solid biomass combustion in private households
  - reduction of number of animals
- **reduction of EF typially more proportionate and cost-effective** compared to reduction of AR

  ➔ **joint responsiblity and action** is **needed on all levels**
- Council Conclusions (5th March 2020):

  *"15. STRESSES that **air quality objectives should be fully reflected in EU emission source legislation** […]; in that context UNDERLINES the **joint responsibility of the EU and Member States** to maintain and improve air quality; **INVITES the Commission** to **ensure** that **any proposals for EU emission source legislation sufficiently contribute to reaching air quality standards**;"*

$$\textbf{Emissions [EM]} = \textbf{Activity Rate [AR]} * \textbf{Emissions factor [EF]}$$

EU source legislation:

- Passenger cars
- light and heavy duty vehicles
- Non-road mobile machinery (NRMM)
- Ecodesign
- MCPD (medium combustion plants)
- IED (large combustion plants)

Conclusions

- significant **improvements** have been **achieved**
- air pollution is still a major health risk, therefore **further reductions** are **necessary** in the future
- **shift of focus in terms of source categories** (mainly due to succesful emission reductions achieved)
- **need for joint action** on **all levels** should be considered in the governance structure of **future AAQ legislation**

Thank you!