Towards assessment of the emission abatement potential in Belarus against emission targets for 2020

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43th meeting of the *TFIAM,*
6-7 May 2014,
Helsinki, Finland

Supported by

IVL Swedish Environmental Research Institute

IAM framework in Belarus:

- National Academy of Sciences/Ministry of Natural Resources projects
- Swedish-Belarus project (coordinated by IVL)

Goals:

- IAM basis in Belarus strengthening for air legislation improvement and new air abatement programs elaboration;
- scientific provision of negotiations on LRTAP Protocols accession.

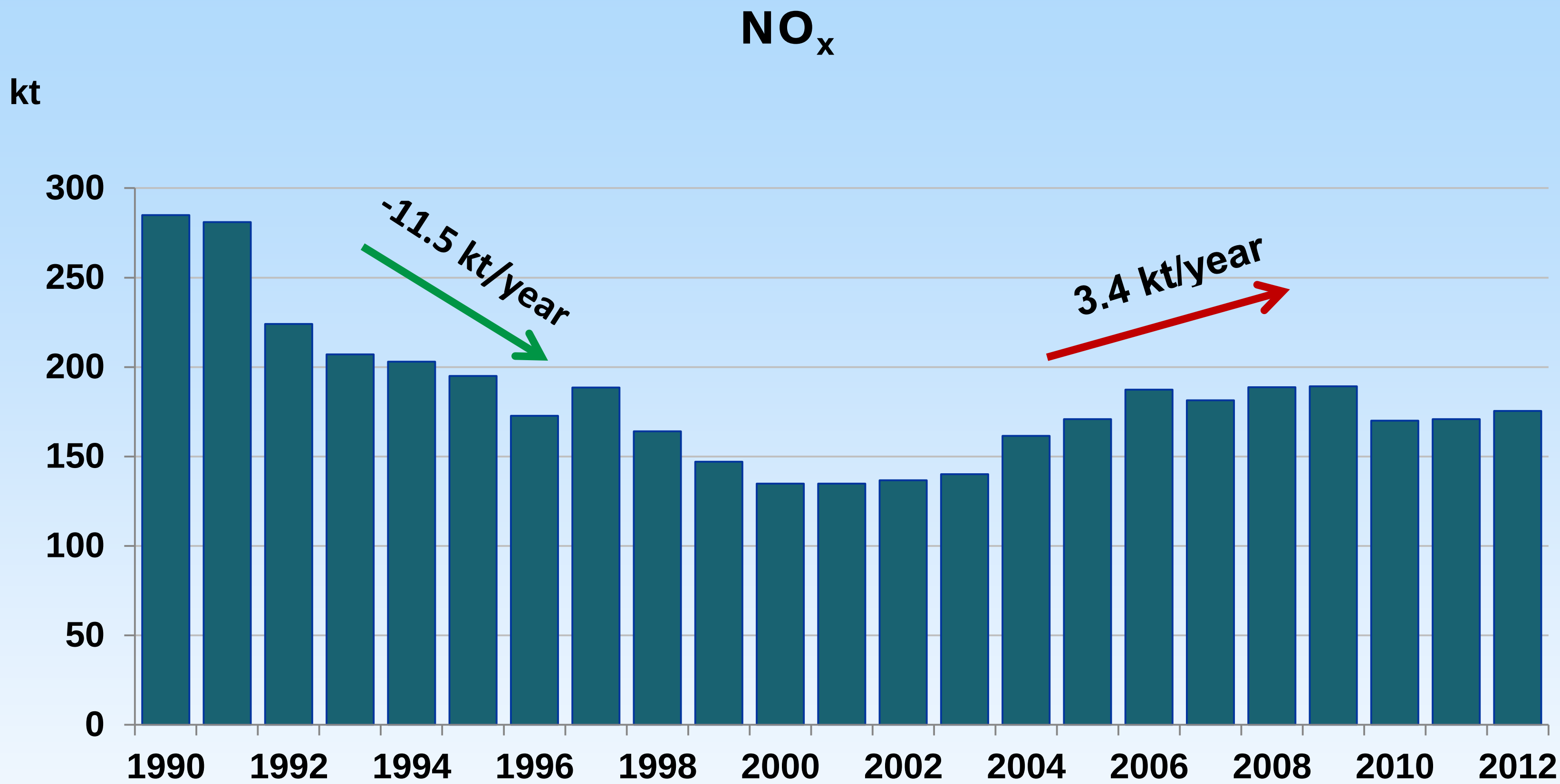
Current status:

- Detailed analysis of NOx reduction potential
- NH3 and PM reduction potential need to be updated
- First steps in analysis of potential for SO2 and VOC
- National baseline scenario.

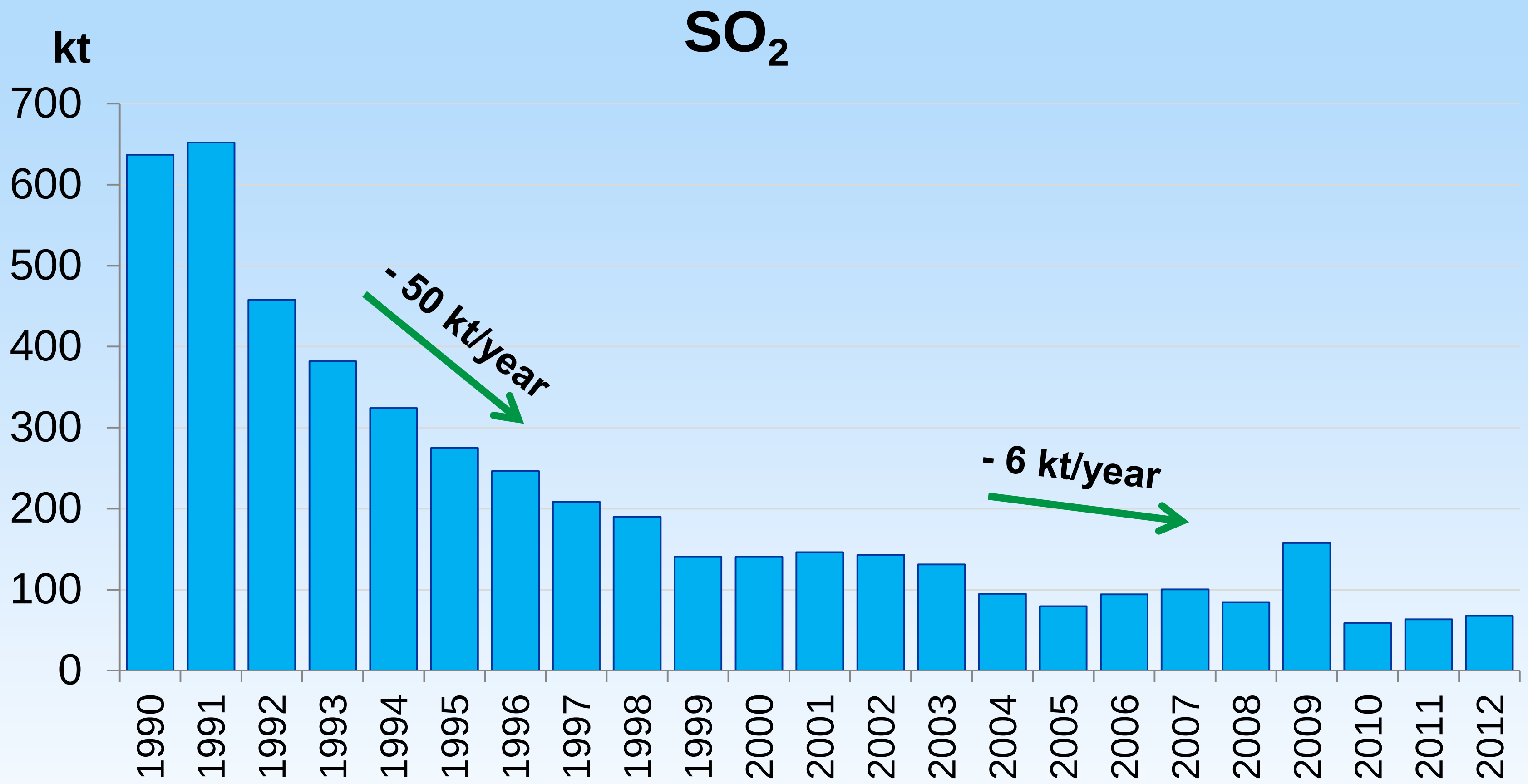
Included into presentation:

- Analysis of current emission trends for Belarus (NO_x, SO_2, PM, and NH_3);
- Comparison of emission trends and projections;
- Discrepancies between the model and the reported sector-specific emissions for 2010;
- Discrepancies between baseline scenario and PRIMES 2013 REF-CLE scenario, their sources and impacts;
- Gaps between the emission scenarios and emission targets for 2020;
- Gaps between baseline scenario and emission targets for 2020 and additional measures.

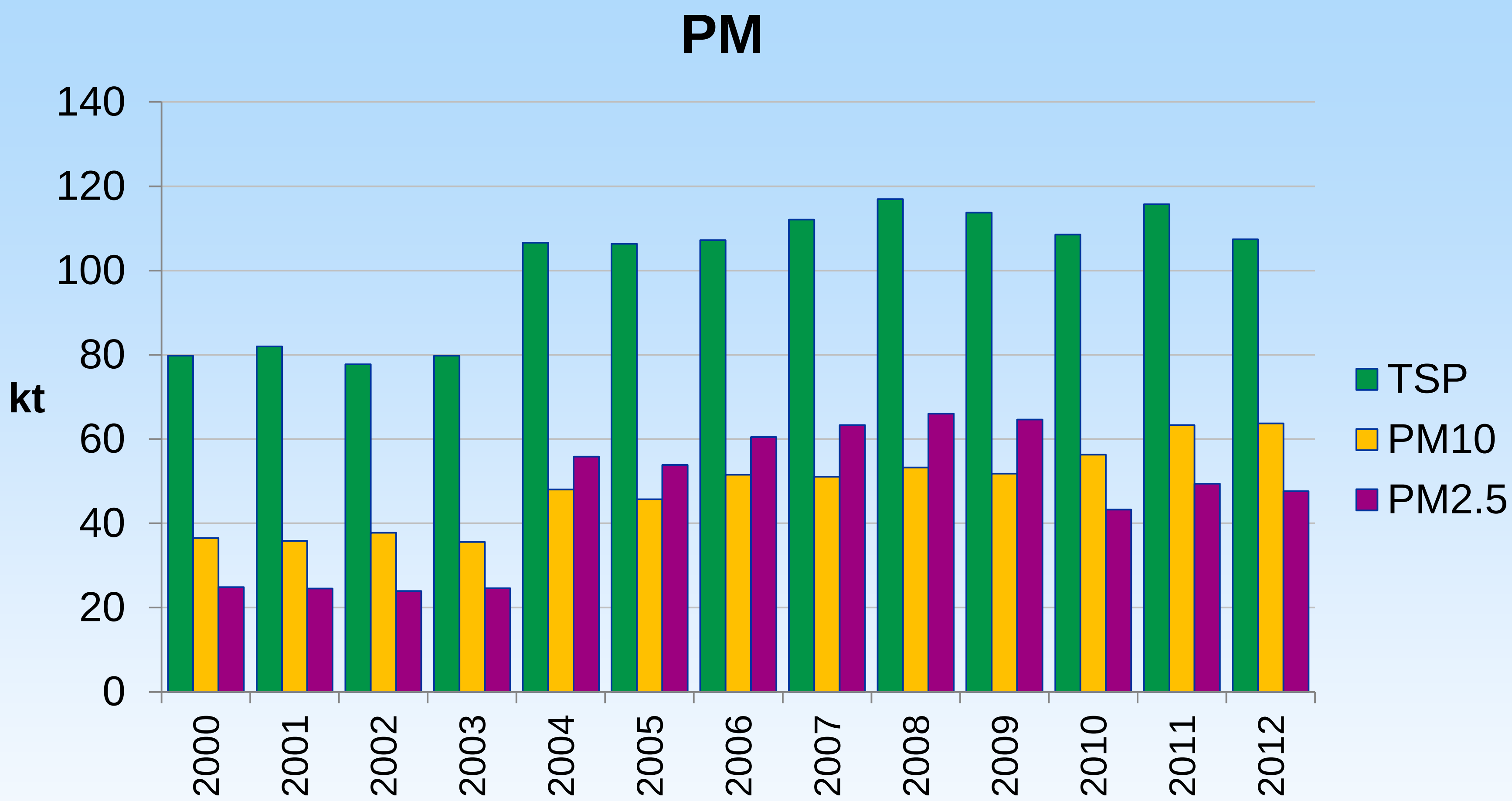
1. Analysis of emission trends in Belarus



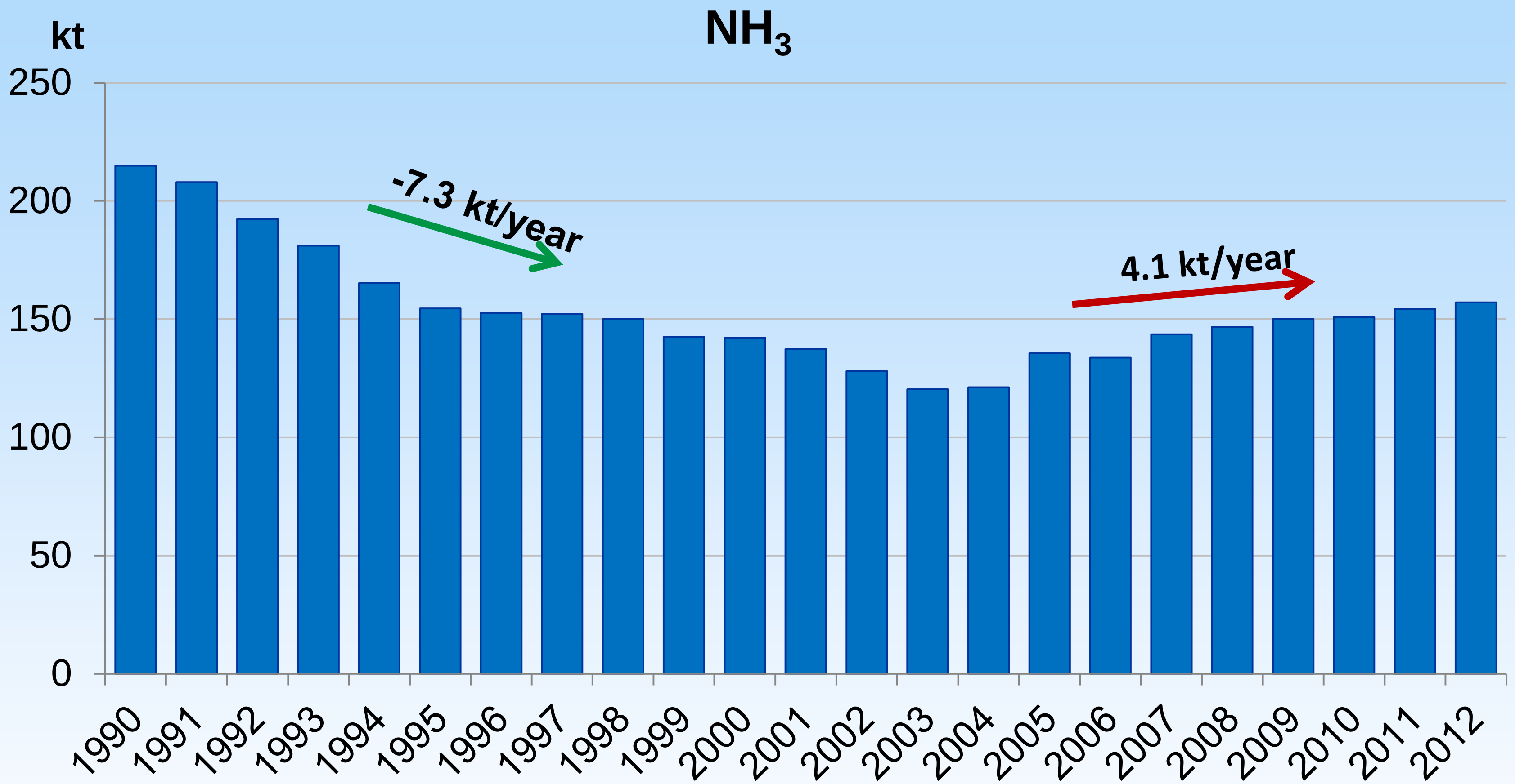
In 2000th general trend is ascending though not fast with some fluctuations. Trend value – 3.4 kt/year or 2.5%/year. Accuracy of trend might be improved though seems of average value.



In 2000th general trend of SO_2 emission is descending with fluctuations sometimes rather sharp. Trend value - 6 kt/year or - 4%/year. Uncertainty of trend seems rather low because of general stability of technologies and accordingly emission factors and abatement efficiencies.



In 2000th general trend of PM emission seems ascending. Trend value is +2,2 kt/year or 6 %/year. Though it needs to be revised: large uncertainty in some sectors due to abatement technology changes not well reflected in emission factors values.



In 2000th general trend is ascending going after activity (livestock) growth. Trend value (2004-2012) – +4.1 kt/year or 3.1%/year. Accuracy is average; improvements are possible though verification possibilities are poor.

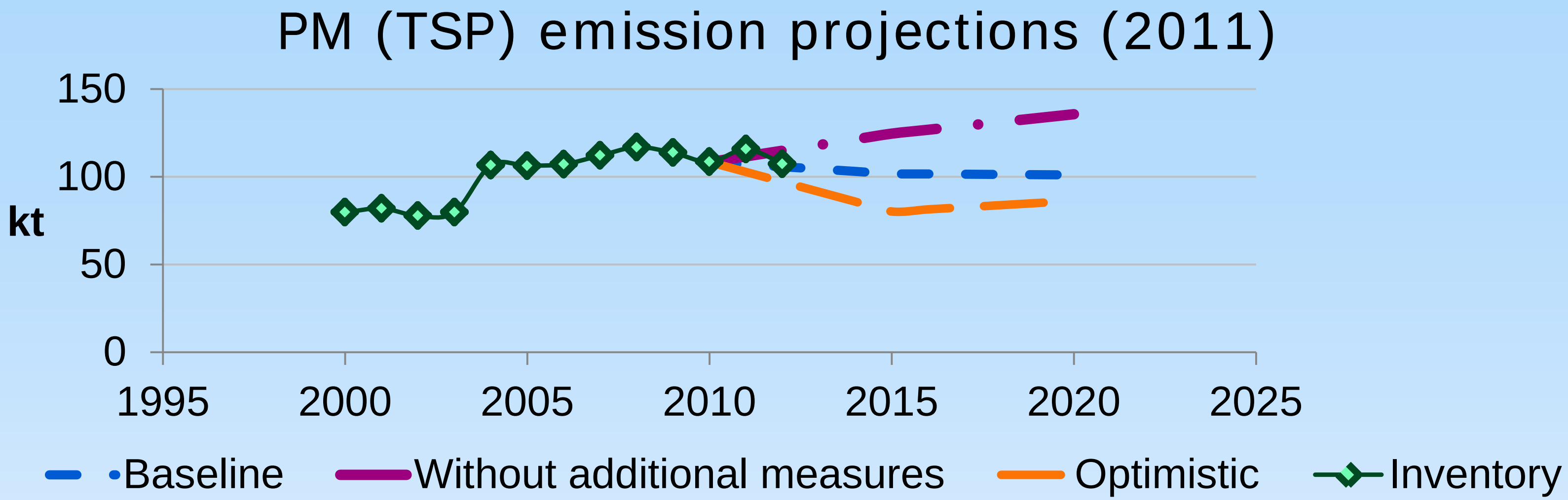
Trend analysis is a supplementary tool to integrated assessment of emission reduction potential: it allows to do emission projection verification, abatement strategies verification.

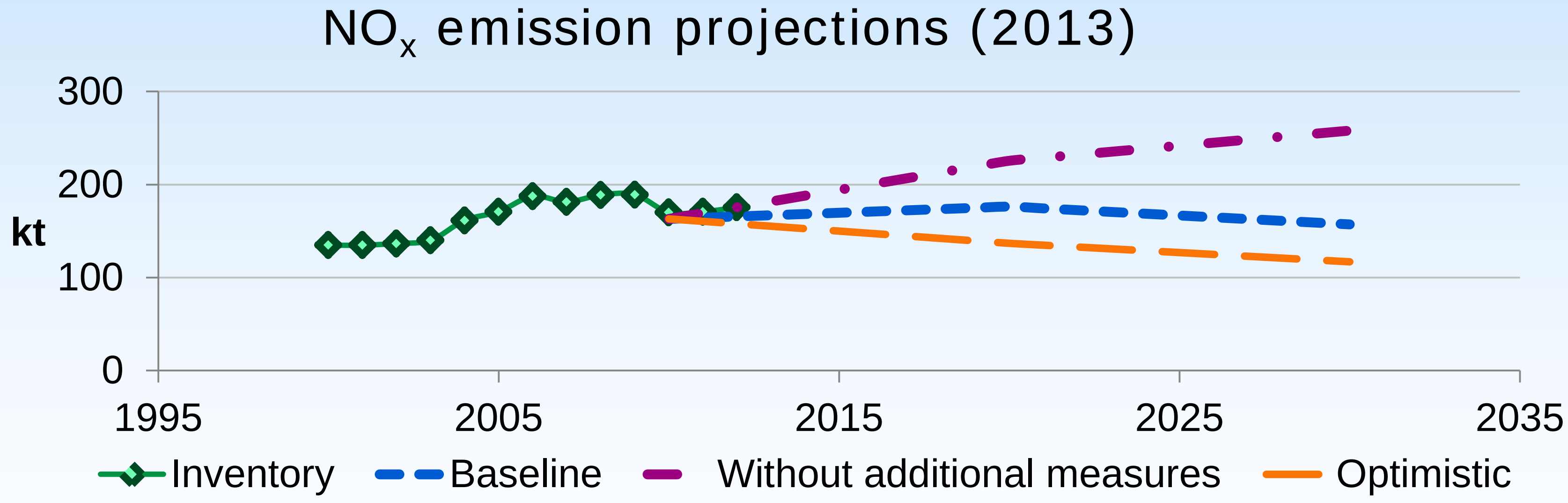
Overall accuracy of emission inventory is average.
It can be placed into the row as: $SO_2 > NO_x > PM > NH_3$.

Uncertainties in emission inventory lead to limited accuracy of emission modeling.

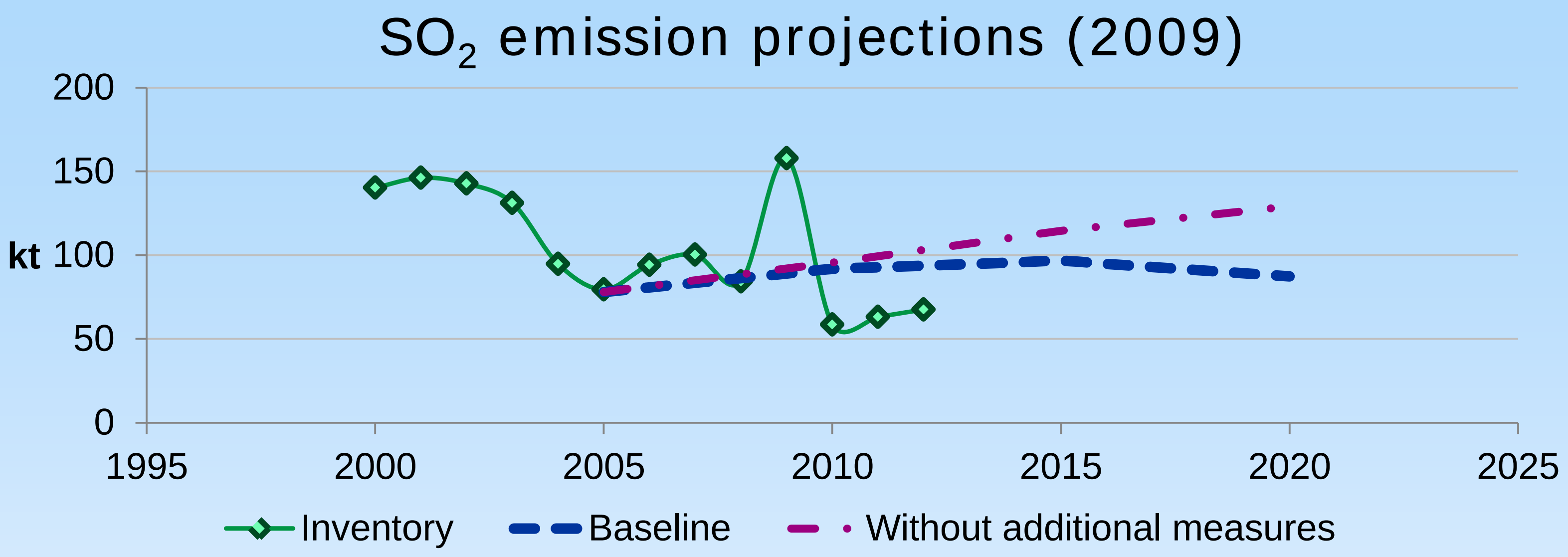
Additional efforts for emission inventory uncertainty reduction are necessary.

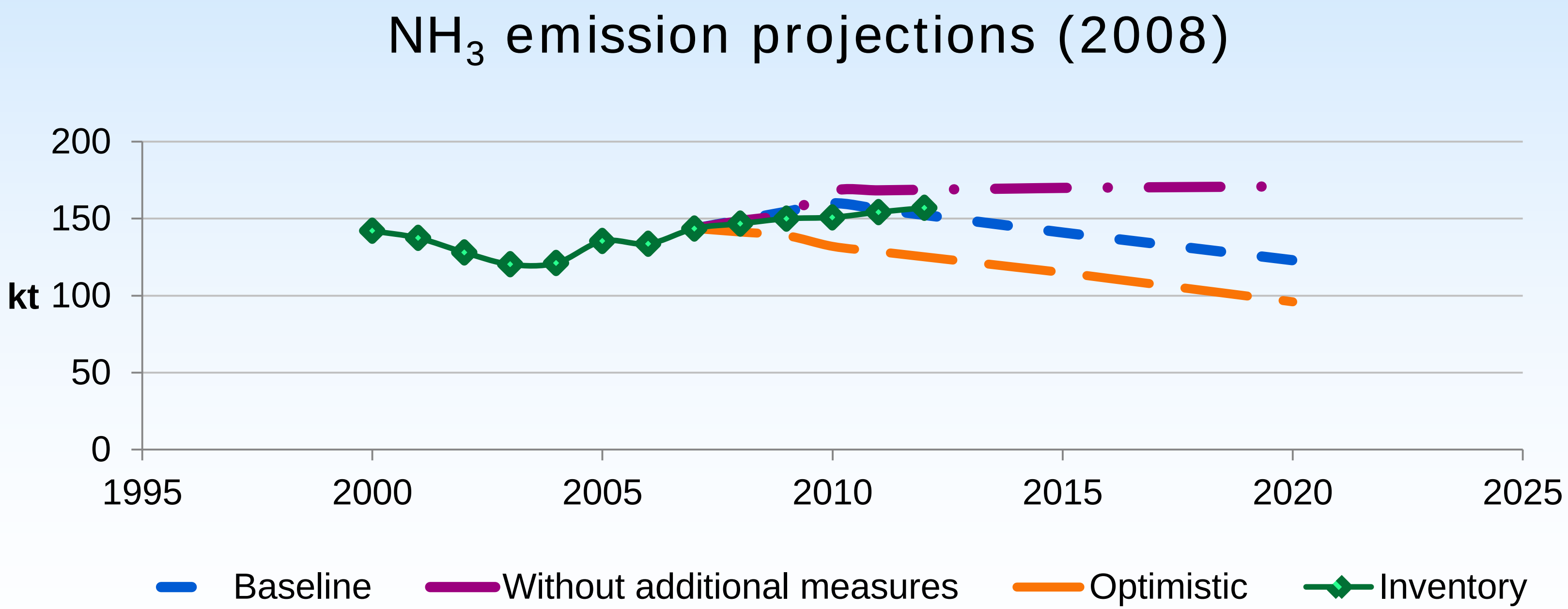
2. Emission trends vs emission projection





Emission values for 2000-2012 were compared to projected values for different scenarios. Current (2010-2012) emission trends correspond rather to scenarios without additional measures.





SO_2 is an exception, its trend is more comparable with value of optimistic scenario.

- All projections were made substance by substance and its socio-economic basis (and GAINS scenarios) is different;
- Projections for NH_3 and SO_2 are relatively old and should be updated;
- One multi-pollutant emission projection based on the latest dataset is required.

3.Discrepancies between the model and the reported sector-specific emissions for 2010

Scenarios for analysis:

PRIMES 2013 REF-CLE (ID: TSAP_Sept2013_P13_REFv3) as IIASA Baseline

p4_c_tr (ID: p4_c_tr) as National baseline

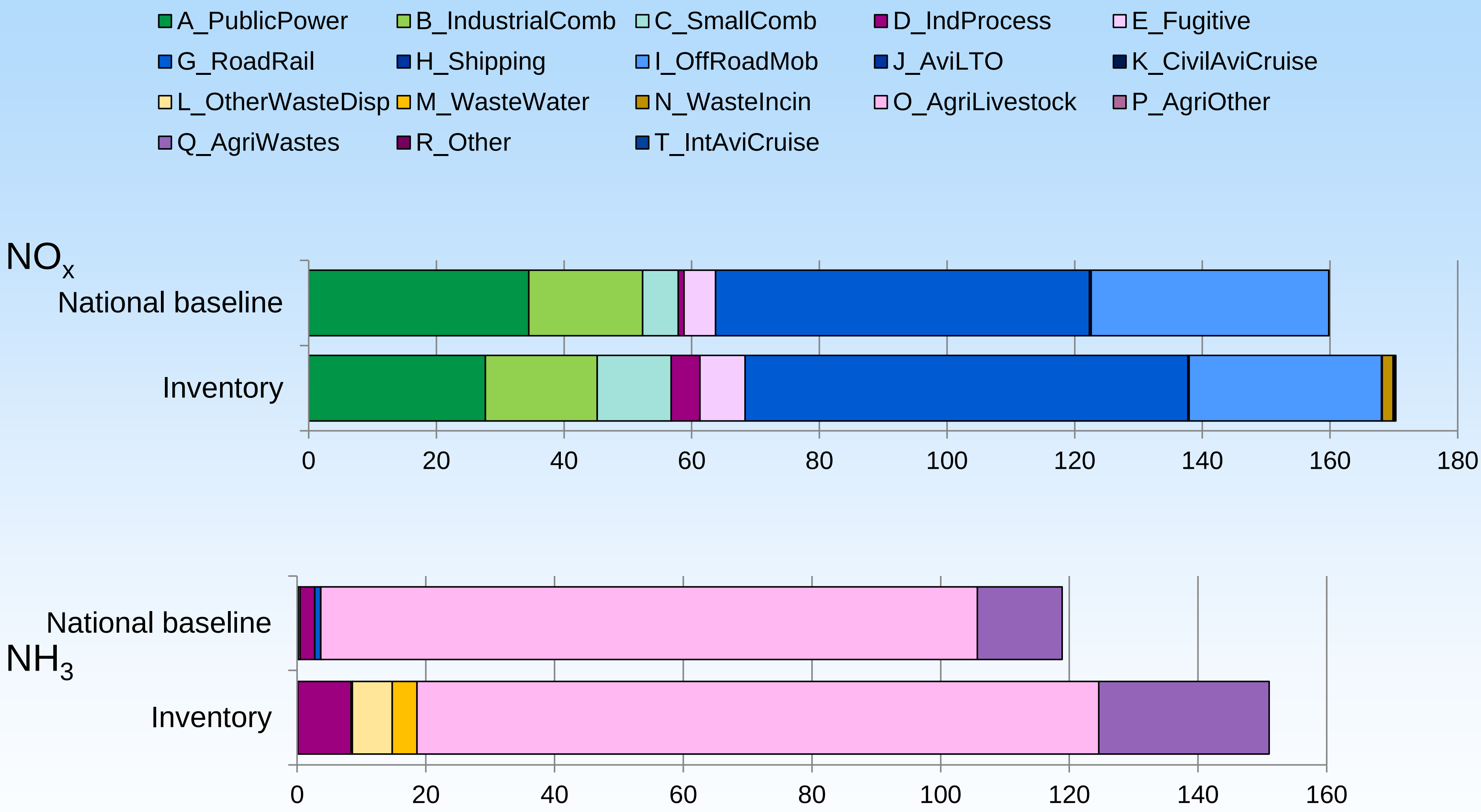
(with natural fleet modernization for road transport)

Scenario	Emissions, kt				
	NO_x	TSP	PM_{10}	$PM_{2.5}$	NH_3
Inventory	170.08	108.53	58.19	45.04	151.05
Baseline	160.14	103.64	72.73	51.26	120.96
Diff, %*	*-6%*	*-5%*	*25%*	*14%*	*-20%*
ΔE	9.94	4.89	-14.54	-6.22	30.09
PRIMES	159.81	97.95	68.45	50.8	152.96
Diff, %*	*-6%*	*-10%*	*18%*	*13%*	*1%*

* Relatively to emission inventory

Sources of inconsistency:

- Activity data
- Control strategy
- Emission factors



A_PublicPower
B_IndustrialComb
C_SmallComb
D_IndProcess
E_Fugitive
G_RoadRail
H_Shipping
I_OffRoadMob
J_AviLTO
K_CivilAviCruise
L_OtherWasteDisp
M_WasteWater
N_WasteIncin
O_AgriLivestock
P_AgriOther
Q_AgriWastes
R_Other
T_IntAviCruise
NO_x
National baseline
Inventory
0
20
40
60
80
100
120
140
160
180
NH_3
National baseline
Inventory
0
20
40
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80
100
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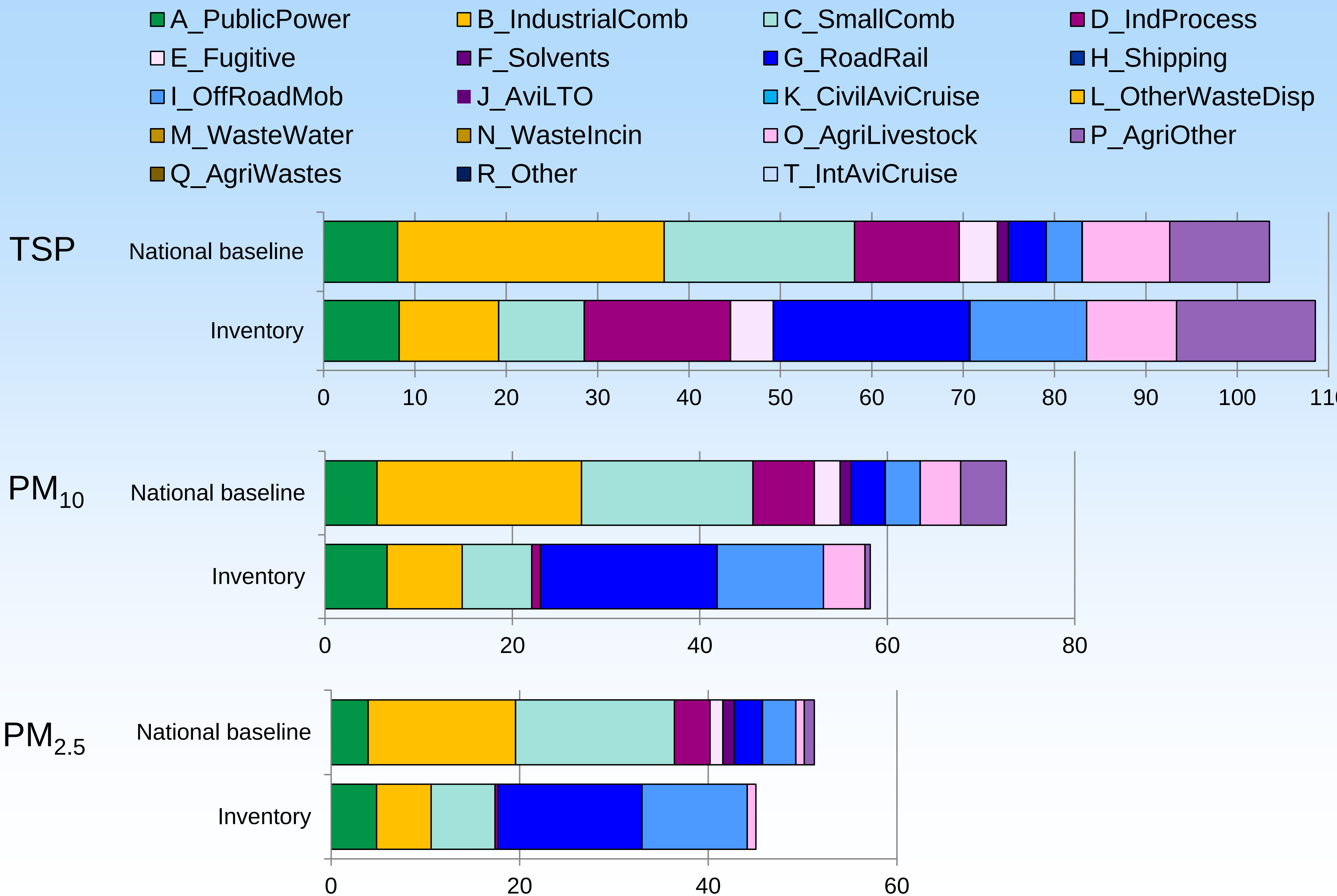
140
160



A_PublicPower
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J_AviLTO
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M_WasteWater
N_WasteIncin
O_AgriLivestock
P_AgriOther
Q_AgriWastes
R_Other
T_IntAviCruise
TSP
National baseline
Inventory
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110
PM10
National baseline
Inventory
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PM2.5
National baseline
Inventory
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20
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60

Discrepancies between Baseline scenario and PRIMES 2013 REF-CLE scenario

Control strategies

Sector (activity)	Technology	National Baseline		PRIMES 2013	
		2010	2020	2010	2020
TRA_RD_HDT (MD)	NSC_TRA	25	10	0	0
TRA_RD_HDT (MD)	HDEUI	23	14	40	3
TRA_RD_HDT (MD)	HDEUII	21	16	10	80
TRA_RD_HDT (MD)	HDEUIII	23	23	0	0
TRA_RD_HDT (MD)	HDEUIV	8	17	0	0
TRA_RD_HDT (MD)	HDEUV	0	15	0	0
TRA_RD_HDT (MD)	HDEUVI	0	5	0	0
TRA_RD_HDT (MD)	HDEUVII	0	0	0	0

Sector (activity)	Technology	National Baseline		PRIMES 2013	
		2010	2020	2010	2020
PR_CEM (NOF)	NSC_PM	0	0	0	0
PR_CEM (NOF)	PR_CYC	5	5	0	0
PR_CEM (NOF)	PR_WSCRB	0	0	0	0
PR_CEM (NOF)	PR_ESP1	0	0	0	0
PR_CEM (NOF)	PR_ESP2	95	95	100	100
PR_CEM (NOF)	PR_HED	0	0	0	0

4. Gaps between baseline emissions and emission targets in 2020

Emission in 2020
by PRIMES 2013 REF-CLE and National baseline scenarios
in comparison with targets

Scenario	Emissions, kt				
	NO_x	TSP	PM_{10}	$PM_{2.5}$	NH_3
Target	**135.1**			**41.1**	**126.5**
Baseline	165.96	112.49	81.27	61.7	127.35
Diff, kt	*-30.86*			*-20.6*	*-0.85*
*Diff, %**	*23%*			*49.8%*	*1%*
PRIMES	165.45	101.49	70.88	52.2	157.2
*Diff, %**	*22%*			*27%*	*24%*

* Relatively to targets

Gaps (relative) between baseline and target emissions in 2020 decrease in line from $PM_{2.5}$ to NO_x and NH_3. In the same order additional measures are required, and resources for reduction increase.

5. Gaps between baseline scenario and emission targets for 2020 and additional measures

Methodology for selection of cost effective measures (by pollutants) includes 4 steps:

1. Assessment of emission reduction potential for each possible measure in addition to baseline scenario (up to 100%)

Sector	Activity	Technology	Activity level	Unabated EF, kt/unit	Removal efficiency	Abated EF, kt/unit	Existing CS (National Baseline scenario), %	Emissions by Baseline scenario	Maximum application, %	Emissions with maximum application	Additional emission reduction by measure, kt (11-sum(9))
1	2	3	4	5	6	7	8	9	10	11	12
…	…	…	…	…	…	…	…	…	…	…	…
IN_OC	GAS	IOGCM	41.255	0.07	50	0.035	60	0.866	100	1.444	0.578
IN_OC	GAS	IOGCSC	41.255	0.07	80	0.014	0	0.000	100	0.578	1.444
IN_OC	GAS	IOGCSN	41.255	0.07	70	0.021	0	0.000	100	0.866	1.155
IN_OC	GAS	NOC	41.255	0.07	0	0.07	40	1.155	100	2.888	-0.866
IN_OC	*GAS*	*sum*						*2.021*		-	-
…	…	…	…	…	…	…	…	…	…	…	…

2. Calculation of cost-effective potential (potential /unit cost)
3. Ranking all measures by cost-effective potential

Parameters of most cost-effective additional measures (NO_x)

Sector	Activity	Technology	Act_unit	Additional emission reduction by measure, kt	Unit cost, MEuro/act_unit	Cost-effective reduction, kt-act_unit/MEuro	Rank
PP_EX_OTH	GAS	POGCM	[PJ]	1.83	0.04	50.53	1
PP_NEW_L	HC1	PHCSCR	[PJ]	6.76	0.17	39.35	2
PR_REF	NOF	PRNOX1	[Mt]	3.00	0.11	27.35	3
PP_NEW	GAS	POGSCR	[PJ]	4.41	0.21	21.21	4
DOM	GAS	DGCCOM	[PJ]	0.77	0.04	20.48	5
IN_OC	GAS	IOGCM	[PJ]	0.58	0.03	19.16	6
PR_REF	NOF	PRNOX2	[Mt]	4.50	0.36	12.43	7
IN_OC	HF	IOGCM	[PJ]	0.32	0.03	10.64	8
IN_OC	GAS	IOGCSN	[PJ]	1.16	0.12	9.40	9
IN_BO_OTH	GAS	IOGCM	[PJ]	0.58	0.06	9.39	10
PR_REF	NOF	PRNOX3	[Mt]	6.00	0.66	9.12	11
PP_EX_OTH	GAS	POGCSC	[PJ]	3.94	0.47	8.37	12
DOM	GAS	DGCCR	[PJ]	1.76	0.25	7.17	13
PP_EX_OTH	OS1	PHCCM	[PJ]	0.22	0.03	6.57	14
IN_BO_OTH	HF	IOGCM	[PJ]	0.32	0.05	6.51	15
IN_OC	GAS	IOGCSC	[PJ]	1.44	0.24	5.94	16
IN_BO_OTH	GAS	IOGCSN	[PJ]	1.16	0.21	5.38	17
PR_CEM	NOF	PRNOX3	[Mt]	5.67	1.10	5.17	18
IN_OC	OS1	ISFCM	[PJ]	0.17	0.03	5.01	19
PR_CEM	NOF	PRNOX2	[Mt]	2.17	0.49	4.40	20

20 measures are shown with ranking by cost-effective NOx reduction (the first priorities are measures in energy sector – CM and SCR)

4. New control strategy with additional measures with the highest rank for each sector (sector-fuel combination) for required reduction

Sector	Activity	Technology	Rank	National Baseline scenario		Scenario with additional measures		
				CS, %	Emission, kt	CS, %	Emission, kt	Emission reduction, kt
IN_OC	**GAS**	**IOGCM**	**7**	**60**	**0.866**	**100**	**1.444**	**-0.578**
IN_OC	GAS	IOGCSC	17	0	0.000	0	0	0.000
IN_OC	GAS	IOGCSN	10	0	0.000	0	0	0.000
IN_OC	GAS	NOC	71	40	1.155	0	0	1.155
Total					2.021		1.444	0.577

Cost-effective additional measures: resulted NO_x emissions and costs

Sector	Activity	Baseline scenario emission, kt	Scenario with additional measures emission, kt	Reduction, kt	Cost, MEuro/Year
PP_NEW_L	HC1	8.445	1.689	6.756	9.67
PR_REF	NOF	7.500	1.500	6.000	16.46
PR_CEM	NOF	9.170	3.500	5.670	10.97
PP_NEW	GAS	5.515	1.103	4.412	22.94
PP_EX_OTH	GAS	6.761	4.930	1.831	3.40
IN_BO_OTH	GAS	2.021	0.866	1.155	8.86
DOM	GAS	3.514	2.741	0.773	2.65
PP_EX_OTH	OS1	1.333	0.666	0.666	2.59
IN_OC	GAS	2.021	1.444	0.578	1.24
PP_NEW	HF	0.690	0.138	0.552	0.92
PR_LIME	NOF	1.331	0.884	0.447	0.24
IN_BO_OTH	HF	1.104	0.788	0.315	0.45
IN_OC	HF	1.104	0.788	0.315	0.27
PP_MOD	BC2	0.391	0.078	0.313	0.58
PP_NEW	OS1	0.764	0.459	0.306	0.95
IN_BO_OTH_S	BC2	0.411	0.176	0.235	0.62
IN_BO_OTH	OS1	0.726	0.519	0.207	0.43
IN_OC	OS1	0.588	0.420	0.168	0.22
IN_BO_OTH_L	BC2	0.411	0.294	0.118	0.15
PP_EX_S	BC2	0.337	0.246	0.091	0.09
PP_EX_OTH	HF	0.173	0.126	0.047	0.03
Total		***54.31***	***23.355***	***30.955***	***83.72***
Required reduction				***30.86***	

Parameters of most cost-effective additional measures ($PM_{2.5}$)

Sector	Activity	Technology	Act_unit	Additional emission reduction by measure, kt	Unit cost, MEuro/act_unit	Cost-effective reduction, kt-act_unit/MEuro	Rank
PR_REF	NOF	PR_ESP1	[Mt]	1.28	0.04	36.15	1
PR_REF	NOF	PR_ESP2	[Mt]	1.35	0.04	32.47	2
PR_REF	NOF	PR_HED	[Mt]	1.43	0.05	29.00	3
PP_EX_OTH	OS1	ESP1	[PJ]	1.49	0.09	16.02	4
PP_EX_OTH	OS1	ESP2	[PJ]	1.58	0.11	13.93	5
PP_EX_OTH	OS1	HED	[PJ]	1.69	0.13	12.75	6
IN_OC	OS1	IN_ESP1	[PJ]	1.11	0.12	9.37	7
PP_EX_S	BC2	WSCRB	[PJ]	1.04	0.13	7.93	8
IN_OC	OS1	IN_ESP2	[PJ]	1.15	0.15	7.87	9
PR_CEM	NOF	PR_ESP2	[Mt]	7.72	0.99	7.82	10
RES_BBQ	NOF	FILTER	[M people]	0.07	0.01	7.58	11
IN_OC	OS1	IN_HED	[PJ]	1.18	0.17	7.03	12
IN_OC	OS1	IN_CYC	[PJ]	0.36	0.06	6.06	13
PR_CEM	NOF	PR_HED	[Mt]	14.74	2.61	5.64	14
PR_FERT	NOF	PR_HED	[Mt]	1.98	0.41	4.86	15
IN_BO_OTH	OS1	IN_ESP1	[PJ]	0.69	0.18	3.86	16
PP_NEW	OS1	FF	[PJ]	0.40	0.10	3.83	17
PP_NEW	OS1	HED	[PJ]	0.40	0.11	3.62	18
PP_EX_S	BC2	ESP1	[PJ]	1.04	0.30	3.51	19
PP_NEW	OS1	ESP2	[PJ]	0.32	0.09	3.41	20

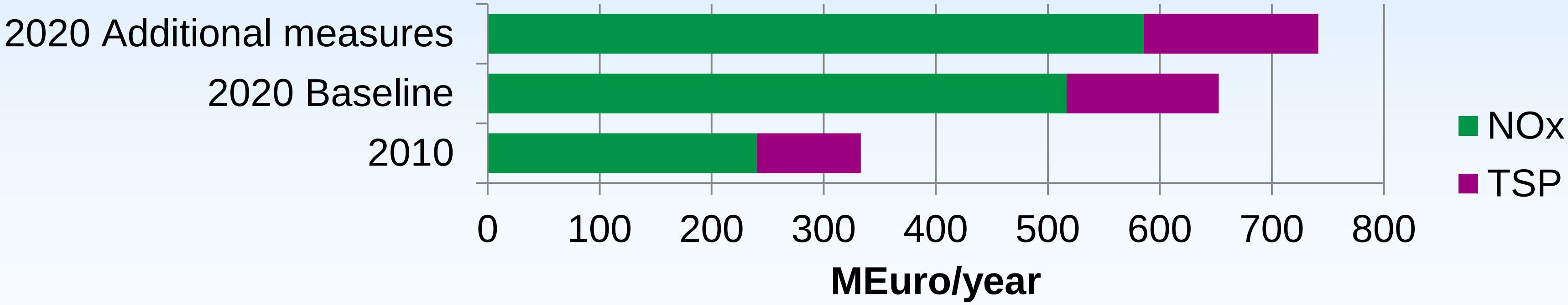
Cost-effective additional measures: resulted $PM_{2.5}$ emissions and costs

Sector	Activity	Baseline scenario emission, kt	Scenario with additional measures emission, kt	Reduction, kt	Cost, MEuro/Year
PR_CEM	NOF	17.082	2.340	14.742	26.12
PR_FERT	NOF	2.172	0.191	1.980	0.43
PP_EX_OTH	GAS	1.708	0.016	1.692	2.27
PP_EX_OTH	HF	1.450	0.168	1.282	0.89
PP_EX_OTH	OS1	1.194	0.012	1.182	1.09
PR_REF	NOF	0.798	0.103	0.695	1.44
Total		**25.089**	**3.448**	**21.573**	**32.23**
Required reduction				***20.6***	

New scenario with additional measures

Pollutant	Emissions 2020, kt	Cost 2020, MEuro/year
NO_x	135.05	585.4
TSP	80.52	155.9
PM_{10}	54.76	
$PM_{2.5}$	38.01	
Total		**741.3**

Costs for NOx and TSP emissions reduction



New scenario with additional measures was developed. Modelling showed that implementation of additional measures may allow to achieve the targets in 2020.

Conclusions

1. Uncertainties in emission trends influence projection verification
2. Emission trends in 2010-2012 correspond rather to scenarios without additional measures with exception for SO_2.
3. Difference between the model and the reported sector-specific emissions for 2010 is quite large (up 25%); such peculiarity of modeling should be kept in mind for interpretation and implementation results of modeling with GAINS;
4. Gaps between national baseline emission scenario and emission targets for 2020 are 30.9 kt for NOx, 20.6 kt for PM2.5 and 0.9 kt for NH3.
5. For indentified gap closure additional measures are required:

   for PM2.5 reduction - in 6 sectors (on 23.7 kt, up to 38.0 kt)

   for NOx reduction - in 21 sectors (on 30.9, up to 135.1 kt).
6. Costs for realisation of additional measures scenario in 2020 are 14% higher than baseline scenario.

Thank you for your attention!