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TASK FORCE ON INTEGRATED ASSESSMENT MODELLING (TFIAM)

39th session, 23-25 February 2011
Stockholm, Sweden

Report by the Chair, with REVISED tables 1 and 2, 29 March 2011

I. INTRODUCTION

1. This report describes the results of the 39th session of TFIAM, held from the 23rd to the 25th of February 2011 in Stockholm, Sweden. The presentations made during the meeting and the reports presented are available at: http://gains.iiasa.ac.at/index.php/tfiam/past-tfiam-meetings.

2. 72 experts attended, representing the following Parties to the Convention: Austria, Belarus, Belgium, Czech Republic, Croatia, Denmark, Finland, Germany, France, the Former Yugoslav Republic of Macedonia, Hungary, Ireland, Italy, Netherlands, Norway, the Russian Federation, Portugal, Serbia, Spain, Switzerland, Sweden, Ukraine, the United Kingdom of Great Britain and Northern Ireland, the United States. Also the Expert Group on Techno-Economic Issues (EGTEI), the Network of Experts on Benefits and Economic Instruments (NEBEI), the Co-operative Programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe (EMEP), the EMEP Centre for Integrated Assessment Modelling (CIAM), the EMEP Meteorological Synthesizing Centre-West (MSC-W), the ICP on Modelling and Mapping, the Coordination Centre for Effects (CCE), the European Commission, the European Environmental Bureau (EEB), the US Clean Air Task Force, CONCAWE, and the Union of the European Electricity Industry (EURELECTRIC) were represented. Representatives from the Working Group on Strategies and Review (WGSR) and the UNECE-secretariat also attended.

3. Mr. R. Maas (Netherlands) and Ms. A. Engleryd (Sweden) chaired the meeting.

II. OBJECTIVES OF THE MEETING

4. The chair of the WGSR highlighted the expected input by the Task Force for the 48th meeting of the WGSR, laid down in the decisions of its 47th meeting and confirmed by the Executive Body (EB) in December 2010. The EB had requested the WGSR to submit a revised Gothenburg Protocol (GP) for its meeting in December 2011 and decided to include Particulate Matter. Provisions in the revised protocol will be needed to increase the possibility for ratification in more countries. Annex 2 of the revised protocol will contain the proposed national emission ceilings based upon

emission scenarios developed by TFIAM and CIAM. A draft of this annex 2 would have to result from the 48th meeting of the WGSR. The EB recognised that more work would be needed on Black Carbon and ozone precursors, but was not inclined to include methane measures in the revised protocol. The EB requested EGTEI and the Task Force on Emission Inventories and Projections (TFEIP) together with TFIAM and CIAM to produce guidance on how to abate BC and PM in a revised protocol. As international shipping also contributes to BC, the International Maritime Organisation had been made aware of this issue.

5. Mr. Maas explained the objectives of the meeting and presented the status of the TFIAM work plan and the findings during its last meetings. He also informed the Task Force about the progress of work of other bodies under the Convention. The EMEP Steering Body had approved Ms. Engleryd to co-chair the Task Force. The WGSR had drafted texts for the revised protocol and most of its annexes. The Task Force on Reactive Nitrogen (TFRN) had developed a draft technical annex on ammonia. The EB had developed a long term strategy aimed at better implementation and more coherence of the existing protocols. From the science perspective broadening the geographical scope and more co-operation with America and Asia is expected.

III. OPTIONS FOR TARGETS IN A REVISED GOTHENBURG PROTOCOL

6. The head of the Centre for Integrated Assessment Modelling (CIAM) presented the technological scope for additional environmental improvement and a number of variants for achievable environmental targets between current legislation and maximum feasible reductions. In total around 4000 variants and sensitivity runs had been analysed. CIAM-report 1/2011 was distributed before the meeting (see: http://gains.iiasa.ac.at/images/stories/meetings/TFIAM39/CIAM2011-1-v3.pdf). The report described a selection of options. New information on measures had been supplied by the TFRN for ammonia, with new cost data and applicability's. Measures for small farms were now excluded. Overall costs now would be lower, with the same potential for emission reduction.

7. The mid ambition scenario is aimed at a 50 % gap closure (between baseline and maximum feasible reductions) for the years of life lost due to exposure to particulate matter, using the European wide optimisation as described in option 4 of CIAM-report 1/2010 presented at the 38th TFIAM-meeting. This mid-ambition scenario was combined with a 50% gap closure of the accumulated exceedance of critical loads for acidification for all ecosystems, a 60% gap closure for eutrophication and a 40% gap closure for the sum of 8-hour mean ozone levels exceeding 35 ppb. For these end-points a country wise gap closure approach was applied as described in option 3 of CIAM-report 1/2010.

8. Costs are most sensitive for the gap closure ambition for ozone. Around the mid ambition case a number of scenarios with higher and lower ambitions was developed. All scenarios implied higher per capita costs beyond the baseline for non-EU

countries than for EU countries, but no country would experience cost increases exceeding 0.6 % of GDP. Calculations were based on a coherent scenario that included climate and energy policies and the effects of the economic crisis (PRIMES-2009). Sensitivity analysis showed for some specific countries and pollutants a disagreement between the PRIMES scenario and the national scenarios for the scope for emission reduction.

9. **The task force took note of the presentation with appreciation and decided to forward the set of scenarios to the WGSR to be used in the deliberations on annex 2 of the revised Gothenburg Protocol.**

REVISED Table 1: Gap closure ambition levels, costs and impacts for various scenarios, 2020, Europe

		2000	2020 BL	LOW	Low*	Mid	High*	HIGH	MTFR	
Ambiton: gap closure % from BL 2020										
Impacts	Health - PM		0	25	25	50	75	75	100	
	Acidification		0	25	25	50	75	75	100	
	Eutrophication		0	25	50	60	75	75	100	
	Ozone		0	25	25	40	50	75	100	
Aadditonal cost above BL 2020										
Costs	million €/yr		0	610	905	2.262	5.380	10.752	69.155	
	% of GDP		0	0,00	0,01	0,01	0,03	0,07	0,45	
Resulting changes from 2000										
Emission reduction%	SO2		60	63	62	68	79	77	83	
	NOx		48	51	51	54	56	60	62	
	PM2.5		22	39	35	50	58	57	71	
	NH3		6	15	25	27	33	30	40	
	VOC		41	46	45	47	48	52	60	
Reduced impacts %	Loss in life expectancy		43	51	51	57	63	63	69	
	Acidification		69	74	76	80	85	84	89	
	Eutrophication		29	36	42	45	50	50	57	
	Premature deaths ozone		32	34	34	35	36	39	42	

[1] Total costs of implementing the baseline measures are estimated to be around € 100,000 mn

REVISED Table 2: Gap closure ambition levels, costs and impacts for various scenarios, 2020, EU27

		2000	2020 BL	LOW	Low*	Mid	High*	HIGH	MTFR	TSAP
Aadditonal cost above BL 2020										
Costs	million €/year		0	245	319	864	2.288	3.807	49.117	**1.501**
	% of GDP		0	0,00	0,00	0,01	0,02	0,05	0,65	**0,01**
Resulting changes from 2000										
Emission reduction %	SO2		74	75	74	76	80	79	83	**76**
	NOx		55	57	58	59	60	62	64	**58**
	PM2.5		39	46	45	48	52	52	67	**46**
	NH3		9	18	27	30	35	32	41	**25**
	VOC		46	49	49	50	51	55	63	**46**
Reduced impacts %	Loss in life expectancy		52	56	56	59	63	63	69	**56**
	Acidification		70	74	76	80	84	84	88	**77**
	Eutrophication		21	28	34	37	42	42	50	**31**
	Premature deaths ozone		34	37	37	38	39	41	44	**35**

10. Scenarios including radiative forcing indicated that additional forcing resulting from the abatement strategy can partly be mitigated at relatively low costs by offsetting cuts in sulphur emissions by lower NO_x, ammonia and black carbon emissions while keeping the ambition levels for the air quality impacts constant. Inclusion of radiative forcing and black carbon are new features of the GAINS model that would require further scrutiny by experts.

11. It was decided that CIAM would make additional country specific information on measures available at the GAINS-website in the coming week. CIAM was also asked

to specify ammonia measures implied in the scenario runs. Additional information on a sensitivity analysis with the national baseline scenario will be made available before the 48th meeting of the WGSR. The assumptions made in the national scenarios on GDP growth, oil prices, energy policy, etc. can be retrieved from the GAINS website (http://gains.iiasa.ac.at).

12. CIAM was requested to open a discussion forum at the GAINS-website where experts could ask for additional information needed for the preparation of the coming WGSR-meeting.

13. The scenarios presented were using the City Delta correction factors for particulate matter for the EU countries, but not yet for non-EU countries. A sensitivity analysis where the urban increment was omitted for all countries had shown only very small changes in resulting emission ceilings (<1%) if they are derived for (relative) gap closure targets. For an impact analysis (of health and materials effects) however, the urban increment should be used. TFIAM suggested that different assumptions on the toxicity of $PM_{2.5}$-species should be part of a sensitivity analysis in the context of an impact analysis. This was also suggested for the possible health impacts of long term exposure to low concentrations of ozone. European-wide optimisation of ozone targets (instead of country-specific) might imply cost-effective shifts in ozone precursor emission reductions between countries. In the target setting approach the ozone target, even though it is a health related endpoint, thus far a country wise gap closure was used, because also ecosystem effects of ozone were involved.

14. The Gothenburg Protocol only requires efforts in certain regions within the Russian Federation, and GAINS assumes measures in the European part of the Russian Federation. WGSR should make clear whether the focus of emission reduction should be on specific regions (oblasts).

15. The chair of EGTEI presented the progress in the development of the methodology to assess the contribution of the ambition levels for emission limit values defined in the draft technical annexes of the protocol to the realisation of the emission ceilings. In Italy the emission limit values for large point sources of PM only covered a small part of the national emissions. If emission limit values in the technical annexes cover only a part of the emission sources, regulation of other (smaller) sources would remain a national responsibility. Also moderate ambition levels for obligatory emission limit values in the technical annexes would imply larger national responsibilities for taking additional measures at the other sources to meet the national emission ceilings. Additional national measures would then be needed in e.g. densely populated countries.

16. **The Task Force decided to encourage national experts to make use of the tool developed by Italy and to informally report the findings to the WGSR in April.** The tool offers a first approximation, but does not take into account the size of the installations. The tool could be obtained from: tiziano.pignatelli@enea.it.

17. The TFIAM chair reminded the participants about a CIAM-presentation in 2008 that showed substantial effects on emissions and impacts on environment and health if 6 selected measures would be implemented in EECCA countries (flue gas desulphurisation for coal and oil fired power plants, low sulphur fuel, primary NO_x-measures for large boilers, PM-measures for large industrial processes, Euro-4/IV standards and electrostatic precipitators). See CIAM-report 1/2008: http://www.iiasa.ac.at/rains/reports/CIAM%20report%201-2008v2.pdf.

18. **The Task Force recommended to clearly represent the 6 key measures in the technical annexes to the revision of the Gothenburg Protocol.**

19. The chair of the ICP on Modelling and Mapping presented work by the ICPs and Task Force under the Working Group on Effects on the impact analysis of the baseline (BL) and the maximum technically feasible reduction (MTFR) scenarios issued from GAINS. The goal of the impact analysis was to provide a more complete rationale for the policy ambition by presenting effects in indicators complementing those in the GAINS model. Biodiversity, crop losses, carbon sequestration and additional information on health risks of particulate matter and ozone were mentioned as relevant elements of such an analysis.

20. Monitoring data had already shown signs of recovery from acidification of lakes and forests. Nitrogen had become the main acidifying component. Recovery would occur faster under the maximum feasible reduction scenario than under the baseline, but severely acidified lakes would still not recover. The risk of biodiversity loss due to eutrophication would be significantly reduced under MTFR. For ozone, interim steps aimed at health protection would not fully protect human health and ecosystems. The use of the flux approach indicated that for the presented scenarios ozone continued to be a concern for crop production although the exact evaluation of the impacts on crops such as wheat still requires scaling the risk to the areas of production. The damage to materials was also projected to be reduced, but the damage in urban areas would probably still be underestimated. All environmental problems were reduced, but none of the environmental problems could be considered as solved by 2020, even with MTFR.

The representative of the CCE presented results of the impact analysis of the 5 ambition levels calculated by GAINS. All proposed that all scenarios reduced exceeded areas and the exceedances of critical loads and target loads. Every step in the sequence of ambition levels BL-LOW-MID-HIGH-MFR (or BL-Low*-MID-High*-MFR) leads (roughly) to an additional non-exceeded area of ~0.5% for acidification (~20,000 km^2 of ecosystem area) and ~3–4% for eutrophication (~120,000–160,000 km^2).

*Table 3: Ecosystem area exceeded (in %) and average exceedance (AAE, in eq/ha) of Critical Loads and 2050 Target Loads of **acidification** in all of Europe (EMEP domain) and the EU27 (total ecosystem areas: Europe: 4.22, EU27: 1.93 million km^2).*

Acidification	**Critical Loads**				**2050 Target Loads**			
	Europe		EU27		Europe		EU27	
Scenario	%	eq/ha	%	eq/ha	%	eq/ha	%	eq/ha
BL_2020	3.5	10.0	6.0	19.4	5.2	32.4	9.1	65.5
LOW_2020	3.0	7.5	5.1	14.7	4.7	28.6	8.3	58.0
Low*_2020	2.8	6.6	4.8	12.9	4.5	27.2	8.1	55.0
MID_2020	2.4	5.2	4.1	10.3	4.2	25.0	7.5	50.7
High*_2020	1.8	3.8	3.2	7.7	3.7	22.6	6.8	46.2
HIGH_2020	1.9	4.0	3.4	8.1	3.8	23.0	7.0	46.8
MFR_2020	1.4	2.8	2.6	5.8	3.4	20.6	6.3	41.9

*Table 4: Ecosystem area exceeded (in %) and average exceedance (AAE, in eq/ha) of Critical Loads and 2050 Target Loads of **eutrophication** in all of Europe (EMEP domain) and the EU27 (total ecosystem areas: Europe: 3.86, EU27: 1.62 million km^2).*

Eutrophication	**Critical Loads**				**2050 Target Loads**			
	Europe		EU27		Europe		EU27	
Scenario	%	eq/ha	%	eq/ha	%	eq/ha	%	eq/ha
BL_2020	36.6	93.7	58.0	164.1	37.5	99.5	60.1	177.4
LOW_2020	32.1	71.8	52.1	126.2	33.0	77.3	54.3	138.8
Low*_2020	29.8	60.0	48.5	105.2	30.8	65.2	50.8	117.2
MID_2020	27.7	53.6	46.0	95.4	28.8	58.7	48.6	107.0
High*_2020	25.2	45.4	42.2	82.5	26.4	50.2	45.1	93.5
HIGH_2020	24.9	45.2	42.1	82.4	26.1	50.0	45.0	93.3
MFR_2020	21.3	33.9	36.2	62.9	22.9	38.1	39.8	72.5

21. **The Task Force took note of the work done on impact analysis with appreciation and advised the Working Group on Effects bodies to analyse the impacts of a reduced set of ambition levels after further guidance from the WGSR in April.**

22. The chair of NEBEI presented recent developments in benefits estimates. A cost-benefit analysis for the EU had shown that when moving slightly beyond the targets specified under the EU's Thematic Strategy on Air Pollution and following a relatively conservative approach to health valuation, marginal benefits still exceeded the marginal costs by a factor of 5. First steps were being taken in the valuation of reduced ecosystem services in polluted areas in a project for UK government, which will be followed up at a European level in the EC4MACS Project.

23. **NEBEI was suggested to analyse the (marginal) costs and benefits of a limited set of ambition levels and present an informal document to the WGSR in April.**

24. NEBEI had continued working on a guidance document on economic instruments to control air pollution. Comments from TFIAM and other experts had been integrated. A new draft would be distributed via email for final comments. Attention

was drawn to a website developed by Ireland giving information on different policy instrument: www.policymeasures.com.

25. A questionnaire on the future tasks of NEBEI and its place in the organisational scheme of the Convention would be sent around. This questionnaire would give input to a proposal to the WGSR.

IV. INTEGRATED ASSESSMENT MODELLING IN EECCA AND BALKAN COUNTRIES

26. The secretariat of the Convention reminded the meeting that in 2007 its Executive Body had given priority to assist EECCA countries in ratifying and implementing protocols. In 2010 a Co-ordinating group led by experts from the Russian Federation (SRI Atmosphera) was initiated. The secretariat assisted in facilitating necessary efforts in the countries. The secretariat also reviews National Action Plans and prepares technical documentation. The secretariat presented the current status of projects in Moldova and in the Balkan region. Other potential countries for similar projects are in Armenia, Azerbaijan, and countries in Central Asia that are members of Convention. Attention was drawn to the SRI Atmosphera 2011 conference in St.Petersburg (15th to 18th of March 2011) and its side events on the Swedish/Finnish/Russian co-operation project (17th of March), and the EECCA country working group project meeting on the 18th. See www.nii-atmopshere.ru.

27. The expert from the Russian Federation has reported about reforms in the State environmental management system and presented results from the Swedish/Finnish/Russian and Nordic Council of Minister co-operation projects. The reform will require improvement of environmental legislation, implementation of advanced environmental standards at the enterprises within the framework of production modernisation, realisation of energy-saving, development of alternative energy sources and raising environmental awareness. Inter alia, this reform is planned to gradually introduce BAT at industrial enterprises. After 2020 all enterprises that are subject to BAT will have implemented the system of technical standards. In the frame of joint projects work had been done on improving GAINS model input data, the construction of source-receptor matrices for the different regions within the Russian Federation using the open source EMEP-model and scenario evaluations for different options for developments in the energy sector and air pollution control strategies.

28. The expert from Ukraine presented the priorities of national models for environment management and integrated assessment. Current models were used to control air pollution, forecasting emergencies related to climate change and assessment of health risks from air pollution. Currently, Ukraine has defined a work plan to implement the GAINS model for the country. Ukraine has collected data for GAINS and presented some of the results. GAINS had been used to explore possibilities for cost reductions and analyse the effect of ammonia emission

reductions in agriculture. The need for further work was recognised, especially to compare the national assessments with GAINS assessments.

29. Experts from Belarus explained the status of air pollution policy and of integrated assessment modelling in Belarus. Belarus had signed three protocols. Legislation is in place for data collection on pollution sources; however the format of the data is not directly compatible with the GAINS model. SO_2 and NO_x emissions had decreased significantly since 1980. Belarus is expecting to deliver a national strategy to the Convention on controlling the emissions of persistent organic pollutants (POP) and heavy metals (HM) and is currently reviewing the remaining barriers for ratification of the POP-protocol. One of the major problems for Belarus is the uncertainty in POP and HM emission estimates.

30. It was shown how integrated assessment modelling activities in Belarus had increased in recent years. Belarus is currently active in GAINS model input data compilation, defining national control strategies and emission scenarios for particulate matter. Work had been done also on GAINS parameterization of emission factors, emission removal efficiencies and abatement costs of particulate matter. Further work was needed to compare the difference between the national estimates and the GAINS estimates for projected emission levels and abatement costs. An on-line version of GAINS using the national parameters would be desirable. Belarus also analysed the costs of different abatement strategies of ammonia.

31. The expert from Serbia presented the current status of emission inventories. Serbia had provided data on sulphur and nitrogen oxide emissions. So far 754 large point sources had reported data on SO_2, NO_x, and particulate matter emissions to the inventories. The main pollution sources are thermal power plants, motor vehicles and industrial activities. 52% of the flue gases from the plants surveyed was reported not to be abated, while data was missing for some 23%. The process to develop air protection legislation in line with EU legislation started in 2010.

32. The expert from the Former Yugoslav Republic of Macedonia informed that Macedonia had ratified the Heavy Metal-, POP- and Gothenburg Protocol in 2010. Macedonia had developed a National Action Plan for its implementation. Emission inventories were in place for air pollutants and greenhouse gases, based on the EMEP/Corinair Guidebook. Integrated Assessment Modelling is planned to be used in the next step of the implementation of the protocol. The emission ceilings in Gothenburg Protocol thus far had been based on the emission data for 2002-2008. Emission projections had not been used yet. Macedonia is currently preparing a new reduction plan and asks for assistance in using the GAINS model.

33. **The Task Force took note with appreciation of the improvements that had been made in monitoring, modelling and policy development in EECCA and west Balkan countries in the co-operative projects and recommended to continue the exchange of knowledge and experience.**

V. OTHER PROGRESS IN INTEGRATED ASSESSMENT MODELLING

34. The expert from the European Commission informed about the current plans to revise the National Emission Ceiling Directive (NECD). While most of the actions under the Thematic Strategy on Air Pollution were on track with the schedule, the review and revision of the NECD was delayed. The current NECD implies a stand still after 2010 and does not include particulate matter. In January commissioners had decided that the EU has to move further as health risks remained to be significant. Additional measures to address ship emissions and emissions from vehicles would need attention. Furthermore agreements on transboundary air pollution and cooperation with Eastern European colleagues would have to be part of the strategy. The link with the climate change agenda was also recognised. A comprehensive revision of air quality directives is foreseen by 2013 at the latest and would also have to look beyond 2020. Public consultations and stakeholder meetings were planned to start mid 2011.

35. CIAM presented the main results of the UNEP assessment on black carbon and ozone. Control of CO_2 is unlikely to reduce temperature increase in the near term, because CO_2 emission reductions will only have a small effect on the total amount of CO_2 that is already in the atmosphere. In addition, the associated reduction of SO_2 will counteract the temperature effect of CO_2 emission reduction in the near term. This motivated an increased focus on emission reductions of short lived climate forcers that can be implemented on a shorter time frame with larger impacts on near term temperature increase, while also having benefits for health and ecosystems.

36. 16 key measures were identified that would have synergetic effects for air pollution and climate change. Diesel particle filters, pellets boilers and a ban of burning of agricultural waste were recognised as important measures for Europe to reduce black carbon emissions. Current policies on $PM_{2.5}$ emission reduction will not automatically imply a focus on black carbon emission reduction.

37. At the global scale, methane measures would roughly constitute two thirds of the potential for reducing radiative forcing from short-lived substances. However, measures in OECD countries would form a minor part of the total potential. Global implementation of the selected 16 measures would drastically reduce radiative forcing in regions over central Africa and central Asia, India and China, but also cause significantly lower radiative forcing in the Arctic region. The 16 measures would imply that the projected temperature increase in the coming decades could be halved. Significant health benefits would occur (mainly in Asia) due to reduced exposure to particulate matter, and there would also be a significant reduction in the ozone damage to crops.

38. **The Task Force took note of the work done in the UNEP assessment and recommended to continue the scientific cooperation on the Northern Hemispheric scale. It also noted that control of short lived climate forcers alone would not be sufficient to solve all air quality problems and that further air**

pollution control measures would be needed. The challenge will be to reduce both CO_2 and SO_2 at the same time.

39. The co-ordinator of the Network of National Integrated Assessment Modellers (NIAM) presented the preliminary agenda for the next meeting on 21-22 March. Several areas had been identified where exchange of national expertise would offer opportunity for further learning. www.niam.scarp.se presents the members of NIAM and provides contact links for further information.

40. Under the FAIRMODE-project working groups are aiming at validating and ensuring quality of national and regional air quality modelling activities in Europe. FAIRMODE has developed guidance documents and FAIRMODE will have a plenary meeting on the 14– 16 of June 2011 in Stockholm. FAIRMODE invited experts to comment on the guidance document developed, available at www.fairmode.ew.eea.europa.eu/.

41. The first European nitrogen assessment (ENA) will be launched in Edinburgh on April 11, 2011, followed by an international science conference on Nitrogen & Global Change. See: www.nitrogen2011.org

42. Under the LIAISE project a toolbox of impact assessment models and tools is set up to assist in impact assessment of policy proposals and improve the science-policy links. See: www.liaise-noe.eu.

43. The Opera project (www.operatool.eu), co-funded by the EU-LIFE+ program, was currently performing an inventory of the national integrated assessment models. NIAM members were encouraged to support this work. The Opera project is aimed at developing a methodology to help regional authorities to implement air quality plans. The ambition is to develop this integrated assessment approach in a software tool (RIAT+), and to apply and compile guidelines for regional integrated assessment modelling.

44. Experts from Germany presented findings of the PAREST project that was aimed at finding the most cost-effective measures to reducing exposure to particulate matter. A cost-benefit analysis, including avoided health risks, had been performed in addition to the PAREST results, with alternative assumptions on the toxicity of particle species based on the HEIMSTA project. Even with a low toxicity assumed for ammonium nitrates and ammonium sulphates, the reduction of ammonia emissions by measures in the agricultural sector and decreased meat consumption, were among the most effective and efficient measures. Other efficient measures included NO_x-measures in industrial processes, improved dust filters for large coal fired combustion plants and some measures in non-road transport. Retrofit of SCR filters of heavy duty vehicles, a 30 km/h speed limit in urban areas, and NO_x-reduction in small gas and oil boilers according to the eco-design directive all had higher costs than welfare benefits, though e.g. co-benefits for climate change were not taken into account.

http://www.umweltbundesamt.de/luft/infos/veranstaltungen/parest2010/index.htm , www.integrated-assessment.eu and www.externe.info contain more information on the methodology and project results.

45. In a study aimed at estimating the personal exposure of $PM_{2.5}$, linkages had been made between outdoor and indoor air quality and the time spent outdoors and in houses and workplaces had been taken into account. Also the urban increment in air quality was introduced. The results show that some 80% of the personal exposure to $PM_{2.5}$ is taking place at home. The personal exposure is to a large extent dominated by smoking and penetration from outdoor sources into the house. It was assumed that for e.g. Germany in 5% of the houses wood burning caused additional exposure. Further research would be needed to enhance the modelling of the exposure from wood burning in houses due to uncertain and lacking data.

46. An expert from CIAM presented a study on how pollution off-setting within a country could increase flexibility in meeting national emission ceilings, and avoid regret investments should new information become available after the ceilings have been set. The analysis maintained the integrity of the original environmental targets as a constraint. The study suggested a potential for developing transparent and efficient rules for off-setting an exceedance of one ceiling by a further reduction of one other pollutant. Therefore, off-setting higher NO_x emissions would not be possible because an exceedance of NO_x would require reductions of several other pollutants to compensate all four environmental impact indicators considered.

47. An expert from the Netherlands presented results of a study of the potential welfare benefits of increased flexibility for meeting emission ceilings. Environmental and health specific emission exchange factors had been determined to guarantee that overall health and ecosystem risks in Europe were not increased when emission reductions were off-set between countries and pollutants. In an economic general equilibrium model (Worldscan) impacts on the economic structure had been taken into account. If no flexibility was allowed, the impact on welfare (measured as the loss in total national income in Europe) would be up to three times higher as in the situation where off-setting was allowed.

48. **The Task Force acknowledged that efficiency gains could be earned, but also saw the institutional challenge to deal with the complexity of off-setting exceedances of emission ceilings in practice while maintaining environmental integrity both domestically and in neighbouring countries.**

49. An expert from the Netherlands informed the Task Force of an ongoing study of the benefits of additional NO_x-reduction from shipping at the North Sea. In order to apply at the International Maritime Organisation to assign the North Sea to be a NO_x-Emission Control Area (NECA) it is required to demonstrate that NO_x-emissions reductions at sea have a greater cost-effectiveness than additional measures on land.

VI. WORK PLAN

50. The 40th meeting of the Task Force will be held in Oslo, 18 – 20 May 2011 (start at noon, finish at noon). A workshop is planned in the fall of 2011 that could be focussed on preparing a scientific background document to the revised Gothenburg Protocol.