



# NOTA DI LAVORO

32.2012

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**Adaptive Policy Mechanisms  
for Transboundary Air  
Pollution Regulation:  
Reasons and  
Recommendations**

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## Climate Change and Sustainable Development Series

Editor: Carlo Carraro

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#### Summary

In the context of transboundary air pollution policy the broad ambition is to achieve reductions in the level of environmental and societal damage associated with certain pollutant concentrations and exposure rates in a cost effective manner. Policy formulation and legislative frameworks in this field, such as the current National Emissions Ceiling Directive in the European Union, are challenged by the degree of scientific complexity involved, the dispersed sources of emissions, and the inherent uncertainties associated with long range forecasting under these conditions. This paper identifies the reasons why varied forms of adaptive policy mechanisms (also termed flexibilities) are necessary and valuable in this arena, presents the critical considerations for their design and operation, reviews a selection of the more prominent options currently considered in the associated transboundary research community, and concludes with recommendations for the next set of transboundary air pollution policy frameworks.

**Keywords:** Transboundary Air Pollution, Emission Ceilings, Flexibility, Adaptive Policy, Integrated Assessment Modelling

**JEL Classification:** Q52, Q53, Q58

*We thank Rob Maas for his support to start this project and Dallas Burtraw for excellent comments on an earlier version of this paper.*

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# Adaptive policy mechanisms for transboundary air pollution regulation: Reasons and Recommendations<sup>1</sup>

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This version: November 11<sup>th</sup> 2011

## Abstract

In the context of transboundary air pollution policy the broad ambition is to achieve reductions in the level of environmental and societal damage associated with certain pollutant concentrations and exposure rates in a cost effective manner. Policy formulation and legislative frameworks in this field, such as the current National Emissions Ceiling Directive in the European Union, are challenged by the degree of scientific complexity involved, the dispersed sources of emissions, and the inherent uncertainties associated with long range forecasting under these conditions. This paper identifies the reasons why varied forms of adaptive policy mechanisms (also termed flexibilities) are necessary and valuable in this arena, presents the critical considerations for their design and operation, reviews a selection of the more prominent options currently considered in the associated transboundary research community, and concludes with recommendations for the next set of transboundary air pollution policy frameworks.

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## 1. Introduction

Cooperative international environmental policy is a challenging, yet arguably necessary, means of managing shared environmental resources and mitigating transboundary externalities. The National Emissions Ceiling Directive 2001/81/EC and the UNECE Gothenburg Protocol have regulated national emissions of selected transboundary air pollutants in the year 2010 to a fixed ‘ceiling’ level. These ceilings were estimated as the allowable combined levels of national emissions which would deliver upon a set of environmental and health related effect targets across the broader defined international region.

The original ceiling setting process for 2010 was underpinned by analysis completed in 1999 and represented a valuable collaborative initiative in regard to the control of emissions and associated effects which carry beyond national policy borders. However, as the 2010 process draws to a close<sup>2</sup>, discussions for future agreements with further ambitions are being actively discussed. Whilst the 2010 ceilings will have undoubtedly achieved significant progress in terms of environmental and health related improvements, there remain a number of lessons to be learned (see Kelly et al, 2010). This paper draws on the experiences from the 2010 process in order to evaluate the manner in which we set and manage future transboundary policy agreements. Specifically this paper considers a fundamental question in the context of long range policy formulation– How do we manage the uncertainties?

The process behind national ceiling setting is complex and dependent on evidence from numerous scientific fields and national agents. Indeed, the determination of ceilings requires a quite comprehensive forecasting of sectoral activity and technologies, as well as a clearly defined scientific perspective in regard to calculating incidence, cause, effect and atmospheric interaction of transboundary pollutants. Clearly this analytical process, which is followed in turn by a political process, includes the potential for considerable uncertainty and this has been borne out from the results of *ex post* analysis in the literature (Kelly et al., 2010, Pilavachi et al., 2008, Winebrake et al., 2006). This paper considers how we can best incorporate a degree of adaptation and flexibility within the

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<sup>2</sup> Compliance review will be based on official inventory results for 2010 .These are generally released in later stages of the subsequent year.

policy framework in respect of how compliance progress and evaluation<sup>3</sup> are managed. In particular the paper focuses upon three classes of flexible mechanisms which would be expected to enable the policy process to reasonably respect the core principles of both cost-effectiveness and environmental performance in the event of unforeseen events. Specifically, our three categories of flexible mechanisms respectively focus upon a) the ceiling set by the regulator, b) the inclusion of an exchange mechanism between gases, and c) the enabling of abatement trading between regulated agents. The paper explores the motivation for including such adaptive policy mechanisms into the legislation, identifying a set of guidelines for their design and implementation, and finally presenting a review of eight specific options that have been actively distilled and discussed within the transboundary air pollution research community<sup>4</sup>.

This paper is structured accordingly. Section 2 sets out the conceptual motivations for inclusion of adaptive policy mechanisms or ‘flexibilities’ in the context of national ceilings for transboundary air pollution emissions. Next section 3 captures the categories of benefits identified by the authors in respect of incorporating adaptive mechanisms into the transboundary policy framework. This is followed in section 4 by an assessment of specific considerations that should be addressed in order to make the benefits of a specific flexible mechanism outweigh its potential cost. In effect section 4 therefore identifies certain risks and costs that may present where these options are introduced. Where relevant the authors also suggest how these risks may be acceptably controlled or mitigated. These ‘pros’ and ‘cons’ are then followed by a presentation and qualitative review of eight selected flexibility options that offer varied scope for the emission ceiling policy mechanism to react to unforeseen events and outcomes. Finally the paper concludes with specific and general recommendations with regard to delivering appropriate levels of flexibility in the emission ceiling

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<sup>3</sup> Flexibility with regard to compliance testing and progression is distinct from allowing some ‘flexibility’ in the manner by which ceilings are originally set. The former concept addresses issues which may persist where absolute ceiling values are set, the latter cannot. A recent report by IIASA describes varied outcomes from alternative means of constraining the analysis that informs the ceilings (Amann et al., 2011). Whilst valuable and sensible with respect to controlling cost, these approaches do not provide any flexibility in regard to the compliance testing aspect of transboundary emission ceiling targets once set.

<sup>4</sup> Specifically, amongst the UNECE Task Force on Integrated Assessment Modelling and the UNECE Task Force on Emissions Inventory and Projections. The latter group, in conjunction with the authors, have recently compiled a technical assessment report of adaptive mechanisms and flexibilities, principally focused on the perspective of inventory teams in regard to managing their introduction (TFEIP Ad Hoc, 2011).

legislation whilst working to preserve both the spirit and scale of the underlying environmental policy ambitions.

## **2. Motivation and background**

One of the greatest challenges in formulating efficient and effective environmental policy and regulation for the future is the uncertainty which can prevail at the time of decision making. With an accurate scenario of the future to hand, and an appropriately calibrated modelling tool, the development of good policy would in theory become largely academic. However, we cannot ‘solve’ the problem of uncertainty regarding the future and as such we must temper our expectations for the role of science, models and expertise in forming effective policy. Holling (1978) succinctly explains ‘Science, models, expert knowledge and the policies based on them are not interpreted as ultimate answers, but merely as a means to guide a cautious process of intervention in complex ecosystems’.

More than 30 years later, this advice remains especially pertinent to the environmental policy challenges facing the world today. To date, even with considerable advances in analytical systems and software, a discussion of the comparatively complex field of agent based modelling suggests that reliance on predictive modelling and optimisation alone is inappropriate. Bankes (2002) notes ‘Policies for complex, adaptive systems will typically need to be adaptive themselves’. Similar warnings are found in the specific context of the transport sector, a key source of transboundary emissions. Marchau et al., (2010) provide a useful discussion of dynamic and adaptive transport policies, concluding that in contrast with traditional policymaking, adaptive policies are a highly promising approach from a rational point of view, in so far as they allow policy to respond to new events and evidence and thereby remain robust in the event of the unexpected. This in turn can lead to more rapid deployment of what should remain as ‘no regret’ policies and broader cooperation from participants.

In a presentation of supporting tools for creating adaptive frameworks, albeit on a more local level, Swanson et al. (2010) touch on a number of relevant challenges also faced by international policymakers operating in complex, dynamic, collaborative and uncertain settings. Indeed, their seven tools include approaches that are relevant and well established in setting policies for international

transboundary air pollution. They touch on topics such as integrated analysis, forward looking scenarios, review and improvement of methodologies and stakeholder engagement. They also mention the role of built-in policy adjustment mechanisms. That is some system which allows for certain conditions to trigger a change in the policy as necessary. However, such a mechanism is precisely what remains missing in the field of European transboundary air pollution policy. In particular neither the National Emissions Ceiling Directive, nor the Gothenburg Protocol, leaves any freedom for the regulating authorities in the participating countries to exploit flexible or adaptive compliance mechanisms. The only freedom is the freedom to choose which options to engage to meet the defined level of abatement for each pollutant that will deliver compliance with the ceilings. Whilst *ex ante* modelling works in principle to ensure that options exist and the policies make sense, over time revisions to abatement technology efficiency, economic development or effect estimation, can all change the game (Kelly et al., 2010). The issue is that there is no allowance made for new outcomes or new evidence to influence the ceilings. In effect the ceilings are defined once and set in stone.

Environmental policy governed by principles of cost-effectiveness lies at the heart of efficient and sustainable resource use both economic and environmental. Where the future differs from the modelled projections at the time where legally binding environmental constraints are set, the burden of cost may rise, and the benefit may fall. Similarly, costs may fall and benefits could grow. This is important and it should be made clear at the outset that flexibilities are not focused only on shifts that allow higher levels of emissions. Indeed high *ex ante* estimations of cost may preclude greater ambition through concern of great expense and insurmountable challenges under inflexible policy frameworks. In fact, rigorous *ex post* assessments (e.g. (Harrington et al., 2000) indicate that cost of emission reduction are often much lower than anticipated. Under these circumstances the emission ceiling under an inflexible process, can in effect become an emission floor (Burtraw et al., 2010).

Whilst imposing additional environmental constraints will of course generally be positive for the environment, emissions abatement investments and policies face opportunity costs and could in some cases present potential challenges for other aspects of the economy e.g. competitiveness, welfare. As a result it is an important and challenging goal, to ensure that the benefits of policy actions are balanced and that abatement policies and investment represent an effective and rational allocation

of resources. In the transboundary context we argue that flexible mechanisms can provide a means of appropriate response and can serve to mitigate the risk of ‘cost-ineffective’ policy or investment decisions being forced by legislative inflexibility.

### **3. Considerations for inclusion of adaptive policy mechanisms – “The Pros”**

We believe that the need and justifications for flexible and adaptive policy mechanisms can be set out qualitatively through a number of considerations<sup>5</sup>. These considerations, in a sense, also reflect what might be gained by a more explicit acknowledgement of the limitations of the current inflexible approach. For this reason we focus in this section on why flexibility might be an appropriate element of any air quality policy mechanism design.

#### *Uncertainty of the future*

One of the main challenges of imposing constraints on behaviour through current policies is to reduce uncertainty with respect to the future. Unexpected events may exacerbate the cost of policy while a more flexible approach might alleviate this burden. Running scenarios for the future to address such uncertainties is not enough. Scenarios are illustrative. They are not predictions. Related to this, sensitivity analysis does not actually incorporate any flexibility into the process. Thus neither of these aspects of the ceiling setting process addresses the potential for unforeseen events to influence the expected outcomes. Uncertainties will persist and the running of multiple scenarios and sensitivities that ultimately settle on a single emission ceiling value will not address this issue (King et al., 2011).

Indeed, contemporary evidence highlights the potential for the unexpected across a range of relevant issues. Consider for example the implications of the ongoing international economic crisis on investment and activity. Also we have the specific and quantified technical failure of certain vehicle euro standards to deliver the expected on road abatement (Tzamkiozis et al., 2010, Kelly et al., 2010). A further example may be the impacts of the Eyjafjallajökull ash clouds of 2010, in regard to issues such as travel and welfare (Miller, 2011) and the moderate direct impact on emissions and air quality

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<sup>5</sup> A quantitative assessment is not feasible without defining specific structures of individual flexibilities and conducting multiple scenario assessments to identify a range of outcomes. This would unduly narrow the focus of our paper which is examining the broader motivations, design factors and considerations of a flexibility mechanism package.



(Collete et al., 2011). And a final recent example is the Japanese tsunami of 2011, which had a devastating direct impact far away from Europe, but which has impacted indirectly on the nuclear industry across the globe (The Electricity Journal, 2011). In this latter case there are potential corresponding impacts for air quality where alternative power generation sources may ultimately introduce additional pollutants. The message is simply that all manner of specific and general events and outcomes may deliver an impact which alters important variables in the modelling process. A mechanism to account for this prevailing uncertainty is necessary.

To set policy without flexibility is to place undue confidence in long range forecasting and assumptions. Doing so effectively indicates that irrespective of outcomes or new information in the intervening years, we remain suitably satisfied with our prescience on matters both economic and environmental to set a fixed policy in place ten years from now. This continued approach may serve to limit existing support and dissuade new participants. Specifically, this may limit engagement from neighbouring developing economies where – in the case of the Gothenburg Protocol – ratifications could offer significant and cost-effective benefits for the European region by extending the process to new areas where more cost-effective abatement actions for transboundary air pollutants can be found.

#### *Role of complementary policies*

One particular area that further adds to the uncertainty about future impacts of air pollution policy and which might justify flexibility are complementary policies like climate policy. Air pollution policies do not exist in isolation. They are often closely linked to other regulatory efforts to reduce emissions from combustion, such as GHG regulation.<sup>6</sup> In practice, a variety of pollutants may be affected by efforts to control any individual one. Furthermore, the responsibility to control these pollutants may be split among different authorities. Such splits in responsibility may occur when the authorities operate at different levels of government or are accountable for discharges into a particular media (e.g., air, water, soils). These complications create new uncertainties for air quality regulation

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<sup>6</sup> Another example in the new U.S.A. program to reduce mercury and other air toxic emissions, is called the Utility Mercury and Air Toxics Standard (MATS). This program effectively requires all plants to have either scrubbers or dry sorbent injection (removing 60-70% of SO<sub>2</sub>) within a decade. As a consequence of these stringent requirements, it is anticipated that trades under the new program to regulate SO<sub>2</sub> and NO<sub>x</sub>, called the Cross State Air Pollution Program, would be expected to go slack, with yet further issues in regard to the undermining of confidence of participants and investors in programs with bankable trading permits.

An important and not unlikely case is that climate policy, and specifically national GHG abatement obligations, will lead and supersede any developments in the transboundary air pollution policy arena. If climate policy targets must be met irrespective of other policy, climate policy thereby creates its own constraint with regard to national use of any of the potential flexibilities. For instance, the current discussion on tightening the level of allowable SO<sub>2</sub> emissions in the U.S.A by the U.S. Environmental Protection Agency (EPA) strongly interferes with U.S. efforts to regulate carbon dioxide. Indeed, multi-pollutant regulation creates problems on its own (Evans et al., 2011). In the U.S.A example, the cost of obtaining the SO<sub>2</sub> cap will fall along with the price of emissions allowances. Faced with this possibility, the U.S. EPA may want to adopt a ‘symmetric safety valve’ regulation that automatically adjusts the allowable level of SO<sub>2</sub> if a CO<sub>2</sub> cap was adopted (Burtraw et al., 2010). Similar considerations apply to the European Union with its current regulation of CO<sub>2</sub>-emissions through the European Union Emissions Trading System. These examples clearly illustrate the need to assess the co-benefit or trade-off implications of air quality flexibilities. Such analytical capacity may be offered via the air and climate integrated assessment models already in use in this arena in Europe (e.g. GAINS Europe<sup>7</sup>).

#### *Risk of the use of additional policy instruments*

Technological solutions currently defined within the modelling systems may not in practice offer sufficient scope at reasonable cost for abatement plans out to 2020. This is almost certainly the case in the context of greenhouse gases where there are a limited number of technology based solutions available, and where there are constraints on the realistic scale for deployment within the next ten years in Europe. As such we can generally expect abatement strategies to increasingly turn toward the use of ‘non-technical’ or behavioural measures in the drive for further reductions e.g. carbon taxation, road pricing. Such ‘non-technical’ measures are not adequately captured (in regard to costs, benefits or emissions impacts) in the existing ceiling setting frameworks in Europe and their increasingly relevant role will introduce an added degree of uncertainty to the process, as their influence is both more

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<sup>7</sup> The GAINS Europe model is available at <http://gains.iiasa.ac.at/index.php/home-page>

variable and unpredictable than technological solutions. For example, the effect of the same non-technical measure (e.g. carbon tax, road pricing) over time, in different locations, and under varied economic conditions may exhibit considerable variation, and is certainly more complex to model and project. This is not to suggest that their costs will be very high, or their performance insignificant. However at present neither their cost nor their potential is adequately incorporated in the European region emissions ceiling setting processes. Ultimately, their formal and full inclusion or their continued partial exclusion will be relevant to the process and the associated uncertainty of outcomes.

#### *Reduction of information asymmetry and learning*

Introducing flexibility is likely in a number of cases to reduce the information asymmetry between regulators and countries or firms, in particular the lack of knowledge of country or firm specific options to reduce emissions at low cost. Regulator assessments of the potential policy responses from regulated agents to a given target will always be somewhat limited to the extent that regulators will face difficulties in having complete oversight on all available *ex ante* options and their cost. Moreover, this lack of knowledge *ex ante* is usually biased in favour of overestimating cost of compliance which, in turn, is likely to result in less strict ceilings relative to the case where abatement cost information is known *ex ante*. Indeed, evidence exists that regulatory costs estimated *ex ante* often turn out to be much lower under *ex post* review (Atkinson and Tietenberg, 1982, Ellerman et al, 2000, Harrington et al., 2000).<sup>8</sup> So even though countries or firms are free under the Gothenburg/NECD protocol to select their own abatement options, there is still serious risk of biased cost estimates which impair negotiations and ceiling setting.

It should also be noted that *ex ante* independent assessments may overlook abatement options other than technological fixes whereas, in practice, a whole array of abatement options are open to the regulated agent. Actually, this lack of information might even apply to the firms themselves if the regulation is designed in such a way that they are presented with no incentive or opportunity to

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<sup>8</sup> Burtraw and Szambelan (2009) also offer a concise and well documented explanation of the development of the US SO<sub>2</sub> and NO<sub>x</sub> trading markets and their *ex ante* and *ex post* assessments.

discover or engage such options. With inflexible regulation therefore, both the regulated agent and the regulator may be constrained to such an extent that they fail to learn about alternative options.<sup>9</sup>

One notable example was the shift by electricity firms in the U.S. towards low-sulphur coal. Under the US SO<sub>2</sub> emissions trading program the electricity firms' SO<sub>2</sub> emissions are capped in a manner similar to more rigid, standard setting rulings. However, firms were allowed to select their own abatement strategy and trading is possible. Analysis by Arimura (2002) found that it was a policy reform in a completely different arena which strongly contributed towards a shift to low-sulphur coal as the predominant measure employed. Specifically, it was rail deregulation, which resulted in a reduced cost for the transportation of low-sulphur coal from the Western States towards the East. The outcome from a cost perspective being that compliance with the cap turned out to be far cheaper than previously calculated and anticipated *ex ante*. The point in this case is that the flexibility provided by regulatory programs was helpful also for regulators (and modellers as well!) to learn more about alternative, cheaper options to comply with their regulatory cap. Indeed, the cost of inflexibility of regulatory programs can be substantial if such information becomes available *ex post* as has been shown recently by Burtraw et al. (2010).

#### *Missing capacity for implementation*

A final consideration in favour of flexibility is that the current *ex ante* modelling and ceiling setting process is complex. Recently joined EU member states, and bordering countries, including Eastern Europe, the Caucasus and Central Asia (EECCA), that are relevant to the transboundary pollution problem may at present lack in some cases sufficient capacity and technical expertise for satisfactory engagement in setting new ceilings for 2020 or beyond (indeed many established participating countries face this challenge). This highlights the importance of capacity amongst participants, and indicates a potential source of additional uncertainty for the 2020 process. A package of flexibility mechanisms would not remove the need for well-developed national capacities, but it would allow some space for error as these capacities develop further.

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<sup>9</sup> So it is far from clear whether information asymmetry is likely to be exploited by the regulated agent to prevent stricter regulation *ex ante*.

#### **4. Considerations for design, implementation and operation – “The Cons”**

There are also potential costs associated with the introduction of flexible mechanisms, although conversely (and already explained in the previous section), there are potential costs as well where they are not available. However, some of the risk of additional cost from the presence of flexible mechanisms may be mitigated through careful mechanism design. For this reason we focus now on both the considerations to be acknowledged as a part of mechanism design, as well as the potential costs that may arise and which should therefore be factored into the broader debate on the value of specific flexibilities in terms of risk and reward.

##### *Effect protection*

A first concern is that, in principle, introducing more flexibility might impair the effect objectives of the transboundary policy. In such a case the gains of more flexibility would at the same time induce serious environmental harm. However, the flexibility we consider in this paper is intended to enable alternative pathways to a specific outcome but not the outcome itself.<sup>10</sup> Only at a higher level may it be worth considering whether it is specific effects and outcomes that we as a society wish to achieve, or if we are content with policy where the benefits (regardless of where and how they are derived) are estimated to comfortably outweigh the costs? If the latter is the case then far more potent flexibilities could be introduced, but at the potential expense of say environmental impact reductions relative to health impact reductions. The decision in this case is ultimately a political choice as to whether we just want net benefits or if instead we want a balance of improvements across environment, health and so on.

Regardless, it remains important to recognize that exceptions to the notion of maintaining the net environmental effects in a policy process may be justified under certain outcomes. Particularly in cases where the cost of the required abatement actions, even in combination with the available flexibilities, is ultimately determined to outweigh the net benefits to society. This is not an efficient use of resources, but of course it is necessary to dissuade participants from believing that sustained

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<sup>10</sup> Economists will recognize here the difference between focusing on cost efficient and optimal policies. In this paper we abstain from discussing how the degree to which uncertainty with respect to the benefits and costs of an environmental problem might affect optimal targeting of this policy or the choice of policy instruments (compare also Baumol and Oates, 1988).

inaction (and an expected growth in the cost of achieving a target) will be rewarded. It is suggested instead that exceptions would be justified in cases where a policy or information failure, rather than a failure to act, led to non-compliance. In such cases, where compliance can only be achieved through very costly short-term interventions that outweigh the expected marginal benefits of the action it would seem sensible to waive the effects protection guideline, engage appropriate flexible mechanisms and enable resources to be more efficiently allocated.

#### *Minimum air quality values*

As a related issue we note that certain flexibilities may offer the possibility of increasing emissions in one area in exchange for a corresponding or otherwise equivalent reduction elsewhere. Whilst net effects may be unchanged under such a system, the risk is that without some constraint on emission rights, certain local areas may suffer too much from higher localised emissions and associated effects as a direct result of such flexibility (Atkinson and Tietenberg, 1982, Atkinson, 1983). This type of undesirable outcome could be, and actually has been addressed in principle by the introduction of minimum ambient air quality (AAQ) values in separate legislation. Indeed, this approach has been adopted in the US ,where the National Ambient Air Quality Standards remain in effect even when there are trading programs for SO<sub>2</sub> and NO<sub>x</sub> at a regional or national level. In terms of a design proposal then, flexibilities could be constrained where they pose a risk in regard to local compliance with these AAQ levels. Whilst monitoring and constraining flexibilities in this regard may be no trivial task, it is believed that a mechanism could be developed such that a series of AAQ breaches, or upward local emission trend changes in an area, would restrict the potential for related flexibility use. The existing infrastructure for monitoring and managing the AAQ legislation would be of considerable support if complemented with additional monitoring and mapping of sources in a given region.

#### *Balanced effects mitigation distribution*

Another concern particularly relevant in the policy arena of transboundary air quality relates to the international distribution of benefits from effect mitigation. As distinct from the minimum air quality

values concept, it is important to also consider the balance of effects mitigation distribution amongst participants and how this may be generally altered via the inclusion of flexible mechanisms. Whilst flexibilities may be introduced which endeavour to maintain the aggregate effect targets of the policy process, it may also be necessary to ensure that sufficient policy benefits still accrue within the borders of all participants. In other words, the benefits from the overall policy – even after the application of flexibility – are distributed in a somewhat balanced manner throughout the participating community. This concept is particularly important in the context of transboundary air pollution policy where the motivations for collaboration and agreement have their roots in each party contributing but ultimately being a net beneficiary of the broader community action. Thus whilst some may benefit to a greater degree than others<sup>11</sup>, all parties are net beneficiaries of the agreement. Flexible mechanisms may alter this balance and perhaps this would create political challenges in “selling action” within countries.

On a related note, recent analysis conducted at IIASA by Amann et al. (2011a) has examined the implications of setting the ceilings based upon ‘European wide’ achievement of effect targets (irrespective of the focus and location of abatement), versus a national specific, or otherwise more evenly distributed share of effort and benefits. The results indicate a more cost-effective attainment of objectives for Europe under the ‘European wide’ approach, though the implications for individual nations and ecosystems are consequently more ‘uneven’ than under the status quo. Nonetheless if such an approach is acceptable then perhaps there is adequate precedent for an uneven distribution of net benefits to allay concerns in regards to this potential risk.

#### *Transaction costs and national capacities*

Another caveat is that effective management of a given flexibility may add to the administrative burden and other transactions costs associated with the current system of defining ceilings and examining compliance intermittently. Integrating these flexibilities to the framework could require more regular monitoring and revision so as to ensure that the systems operate as intended and also that a path to the overall environmental objectives is maintained. Indeed a recent report by an ad hoc group of the UNECE Task Force on Emissions Inventory and Projections, considered flexibilities with a

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<sup>11</sup> See for example any of the cost-benefit studies conducted in relation to transboundary air pollution policy such as AEA (2011)

strong focus on the possibility of additional transactions costs for their members as emissions inventory and projections professionals (TFEIP ad hoc, 2011). The additional transaction costs are certainly a consideration to be evaluated for any prospective package of flexibilities. However, related to this point, there are benefits to accrue from a more regular, yet still reasonable, schedule of engagement for stakeholders and modelling teams that would be necessary in respect of some of the proposed flexibilities. Specifically, broader engagement and regular interaction will help to identify potential problems in the process and will offer a mechanism through which the parties can discuss appropriate responses in good time. This active participation will also help to further develop adequate national capacities which should in turn support policy responses from participants and thereby deliver sustained progress on targets.

Related to regular monitoring and revision it is also suggested that these improved national capacities are required, not only for the operation of any of these proposed systems, but also in a more general context to ensure that comparable rigour is invested in providing information upon which these systems may be built and by which they will operate. The necessary degree of national engagement in both the modelling and formal reporting requirements should be integrated into the legislation as a means of enhancing the quality of the evidence base and modelling upon which ceilings are set, and progress is measured.

#### *Appropriate penalties*

Related to the previous point any scheme introducing flexibility requires real and appropriate penalties for non-compliance. Although this provision would equally be important for the existing scheme to be effective, in the points above we note that there are certain additional risks for potentially undesirable outcomes where flexibilities are introduced. It is therefore important to ensure that the mechanisms and policy goals cannot be manipulated or ignored without consequence. As such within the context of the NEC Directive in the EU, for instance, penalties would presumably remain to be determined by the European court of Justice in accordance with the established rules for not only attainment of ceilings, but also appropriate use of the available flexible mechanisms. Here the U.S.A. offers valuable



experience with its penalties not subject to judicially determination or negotiation in trading programs, such as the one for SO<sub>2</sub>.

#### *Common European and UNECE mechanisms*

Specifically in the context of the broadly European focused transboundary air pollution legislation, a final consideration for the proposed flexibilities is simply that any and all flexible mechanisms adopted under either the UNECE (Gothenburg Protocol) or European Commission (National Emissions Ceiling Directive) policy umbrella must be common to both systems if the mechanism is to be of value to those who are party to both agreements (i.e. most of the EU 27). Without such a provision the objective of the flexible mechanisms will be diminished if not lost for countries participating in both arenas. Thus it is imperative that there is a formal agreement for parties that exist under both systems to ensure that mirrored flexibility mechanisms be adopted in both frameworks. A failure to allow this ‘mirroring’ would likely result in participation for some member states only with the legislated obligations put in place by a subsequent European Directive on national emissions ceilings for 2020. The effectively ‘optional’ UNECE agreement for the Gothenburg Protocol may thereby suffer a loss of participation<sup>12</sup>.

### **5. Presentation and review of selected potential adaptive mechanisms – “The Options”**

Even though the arguments in favour of more flexibility may seem overwhelming, a final judgement depends on whether appropriate specific instruments can be found to strike an acceptable balance between the “pros” and “cons”. Also in this case the devil is in the detail. This section reviews a selection of potential adaptive mechanisms that could be introduced into the transboundary air pollution policy arena. As noted before these flexible mechanisms are intended to offer the option of an alternate path to an acceptable specified outcome for parties to a given agreement.<sup>13</sup> A summary of

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<sup>12</sup> The current Gothenburg Protocol to abate acidification, eutrophication and ground level ozone has, as of the 1<sup>st</sup> of March 2011, 31 signatories and 26 ratifications.

<sup>13</sup> We do not consider mechanisms that allow for flexibility between different regulatory systems, such as the different flexible instruments Joint Implementation (JI), the Clean Development Mechanism (CDM) and Emission Trading (ET) allowed under the Kyoto protocol. These systems provide flexibility also by allowing “trade” between emissions in one program or another. JI and CDM can be distinguished from classic cap and trade systems as they allow for project-based baseline-and-credit trading (Sorrel and Skea, 1999, p. 11; Hargrave c.s. 1998).

the eight options we consider subsequently is presented in Box 1<sup>14</sup>. As noted in the introduction, the flexibility in the adaptive mechanisms we consider refers to:<sup>15</sup>

- i) The ceiling set by the regulator ('fixed target')
- ii) The inclusion of an exchange mechanism between gases
- iii) The allowance of abatement trading between regulated agents.

Flexibility applied to the ceiling focuses in fact on compliance by agents (firms, sectors, national states) of a negotiated reduction effort or target. The flexibility in this case is principally a mechanism which comes into play only when evaluating whether an emission ceiling has been complied with or otherwise. Thus in the case where emission ceilings are established for the year 2020 (as they are in the case of EU air quality policy), these flexibilities would only come into play around that time in the process.

The second type of compliance flexibility is possible if regulation is applied to more than one type of emission responsible for the environmental damage. In air quality regulation, for instance, several pollutants play a role in specific impacts and in this category of flexibility one could allow for swaps between these gases if the outcomes deliver equivalent damage. This type of flexibility could be in play either during the operational phase of the process or simply at the compliance testing phase.

The third type of flexibility is a mechanism that involves some ongoing operation and/or additional adjustment and management over a period of time and might therefore also be labelled operational flexibility. The prototype of an emissions trading mechanism is a clear example. In this case the regulated agents are allowed to trade their abatement options with others if, for instance, abatement cost of another agent are much lower. Note that such a mechanism could also be designed between nation states as well.

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<sup>14</sup> Some of these options have also been considered as part of a recent report (TFEIP Ad Hoc, 2011), which built on some of the earlier work by the authors and to which the authors have contributed.

<sup>15</sup> Note our adaptive mechanisms may apply to national states as well as to emitters of pollutants. Several of our adaptive mechanisms might also be called 'offsets' which is the common term for environmental policy mechanisms where emitters of a pollutant may increase emissions or avoid required reductions in emissions by committing to verified reductions in emissions elsewhere (see also Richardson, 2010).

## Box 1 Options to enhance transboundary air pollution legislation flexibility

### *I Flexibility in ceiling*

#### *1. Three year averaging*

Compliance is currently tested in the ceiling process by checking the national inventory of emissions in the target year against the ceiling for the target year. Thus where three year averaging is introduced, compliance can be tested against a defined three year average. Various options exist, including the currently favoured option of  $(X-1 \text{ year}, X, X+2 \text{ years})/3$  where X is the compliance year.

#### *2. Relative ceilings*

Ceilings for the purpose of compliance are currently fixed. Under relative ceilings provisions would be made for circumstances under which either the ceiling or the reported emissions for the compliance test would be adjusted to maintain the original relative challenge of the ceilings, such as new scientific evidence. The allowable triggering mechanisms for a change in the ceiling to maintain its relative position are important.

#### *3. Overcompliance pledge*

The overcompliance pledge is a means for a country to secure greater time without penalty to implement additional measures. This mechanism would require commitment to deliver greater abatement beyond the ceiling level in the years subsequent to the compliance year. The flexibility could support short-term drives to reduce emissions but remains dependent upon available options.

#### *4. Split ambition targets*

Split ambition targets are in essence a variation of relative ceilings whereby a portion of the ceiling remains fixed but an element of the ceiling emission amount becomes flexible in response to new evidence that is deemed an acceptable criteria for a change in the aggregate ceiling. The critical component is again the determination of the evidence or events which would trigger a change

### *II Flexibility between regulated gases*

#### *5. Domestic gas swaps*

Domestic gas swaps are a national level flexibility whereby exceedance of limits for a given pollutant may be compensated nationally through additional abatement of an effect-cost comparable pollutant. That is the domestic trading of pollutants which are estimated to deliver a comparable impact cost reduction. The critical component is the definition of the appropriate exchange range.

#### *6. International gas swaps*

International gas swaps are an emission trading variant. The flexibility builds on the domestic gas swap concept by affording a country the potential to trade overcompliance within any pollutant in their country against noncompliance in any pollutant in another country. This requires a more complex international exchange rate than required under the individual domestic gas swap option.

### *III Allowance trading*

#### *7. Cap and trade*

Under this approach participating polluters still face an absolute cap on their emissions, and they may decide on their own whether to reduce emissions, buy additional permits at the permit market or a combination of both, according to the costs of both options.

#### *8. Relative cap and trade*

Such trading systems are no longer based on an absolute cap of total emissions, but on a much more flexible cap defined in emissions per unit of output or per unit of input.

Under the following headings we discuss the eight adaptive mechanisms which fall under one of these three categories of flexibility. In their description we identify their means of operation, the nature of the flexibility provided and offer a qualitative appraisal of their merit. We acknowledge that in most

cases the specific details of their design and introduction would require more detailed analysis of sectoral characteristics, market conditions and legal issues<sup>16</sup>, as well as political decisions in response to whether a specific instrument strikes an acceptable balance between the “pros” and “cons” described earlier in this paper. For each case it should be noted that the flexibilities can vary in their ability to manage issues of uncertainty. Each of the flexibility types has merits and weaknesses and their introduction is not mutually inclusive.

### ***I Ceiling focused flexibility***

#### ***1. Three year averaging***

The first of the eight mechanisms is the simplest and most readily adaptable into any future policy framework. Three year averaging is ‘compliance related’ flexibility. This means that there is little additional operational management required, as the flexibility it provides is simply an alternative calculation for determining whether compliance with the ceiling has been achieved or not. This type of flexibility offers a mechanism by which compliance testing is afforded a means of ‘smoothing out’ any short-term irregularities or surprises that may occur specifically in the target year. This is achieved by taking account of emissions in bordering years. The average can be composed of emission levels in the target year plus or minus one year, or indeed use alternative mixes such as the target year, minus one and plus two and so forth. Whilst a simple mechanism that can be easily introduced in a pairing with other flexibilities, two specific notes are made in relation to operation. Firstly, it must be defined whether or not the flexibility is optional or mandatory as individual compliance may vary between the two conditions. Secondly, where a country remains in non-compliance ‘on-average’, having waited two years for the final inventory values, is the compliance failure fine taken from the original ceiling target date or the current date? Overall we believe that the option incorporates useful adaptive flexibility into the compliance testing component of the process with little added transaction cost.

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<sup>16</sup> Additionally we note that as of late 2011 formal discussions are underway on the topic between the Commission and policy stakeholders. In this regard however, we note that in many cases the precise format or operational structure of a flexibility need not be formally agreed immediately. Rather the key point would be that provision is made for the potential approach or type of approach to be subsequently incorporated subject to certain constraints that we outline in this paper. At present relative ceilings and the three year averaging are two of the most likely mechanisms to be incorporated. There are considerations with both (e.g. structure, rules for use) and there are yet further options which may be complementary to their adoption (e.g. domestic gas swaps).

## *2. Relative ceilings – Compliance focused flexibility*

Relative ceilings may be designed and introduced in a number of ways. They can also be considered a ‘compliance related’ flexibility, although as distinct from ‘three year averaging’, relative ceilings as envisaged here would see a change in the *ceiling* component of compliance testing, as opposed to the *emissions* component. The operation essentially offers scope for the ceiling level to be adjusted in response to a specific set of changes or outcomes. For example, where a methodological change or new scientific evidence leads to an increase in reported emissions, the ceiling level would adjust by an appropriate proportion to maintain the prior relative challenge of the ceiling.

The act of modifying a ceiling and altering the compliance testing process is a rather simple administrative matter. The challenge in respect of introducing relative ceilings is principally captured under the following two questions:

1. Under what conditions and on what justification should the ceiling be adjusted?
2. What would the methodological process be for recalculating the new ceiling?

The first point could include defining which types of event should enable a change, and what degree of evidence is required to support it. Thus for example, should a country be allowed to request a relative change where they have underestimated future activity levels? Or should relative ceiling changes only be allowed where the outcome triggering the request is deemed outside of national control e.g. new scientific evidence, changes in methodological guidelines.

In terms of the methodological process for quantifying the new ceiling change, this is not a trivial task. Ceilings have traditionally been informed by a complex optimisation process from related modelling work (Amann et al., 2011). As such it is not sufficient to recommend that if 10 kilotonnes of new emissions are ‘created’ methodologically, that 10 kilotonnes should be added to the ceiling. The approach to such considerations may impact on the effect reductions achieved and therefore are a matter for policy makers to consider carefully at the outset.

Clearly the risk of relative ceilings is that rather than responding to the new evidence of emissions and working to overcome the challenge, the mechanism provides an ‘out’. This brings us back to the earlier point in relation to cost and effects. It is suggested here that whilst relative ceilings

may be considered as an option, perhaps the conditions under which it is allowed, and the method by which the change is quantified, can be managed in such a way as to support additional action where it remains cost-effective to do so.

### *3. Overcompliance pledge*

The over compliance pledge is a somewhat more complicated mechanism which would afford no penalty for ceiling exceedance for a further three years, on commitment of over-compliance on that new date. The objective would be to increase the annual rate of reduction on top of meeting the necessary ceiling. Failure to achieve the new pledge would be treated as non-compliance up to the present day with penalties appropriately scaled. An advantage of the approach is that it could be a mechanism to free up funds nationally for initiatives to reduce emissions, as a rational country taking this option would make significant efforts to reduce emissions and avoid the deadweight loss of fines where the requirement to comply remains. Thus in the event of failure to comply, the overcompliance option may have the effect of stimulating greater emission reduction effort than the original ceiling compliance level alone, and providing a clear case nationally for funds (that would otherwise be lost to fines and penalties) to be directed towards the task. However, on balance the system may yet be too complicated and challenging to warrant much support, and may be unnecessarily complicating when combined with other options such as three year averaging or relative ceilings.

### *4. Split ambition targets*

This flexibility involves the setting of two ceiling components, a fixed value proportion and a flexible 'range' portion. The fixed component is the maximum level of emissions allowable (as per the current ceiling approach), whilst the flexible range component would be linked to uncertainties in other outcomes or developments. The flexible range of the split ambition target would potentially be based on a value derived from an estimated degree of uncertainty in the process. This uncertainty range could be determined from two main factors. Firstly, general uncertainty with regard to forecasting of energy activity, animal numbers and assumptions about the efficiency of future abatement technologies. Secondly, uncertainty associated with particular measures, specifically measures relating

to behavioural change, where the future outcomes are particularly difficult to estimate with any degree of confidence.

In essence the split ambition target would define a minimum ambition in the form of the fixed ceiling, and then quantify an acceptable range within which the balance of the ceiling could move. The split ambition target is therefore a constrained version of the relative ceilings in some ways, which would be less flexible, but more predictable. Challenges include the transaction costs of setting and managing the ceilings in terms of required analytical capacities, and the approach to determining ‘how much’ the flexible range should change in a given direction. The option is considered a compromise between fixed and relative ceilings, and could be proposed where majority support cannot be obtained for either fully fixed or relative options.

## ***II Pollutant focused flexibility***

### *5. Domestic gas swaps*

Domestic Gas Swapping would allow a country to exceed the emission ceiling imposed on a given pollutant as long as an ‘effect-corresponding’ additional reduction of another pollutant was delivered.<sup>17</sup> The premise for allowing such internalised offsetting of a specific ceiling obligation is therefore that the corresponding offset would deliver an equal or greater level of effect reductions. Ultimately therefore the net value of the ‘effect’ targets would be met. This could be considered reasonable as the actual distribution of effect targets amongst types of effects is a somewhat arbitrary political process as it stands. From an economic and cost-benefit perspective, the objective should be to retain the value level of ambition albeit in a somewhat varied form. This mechanism would require clear rules related to a) which gases can be swapped b) what amount of gases may be swapped and c) at what exchange rate they would be swapped. In regard to the former it has been provisionally suggested that NO<sub>x</sub> and NH<sub>3</sub> would offer a good exchange as they are both eutrophying pollutants, whereas primary particulate matter (PM<sub>2.5</sub>) could be exchanged with precursors of secondary particulate matter (SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>).

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<sup>17</sup> To find acceptable ‘exchange rates’ is key to this approach. Van Leeuwen (2002) provides an assessment of how different impacts associated with different emissions could be made ‘transferable’.

On the point of the amount of each swap, perhaps the most appropriate operational approach would be an *ex post* compliance assessment format whereby the ultimate contribution of the country to effect reduction would be estimated. If the net contribution to effect reductions was negative or neutral then a domestic gas swap would not be allowed, and in the case of the former, disciplinary action would be warranted. However, if a positive net contribution to effect reduction had been made, and another pollutant was in excess of the ceiling then this exceedance could be allowed with no further penalty.

### *6. International Gas Swaps*

The idea behind this mechanism is to allow countries to offset over compliance with one pollutant ceiling against a failure to comply with another, but allowing the swaps between countries. This means that for a given unit of some pollutant, e.g. SO<sub>2</sub>, within one country trade options would be allowed such that over compliance with one pollutant, and a failure to comply with another could be reconciled between two countries whose trading requirements are compatible. This flexibility is essentially an internationally extended version of the domestic gas swap option discussed previously, and is not therefore a dynamic or operational trading scheme such as a cap and trade system. However, also trades under such a system could be subject to some country specific ‘exchange rate’ – like in the case of domestic gas swaps – to account for differences in source, dispersion and impacts.

To account for differences in air quality impacts across different countries, for instance, the exchange rate might reflect the concept of an ‘equal impact factor’, i.e. trades should reflect location specificities with the location with which the trade is set. Both the dimension of the swap (which gases to be included) and its local differentiation (country, EMEP area) are essentially free to choose. A somewhat related concept had been explored previously in a European context (TNO, 2006), with the simulated establishment of regional trading ‘bubbles’ wherein trades of equal impact factor emissions would be allowable. Although in this case the principal distinction is again that no swaps would take place until the compliance evaluation phase. There is also the question as to whether countries which over comply with a ceiling, and have no need of trades, could sell their excess compliance via this mechanism. This is a political decision, and whilst it may reduce the possibility of net ‘windfall’ gains



for the environment (i.e. countries simply over complying), it may also stimulate some countries to invest in or otherwise promote further abatement options nationally.

From an effects perspective we note that, in principle, relatively large trading areas already exist under the NECD and Gothenburg protocol. For example, if we consider that a larger country such as France, has a single national target and thereby regional and local flexibility (subject to constraints such as minimum ambient air quality), whereas a defined regional cluster of smaller countries occupying a smaller land area and a broadly comparable geographic area, such as Ireland, the U.K, Netherlands and Belgium, represent four individual zones with no scope for trading.

The challenge with international gas swaps is the determination and international agreement in respect of the appropriate exchange rates. This work would be challenging and undoubtedly contentious. Furthermore, where an exchange rate was agreed, the associated work to manage, monitor and model multiple trades and adjustments in the compliance phase would be considerable, and may cloud the transparency of compliance testing. A final issue is that the scope for trades may be limited under stringent targets where few countries are expected to 'over comply' to any great degree. This is especially the case for larger countries whose absolute demands may offer few potential 'trading partners'. On balance we believe that the potential benefit of this mechanism should be large to outweigh the potential complexity and transactions costs of the scheme, as well as the uncertainty over the actual value and level of flexibility that would ultimately be offered to participants.

### ***III Allowance trading***

#### ***7. Cap and Trade***

According to the traditional approach to tradable emission permits, cap-and-trade (C&T), the government restricts emissions relative to the status quo and next allows agents to trade with the remaining quantity through so called 'permits'. Thus participating polluters face an absolute cap on their (historical) emissions, and then decide to reduce emissions, buy additional permits at the permit market or a combination of both, according to the costs of both options. Such a quantity restriction can be introduced in a number of ways. First, all agents can be restricted in the same way relative to some baseline (historical or in relation to some projection). The regulator can also discriminate between

them, for instance between sheltered and unsheltered sectors. Second, agents can receive their permits for free (grandfathering) or they have to buy them at an auction. Although it has been recognised for a long time that auctioning off the initial permits would be important to prevent the new ‘scarcity rent’ to materialise as a producer rent, practical policy has always been more concerned about its potential negative redistributive effects, in particular in exposed sectors of the economy. However, hybrid systems of selective grandfathering and auctions also provide opportunities to meet distributional concerns for the regulator (Vollebergh et al., 1997).

A flexible mechanism like cap and trade leaves the responsibility to meet the (overall) ceilings set by the regulator entirely with the regulated agent. This flexibility also lies at the heart of why economists consider this type of policy instrument more cost efficient than inflexible instruments. In this case firms (or consumers) select the lowest-cost options when they are confronted with a tradable permit scheme.<sup>18</sup> At the industry level differences in abatement options (‘marginal abatement cost’) are known to exist and firms or consumers would be stimulated to explore which of the substitution channels might offer for them a less costly alternative for paying this tax on emissions or a tradable permit. However, introducing cap-and-trade is not costless. Indeed, such systems require setting up appropriate (trading) institutions and knowledgeable staff and accountants.

The U.S. cap and trade system of SO<sub>x</sub> and NO<sub>x</sub> are the best known applications of cap and trade in general and in the air quality context in particular. In a recent review of both systems Burtraw and Szambelan (2009) conclude that both programs are widely viewed as successful in achieving the emissions caps at less cost than would have been achieved with traditional approaches to regulation. Most importantly, emissions caps achieve their stated goals and markets emerge as viable ways to reduce the cost of compliance. Transparent data systems, public access to information, and strict and certain penalties for noncompliance have led to a virtually perfect compliance record. However, the *ex post* information gathered from the system in regard to the level of the allowance prices on the real (marginal) cost of abatement has not been used by the regulators to readily adapt the program itself.

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<sup>18</sup> The necessary condition for static efficiency is that marginal abatement costs are equalized across firms, and in this respect instruments like emission taxes or tradable emission permits are generally preferred to quotas, performance standards and investment subsidies (Baumol and Oates 1988). Key to this result is not whether regulation is applied by prices (taxes or subsidies) or quantities (tradeable permits), but whether they allow for flexibility or other prescriptions of behaviour.

There is evidence that some cost savings have been not been realized. Moreover, despite substantial emissions reductions, the ultimate environmental goals have not yet been achieved.

The US experience clearly illustrates the advantages of cap-and-trade relative to inflexible regulation. However, these advantages could even be improved if the design of cap-and-trade systems allows for specific adjustments to such a system, in particular the inclusion of a 'symmetric safety valve' (Burtraw et al., 2010). Such a safety valve mitigates against both peaks and troughs in the price of emissions which could stabilise performance for all interests, and improve environmental and cost outcomes. Related research also considers the relative merits of soft and hard price collars in a cap and trade scheme with respect to their response to shocks to forecast emissions, abatement costs and the supply of tradable offsets (Fell et al., 2010) In a European context such considerations are already relevant to the future evolution of the European Emissions Trading Scheme but would also clearly be of relevance should a cap and trade mechanism be formally adopted in regard to transboundary pollutants.

Whether this system, or some adaptation thereon, is simply transferable to the European setting, where most of the readily available cheap abatement options have already been taken, is not easy to answer. Although it is noted that recent analysis for transboundary air pollution in the broader European region does however indicate that there are significant emission savings potentials in neighbouring non-EU countries such as Russia or the Ukraine were they to be formally engaged in a future process (Amann et al., 2011b). Indeed in a further recent study ENTEC (2010) suggest that large benefits would still be possible. Using a so called Trading Simulation Model cost impact of a number of trading variants are studied relative to a reference scenario that aims to implement the current European Directive on Industrial Emissions through standard individual BAT-based permitting approach. The study reports considerable cost savings for these trading options at significantly lower level of emissions. Although the benefit/cost ratios in this study do not include any assessment of additional transaction cost involved, the results point again at the considerable potential of these mechanisms.

## 8. Relative cap and trade

Interestingly, in the context of climate change policy, the concept of flexibility has generated a new approach based on relative ceilings. Such trading systems are no longer based on an absolute cap of total emissions, but on a much more flexible cap defined in emissions per unit of output or per unit of input. Indeed, such *relative* C&T policies are becoming increasingly popular. It was part of the recently implemented UK climate trading scheme, in which the so-called ‘unit sector’ has relative targets. It has also been applied as the model for a Dutch NO<sub>x</sub> emission trading scheme.<sup>19</sup>

Recent experience with cap and trade reveals that the cost advantages claimed for this system only apply if the system is strictly based on the provision of emission permits based on (the level of) historical emissions. Most cap and trade systems found in practice, however, are of the relative type. This system boils down to the combination of a constraint on emissions on the one hand, but also of a production subsidy on the other hand (Gielen et al., 2002). This clearly undermines both the efficiency and effectiveness of a cap and trade system. The Phase II system for tradable carbon emission permits in Europe between 2008-2012 is a clear case in point. EU member states hand out these permits without charge using criteria that result in perverse behavioural effects.<sup>20</sup> This experience clearly shows the necessity of a proper design of any cap and trade program including the political decision to what extent caps should be absolute or relative constraints. Clearly, relative cap and trade provides a reasonable alternative if distributional concerns may prevent any flexible mechanism to be implemented. However, potential abatement cost savings in this case cannot simply be weighted against a given amount of emission reduction, but because the system also allows for compliance that may turn out less strict *ex post*.

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<sup>19</sup> An important difference between emission trading and project based trading mechanisms mentioned in footnote 6 is that in the latter, sources which emit more than their baseline do not have to buy permits to cover these emissions. The project-based trading schemes create the possibility to sell credits but do not include the obligation to buy permits. See Koutstaal 2001 for an analysis of the efficiency of different flexible instruments.

<sup>20</sup> For instance, some member states distribute permits based on current production. This provides an incentive to expand production capacity in order to obtain additional, valuable emission rights. The additional capacity results in additional pollution, which must be reduced by other, less efficient measures. Furthermore, companies that invest in additional capacity for a coal-fired power plant receive valuable emission rights whereas companies investing in wind power do not. These rules induce too much investment in relatively dirty capacity. Finally, member states treat the distribution of permits as an instrument of industrial policy thereby distorting the internal market. However, handing out permits for free can also be a useful remedy against leakage which was an important element in EU considerations for the design of the system for phase III (2013-2020).

## **6. Conclusions and recommendations**

This paper has identified the importance of creating robust adaptive environmental policies. The piece examined the complexity of policy design in the field of transboundary air pollution and highlighted a number of design considerations for any proposed adaptive policy mechanisms. The paper then reviewed eight specific adaptive policy options.

In the case of transboundary air pollution, the acceptable outcome should generally remain consistent with the defined (inter)national objectives of reduced health impacts, reduced ecosystem damage and so forth. That said, these latter effects are managed within (inter)national policy because they impose a cost on society and the environment, for example, the cost of poor health or the cost of acidification of ecosystems. However, it is important to remember that the policies or technological investments to abate emissions and reduce these effects can also carry a degree of cost. In theory then, the flexibility should, from a purely economic perspective, seek to achieve net positive outcomes. That is that the benefits outweigh the cost.

Nevertheless, complexities exist within this seemingly straight forward mantra, and two of these complexities are particularly relevant to the broader decisions on flexibilities and require political level decisions. Firstly, at what level must benefits outweigh cost? On a pan European scale there is little doubt from the associated analysis that benefits will outweigh costs for current ceiling proposals (AEA, 2011), however, where we move the assessment to the national, regional or even local scales this may always not be the case. The first question to keep in mind then is are we willing to trade lower tier outcomes (e.g. local, regional benefits) for the greater good (e.g. international benefits)? Secondly, are some effects more important than others or is it the cost of their impact which should be paramount? This second question is relevant where we may seek to alter the type of impacts, but allow for comparable monetised savings and effect reductions. In practice there are difficulties with adopting such a purely economic perspective, including the level of confidence in monetised valuations of appropriately defined costs and benefits, as well as the more political challenges alluded to in section 3, with respect to allowing damage to the environment where certain actions prove too costly.

What seems clear is that some provision of flexibility to facilitate cost effective abatement and allow for the associated risks posed by uncertainty is sensible for future transboundary air pollution processes. It may be the case that with the increased national expertise and engagement we see in 2011, strong European climate policies, and an expectation of moderate economic growth and stable populations in the European region, that the chance of major deviations from our current forecasts of transboundary air pollution emissions will be more restricted for 2020 than the past. However, even this is just an informed guess. If it comes to pass that the analysis for the future is robust, then the flexibilities may not be necessary and there is little additional cost to the process. However, if 2020 is not as we now expect, then flexibility has an important role to play. It is not a question of choosing between the environment and the economy. It is a question of acknowledging the uncertainty inherent in the future and setting in place appropriate mechanisms with the aim of balancing our use of economic and natural resources effectively and equitably.

By way of recommendations, there are many possible combinations of flexible packages that could function well. However, the specific choices require clarity on the specific conditions of operation, as well as political decisions on topics presented in this paper, as to what outcomes would be acceptable where flexibilities are in play. An example of a package that would offer good flexibility, synergies and interoperability would be the three year averaging, relative ceilings and *ex post* domestic gas swaps. This package would afford capacity to address temporal issues, changes in methodology or knowledge, and some further scope for countries to pursue the most cost-effective abatement options across all pollutants.

Ultimately, scientific research serves as the compass for environmental policy, and legislation can deliver the forward momentum. However, the future is inherently uncertain and the quip that “Economists provide forecasts to one decimal point to indicate they have a sense of humour” should perhaps give us pause to reflect and temper our approach to dealing with significant policy frameworks that are set for the long-term but informed by analysis today. We may reduce some uncertainties but we will not eliminate them. As a result, in the transboundary policy context we cannot expect to map out the twists and turns we will experience ten years in advance. In carefully designing and deploying adaptive policy mechanisms into future agreements we can be confident

however, that we will continue to move environmental policy in the right direction, that we will foster and encourage broader participation internationally, and that we will mitigate the risk of unnecessary and inflexible frameworks which may force poor choices in the management of economic and environmental resources.

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