

**FLEXIBILITY MECHANISMS IN ENVIRONMENTAL REGULATIONS:
THEIR USE AND IMPACTS – ENVIRONMENT WORKING PAPER N° 151
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Authorised for publication by Rodolfo Lacy, Director, Environment Directorate.

Keywords: Flexibility mechanisms, environmental regulations, valuation of environmental externalities, air pollution, government policy, emission trading.

JEL Classification: Q51, Q53 and Q58.

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JT03450306

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Abstract

Based on an in-depth literature review and responses to a survey among OECD member countries, this paper discusses the use of flexibility mechanisms in environmental regulations. Such mechanisms can provide flexibility as to *how* a given environmental improvement is achieved, regarding *where* environmental improvements take place, *when* they take place, as regards *who* is to achieve the improvements, and for *which* pollutants the emission reductions are to be achieved.

The literature on these issues is limited, but it is clear that some such mechanisms can have important environmental and economic impacts. In certain cases, flexibility mechanisms which have provided important benefits in terms of cost reductions have proven to also shift pollution to areas where the negative health impacts are larger. Hence, it will be useful to carefully assess the related social costs and benefits of both existing and new flexibility mechanisms.

Keywords: Flexibility mechanisms, environmental regulations, valuation of environmental externalities, air pollution, government policy; emission trading.

JEL Codes: Q51; Q53 and Q58

Résumé

Cet article traite de l'usage des mécanismes dits de flexibilité dans les réglementations environnementales, en s'appuyant sur une revue de la littérature et sur les réponses à un questionnaire adressé aux pays membres de l'OCDE. Ces mécanismes introduisent de la flexibilité dans les politiques environnementales concernant la manière d'atteindre un objectif environnemental donné, la localisation des progrès environnementaux, leur réalisation dans le temps, les acteurs responsables de ces progrès, et les polluants faisant l'objet de réductions d'émissions.

La littérature sur ce thème est limitée, mais il apparaît clairement que ces mécanismes peuvent avoir d'importants impacts à la fois environnementaux et économiques. Dans certains cas, les mécanismes de flexibilité, qui ont permis des réductions considérables des coûts liés aux politiques environnementales, ont également conduit à déplacer la pollution vers des régions où ses effets sur la santé sont plus élevés. Il est donc important d'évaluer attentivement les coûts et bénéfices liés aux mécanismes de flexibilité actuels et futurs.

Mots clés : Mécanismes de flexibilité, réglementations environnementales, l'évaluation des externalités environnementales, pollution de l'air, politique gouvernemental; échanges d'émissions.

Codes JEL : Q51; Q53 and Q58.

Acknowledgements

This paper was prepared by Nils Axel Braathen of OECD's Environment Directorate.

The paper has benefitted from comments and input from Delegates to OECD's Working Party on Integrating Environment and Economic Policies. It has also benefitted from comments from colleagues in OECD's Public Governance Directorate.

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FLEXIBILITY MECHANISMS IN ENVIRONMENTAL REGULATIONS: THEIR USE AND IMPACTS – ENVIRONMENT WORKING PAPER N° 151

1. Introduction

OECD has conducted extensive work highlighting the advantages of using market-based instruments for environmental policy, with a focus on aligning incentives and getting the prices right, to efficiently and effectively achieve environmental objectives. Over the years, this has contributed to the greater use of taxes, charges and tradable permits to manage environmental issues, both within and beyond the OECD's membership. Nevertheless, what often is referred to as “command-and-control” (CAC) regulatory instruments still represent the major proportion of all instruments currently being used for environmental policy in OECD countries. Such regulations include laws or regulations stipulating compulsory environmental quality standards which e.g. sub-national administrative units are obliged to attain; limits on total emissions of various pollutants during a given time-period; and limits on the concentration of various pollutants in emissions to air or water, etc.

Introducing one or more flexibility mechanisms in such regulations could possibly reduce the costs of complying with the regulations – which in principle also could make it possible to increase the level of ambition underlying the environmental objectives behind the instruments.

The objective of this paper is to discuss the impacts of introducing such flexibility mechanisms on top of CAC regulations. This is accomplished through a literature review, drawing also to some extent on a recent survey among OECD member countries. The goal is to examine the types of existing regulations, the nature of flexibility mechanisms that might layered on top of them and the impacts of doing so.

The purpose of this paper is *not* to discuss market-based instruments *versus* CAC regulations, but instead to discuss impacts of adding some sort of flexibility mechanism on top of a regulation. However, in order to “set the scene”, Section 2 discusses potential drawbacks with CAC regulations, which one might want to address through the application of different flexibility mechanisms. Section 3 outlines different types of environmental issues that policy instruments might be applied to. Different types of flexibility mechanisms are discussed in Section 4.

The literature on the use and impacts of such flexibility mechanisms is modest.¹ The Secretariats has made searches in several databases and been in contact with a number of

¹ There is, however, a rich literature on the use of *overlapping* policy instruments in general, see for example Sijm (2005_[26]), Böhringer Koschel and Moslener (2008_[28]), Levinson (2010_[25]), Braathen

potential experts in the field, but has found very few documents of relevance for this project. For example, a search in the “Econlit” database for the joint appearance of the terms “flexibility”, “environment” and “regulation” gave 89 “hits” in all, only a small handful of which was of any relevance to this project.²

An interesting exception to the lack of focus on the impacts of various flexibility mechanisms is a forthcoming in-depth study of the impacts of such mechanisms in various parts of the US *Clean Air Act* on the durability, adaptability and flexibility of this law, with a number of cases related to both stationary and mobile sources – cf. Carlson & Burtraw (2019_[1]). Several examples from this book are highlighted below.

Some types of flexibility mechanisms might entail negative environmental impacts, for example shifting local air pollution from areas with low population density to areas with higher population densities, thus increasing the social costs of a given amount of emissions. Chan et al. (2018_[2]) found that such effects were important in relation to the US Acid Rain Program, which was introduced via the 1990 amendments to the US *Clean Air Act*. Hence, a careful analysis of the costs and the benefits of the different policy instruments – and of potential modifications to them – is called for. This and related examples are discussed further in Section 5.

Section 6 draws out some conclusions and cross-cutting findings of this project.

(2011_[24]), Böhringer (2013_[29]) and Fischer, Newell and Preonas (2014_[27]). Kosobud et al. (2008_[21]) studied an innovative cap-and-trade programme designed to make cost-effective reductions of VOC in Chicago and found that this market-based tool was undermined by the continued application of Federal command-and-control regulations. Evans and Kruger (2007_[34]) made a similar point. In addition, they highlighted that the baselines used in the trading system were based on what the different polluters were *allowed* to emit in years preceding the implementation of the system, not what they had actually emitted. This tended to inflate the baselines, and contributed to very low allowance prices.

² Haščič, Johnstone and Kalamova (2009_[7]) and O’Brien (2001_[19]) are two of the few relevant papers that were found.

The latter paper did i.a. make reference to the “Reinventing regulation” programme, Project XL (for Excellence and Leadership), which “is an experiment in trying to make existing approaches more flexible and therefore to lower costs. Regulatory programmes are frequently criticised for not taking sufficient account of local conditions; under Project XL the EPA is empowered to waive regulations on particular sites, for example on technologies required to clean up air pollutant emissions, provided that the firm or facility concerned comes up with a plan that improves its environmental performance (which must already be in compliance with existing regulations). The plan must be drawn up between the facility and the EPA and be developed through a process of stakeholder consultation – with local government and communities.

Project XL was launched in March 1995. As of March 1999 only ten projects had been implemented, with another 14 at various stages of development, but by October these figures were 15 and 28 respectively. A study [(Blackman and Mazurek, 2000_[18])], looking at progress up to March 1999, suggests that these initial experiments have been rather expensive, with discussions between the firms involved and the regional and central EPA offices absorbing a lot of resources. Costs averaged over \$450 000 per firm”.

2. Potential drawbacks of CAC policy instruments

The term “command-and-control regulation” covers several different instrument categories, with different characteristics. The most restrictive type of regulation is probably an outright ban on certain products, or of certain production processes. This could, for example, be a ban on the use of incandescent light bulbs, a ban on the use of some bleaching technologies in the pulping & paper sector, or a ban on the use of coal for electricity generation. An obligation to use a particular technology in a given circumstance (such as a rule explicitly requiring the use of a selective catalytic reduction technology at a power plant) is also quite restrictive. A standard limiting emissions of certain pollutants during a certain time-period gives the polluters more flexibility in how to comply with this regulation – the more so, the longer the time-period in question. A standard specifying a given minimum environmental quality that has to be achieved within a given area is even more flexible – but it can be difficult to enforce such a regulation if there are many sources contributing to the environmental issue at stake.

As mentioned, the focus of this paper is *not* to discuss whether market-based policy instruments are “better” or “worse” than “command-and-control” instruments. In fact, such a dichotomy is not very helpful. Most real-world policy instruments will represent a sort of compromise between giving polluters full flexibility on how to reach a given environmental outcome and “dictating” to them exactly how to do so. It can nevertheless be useful to highlight some potential drawbacks of different CAC policy instruments, building inter alia on Gunningham (2011^[3]). This brief overview addresses the environmental impacts of the instruments, their cost-effectiveness and their impacts on future technological developments. A fully-fledged policy assessment would also generally address issues such as the distributional impacts of the policy and its practical and political feasibility.

2.1. Overall policy stringency

The overall strictness of the CAC policy instruments could be too strict or too lenient. This would imply that both the marginal and total social benefits of a well-designed modification of the instrument could be larger than the related marginal and total costs.

However, one can also have a similar problem with other types of policy instruments: The rate(s) of an environmentally related tax will often differ from what is socially optimal,³ and the “cap” in an emission trading system can be too slack or too tight. It is difficult to see a particular reason for why the strictness of a CAC instrument should differ more systematically from what is optimal than what is the case for other instrument types. On the contrary, as the use of a CAC instrument will not oblige polluters to pay anything for remaining emissions, one could speculate that industry organisations will lobby less intensely against an optimal strictness of such an instrument than against a tax or a trading system.⁴

³ In relation to energy products, OECD (2018^[31]) does, for example, document that there are large variations in the tax rates applied to different energy products and in different sectors in any given country.

⁴ A counter argument is that a cap-and-trade system will create economic rents for incumbent firms, especially if the permits are grandfathered – which could reduce resistance to their introduction.

2.2. Lack of static efficiency

CAC instruments generally do not equalise marginal abatement costs across sources contributing to the same problem – there is a lack of static economic efficiency. This means that polluters for whom abatement is costly are abating more than what is socially optimal, whereas polluters for whom abatement is not so costly are abating too little. The total costs to society of achieving a given level of environmental quality are therefore higher than necessary.

The underlying cause of this problem is a lack of information for the authorities administering the policy instrument. In a real-world setting, it is impossible for these authorities to know the full shape of the abatement curves of all sources contributing to problem in question – which *in theory* could have allowed them to design the regulation in such a way that the abatement costs were equal at the margin for all polluters, at the optimal level of pollution. Instead, the authorities will in reality have to rely on some estimates of the polluters' abatement costs which in practice will be somewhat inexact.

Market-based instruments, such as taxes and emission trading systems can differ with respect to static efficiency. An emission trading system – with a uniform permit price – will always tend to equalise marginal abatement costs, regardless of whether the permits originally are grandfathered or auctioned. A uniform tax rate applied to all sources will also equalise marginal abatement costs, and hence provide static efficiency – but very often, tax rates vary somewhat across different sources, e.g. due to exemptions or tax rate reductions granted to some polluters. In such cases, an environmentally related tax will not provide full static efficiency. For further discussion, see Smith (2008^[4]).

2.3. Lack of dynamic efficiency

CAC instruments do also not provide “correct” incentives for further technology development and innovation – there is a lack of dynamic efficiency. With many types of standards, once a polluter is in compliance, he or she has no economic incentive to develop technologies to abate even more.

However, some regulations include mechanisms that provide incentives for new inventions. For example, Wiseman (2019^[5]) explains that the US EPA keeps a clearinghouse up-to-date with technology options from which States may choose when they issue permits according to the *Clean Air Act* to newly built or modified stationary emission sources. The States approve a particular technology that the given source must implement in order to reach a technology-based emission limit. This case-by-case review contributes to increased stringency of pollution controls over time. The clearinghouse lists all the different types of pollution control technologies installed at stationary sources globally. If a source in one State implements a new, more effective innovative control technology and the State requires this technology in a permit that it issues, this technology will be included the clearinghouse. While other States are not required to select this specific technology when issuing their permits, they must justify choices that are less stringent than technologies implemented in other States.

Ruijs & Vollebergh (2013^[6]) describe a somewhat similar mechanism used in the Netherlands. Firms investing in technologies listed in an annually updated “Energy List” may deduct some of the investment costs from their taxable profits in the year of the investment.

The possibility of having a given technology included in such a list or clearinghouse provides an incentive for potential entrepreneurs to develop new technologies. The officially recognised – and favoured – lists help provide a potentially large market for these technologies.

An environmentally related tax and an emission trading system would both automatically provide an ongoing incentive for individual polluters to reduce their emissions – assuming that they face a positive tax rate in the first case. With a cap-and-trade system, the total level of emissions is, however, determined by the “cap” that has been set, and it will not be directly affected by the abatement incentive each individual polluter is facing.

Haščič, Johnstone and Kalamova (2009^[7]) discussed the innovation impacts of different policy instruments and found i.a. that

“the juxtaposition between market-based instruments and direct forms of regulation is somewhat misleading. For instance, while a tax on CO₂ is flexible, a differentiated tax for environmentally friendly products is unlikely to be as flexible.⁵ In the first case any possible means to reduce CO₂ is potentially attractive, while in the latter case the technological possibilities are constrained by the precise means of tax differentiation. Indeed, to the extent that the criteria for differentiation are based on technological criteria, it could be argued that such a measure would have more similarity with technology-based standards than with a CO₂ tax. Similarly, a performance standard may have more similarities in terms of flexibility with an emissions tax than with a technology-based standard. For instance, if the point of incidence of the performance standard is identical to the base upon which an environmental tax is applied, then they will be equally flexible.⁶”

3. Different categories of environmental problems being addressed

It is also useful to keep in mind that the environmental problems which the policy instruments are meant to address can be of a *local*, *regional* or *global* geographical scale, and they can be related to environmental *stocks*, e.g. levels of pollution (e.g. GHG concentrations in the atmosphere), or environmental *flows* (e.g. noise or short-term peaks in concentrations of ground-level ozone).

If the environmental issue is of a local or regional character and the flexibility mechanism makes it possible to move emissions from one geographical area to another, this could have positive or negative impacts on the environment and for human health, depending on – among other factors – the population density at the different locations. For an environmental problem of a global scale, such as emissions of CO₂, it would not have any direct significance if emissions were moved from one place to another (but this could be of importance for other pollutants being emitted jointly with the CO₂).

For a flow issue, like noise for example, it could be quite important if a flexibility mechanism extended the period when noisy activities were permitted to be carried out, or

⁵ For instance, the application of the “bonus-malus” system on the sales price of motor vehicles in France. (*Note in the original.*)

⁶ Note, however, that the “depth” of the standard will be shallower since there will be no incentives to innovate beyond the level of the standard. (*Note in the original.*)

if it e.g. allowed such activities at night-time, thus disturbing the sleep of much of the population in the area. For a stock issue, such as the concentration of greenhouse gases in the atmosphere, it would not matter very much if a flexibility mechanism shifted the timing of a given amount of emissions to a certain extent, as long as the total stock of pollutants at any time were not much affected.

4. Different categories of flexibility mechanisms

In general, the large majority of environmental regulations will include some sort of flexibility. For example, it would be rare that polluters would be required to report the concentrations of a given pollutant in their emissions e.g. every minute of the day – it is more likely that they would be reporting some sort of hourly, daily, weekly, monthly, quarterly or yearly average. Such *averaging* will automatically represent an element of flexibility – a “too high” concentration of the given pollutant at one time of the day or the month can be compensated by a lower concentration at some other moment in time.

In many cases, various flexibility mechanisms have been introduced *incrementally* into pre-existing environmental regulations, for instance if it was seen that the cost of compliance with the original regulation was higher than expected. An important example of gradual addition of flexibility mechanisms is the US *Clean Air Act*, first introduced in 1970. The law set national ambient air quality standards (NAAQS) for selected pollutants, and defined performance standards for new sources and for existing sources that carried out major modifications. These performance standards were made stricter through the 1977 *Clean Air Act Amendments*, which effectively required the installation of scrubbers to remove sulphur from the emissions of new and modified coal-fired power plants.⁷

The law includes sanctions for areas that do not attain the NAAQS, which can negatively affect economic development in that part of the country. To address this issue, a system was developed whereby new sources were allowed to “offset” the emissions they would be causing by paying existing sources to reduce their emissions instead. The so-called “bubble” system was another flexibility mechanism that later on was introduced. This allowed a facility to comply with a standard defined over several sources rather than having to comply with individual restrictions for each smokestack. But, as explained by Burtraw and Szambelan (2011_[8])

“The 1977 Clean Air Act Amendments recognized the offset policy in law. These changes provided flexibility compared to the status quo, but the markets were informal. Trades had to be preapproved by the environmental regulator. There was limited ability to bank, some unused emissions reduction credits were lost, and the transaction costs for each trade approached 50 percent of the value of the trade. This set the stage for a major reform that was to follow.”

The major reform referred to by Burtraw and Szambelan (2011_[8]) was the introduction of the so-called Acid Rain Program, through the 1990 *Clean Air Act Amendments*. This was

⁷ See Coysh et al. (2019_[36]) for a discussion of the effects of vintage-differentiated environmental regulations. Focussing on NO_x and SO_x emissions, the paper applies survival analysis techniques on a sample of coal-fired power plants across 31 OECD and non-member countries between 1962 and 2012. While higher policy stringency speeds up the exit (decreases the survival rate) of older plants, greater vintage-differentiation is associated with significantly higher age at exit of a plant.

an emissions allowance trading programme for electricity generation plants, and is discussed further below.

One can distinguish between several different categories of flexibility that could be added to a CAC regulation:

- Flexibility regarding *how* to reduce emissions, for example when a standard requiring the use of a particular abatement technology is replaced by a standard that sets limits on pollutant concentrations from a firm's smokestack, without saying exactly which technology should be used to achieve such a concentration level.
- Flexibility regarding *where* emissions are being reduced, e.g. through an averaging system that allows emissions to be shifted from one plant facility another, or from one smokestack at a facility to another.
- Flexibility regarding *who* should reduce emissions. An emission trading system can (also) provide such flexibility – and so could e.g. various offset mechanisms covering point- and non-point sources of pollution. Whereas *who*-flexibility for practical purposes always will include an element of *where*-flexibility, *where*-flexibility *could* be restricted to relocation of emissions within a single firm.
- Flexibility regarding *which* pollutant to address, for example if a given enterprise emits several pollutants that contribute to the same environmental problem, like nitrogen and phosphorous, which both contribute to eutrophication of water.
- Flexibility regarding *when* emissions are to be abated, for example through banking and borrowing provisions, or through extended time-periods for which average emission concentrations are to be held below a certain maximum average value.⁸

Flexibility *for whom* is also an issue: To what extent is the ministry or agency managing a given regulation given flexibility by the lawmakers to make modifications to the way a given regulation is being implemented, without having to go through sometimes time-consuming procedures for changing the law or the regulation in question? Does the law in question make it possible for the managing agency to introduce stricter (or more lenient) rules for the polluters, in light of new information regarding i.a. human health impacts of the emissions, or regarding the costs of different abatement technologies? Does the law in question include waivers, so that the managing agency can suspend certain rules for a limited time-period in order to address extraordinary circumstances?

For example, Aldy (2019_[9]) refers to a pipeline outage in the spring of 2000 that resulted in strong price increases for gasoline in Chicago during the implementation of the so-called reformulated gasoline (RFG) rule. Motivated by this experience, the Congress included a provision enabling the EPA to temporarily waive fuel and fuel additive controls in the *Energy Policy Act* of 2005, if significant supply interruptions should occur. By 2018 EPA has waived regulations more than sixty times, with nearly 90% of these based on hurricane damage to refineries, pipelines or storage terminals, according to Aldy (2019_[9]).

As Aldy (2019_[9]) points out, such waivers protect society against unexpectedly high costs that could adversely affect consumers and potentially undermine public support for the environmental standards. Whereas the benefits of a given regulation may justify its costs under normal market conditions, unexpected shocks could increase costs well above the related benefits, at least temporarily.

⁸ Toman, Morgenstern and Anderson (1999_[23]) provides an early discussion of various types of flexibility mechanisms in relation to the Kyoto Protocol.

Burtraw & Szambelan (2011^[8]) discusses another case where they indicate that sufficient flexibility was not given to the managing agency. Drawing on Burtraw et al. (2010^[10]), they suggest that if a price floor one-third below anticipated allowance prices had been in place in the US Acid Rain Program, it would have triggered additional emissions reductions that would have led to additional social benefits of 8 USD billion per year over one decade. Further, the “inability of the program to adapt to information about the marginal cost of emissions reductions that is revealed in the allowance price is an important flaw in cap-and-trade as it has been implemented to date in environmental policy.”

Aiming to get a better understanding of the experiences with, and impacts of, adding flexibility mechanisms on top of various CAC regulations, a survey was conducted for this project among OECD member countries. The questionnaire that was used covered three different environmental issues, namely regulations addressing air and water pollution as well as regulations addressing energy efficiency or CO₂ emissions. Unfortunately, the response rate in the survey was low, and the responses that were given did not provide many examples of experiences with such mechanisms. In addition, the replies received revealed that very few ex post assessments of the impact of the flexibility mechanisms have been carried out. However, some information on the survey responses is provided in Annex A and the questionnaire itself is presented in Annex B.

The various categories of flexibility listed above are discussed further in Sections 4.1-4.5, drawing both on the few examples provided in the questionnaire responses and on available literature.

4.1. How-flexibility

There are many examples of the use of how-flexibility included in CAC environmental regulations. Some of them are described further in the following paragraphs.

In relation to air pollution, federal and sub-national Governments across Canada pursue programmes on air issues both individually and collectively. At the federal level, the *Multi-Sector Air Pollutants Regulations* (MSAPR) set mandatory national performance standards for the cement sector and two equipment types used in several industrial sectors – gaseous-fossil-fuel-fired boilers and heaters, and stationary spark-ignition gaseous-fuel-fired engines. The performance standards limits the quantity of nitrogen oxide (NO_x) and sulphur dioxide (SO₂) that can be emitted from cement manufacturing facilities, and it limits the rate at which NO_x can be emitted from the two equipment types. However, MSAPR does not specify a particular technology that the firms have to use.

Also regarding air pollution, in Chile, there are local clean-up plans related to SO₂ and PM emissions, for example for “big industrial sources”. These include overall emission limits for the two industrial sources covered by the plans, rather than indicate specific control technologies that the firms have to apply. This allows companies to abate or reduce emissions in the sources and by the means of their convenience – they can select the process inside of their plant to implement abatement and can also compensate emissions with reductions at other sources if they want, also giving the firms a *where*-flexibility.

Regarding water pollution, in the United States, the 2009 *Effluent Guidelines for Discharges from the Construction and Development Industry* required all construction site owners and operators to implement a range of erosion and sediment control best management practices (BMPs) to reduce pollutants in storm-water discharges. In 2014, the *Revisions to the Construction and Development Effluent Guidelines* rule was promulgated to provide flexibility for permitting authorities to implement some of the rule requirements

and for permittee compliance. The revisions also clarified the requirement for permittees to provide and maintain buffers around many surface waters at construction sites, to reduce downstream siltation and flooding. Specifically, the 2014 revisions clarified the rule's languages in several areas that had caused confusion, and revised a number of the rule's non-numeric requirements to allow for additional flexibility in achieving them.

In relation to energy efficiency and CO₂ emissions, New Zealand's *Energy Using Products Regulations 2002* includes performance-based, and not prescriptive, requirements. A maximum allowable energy consumption standard is set for various products but the legislation does not constrain how compliance is to be achieved.

4.2. Where-flexibility

The questionnaire responses also provided examples regarding *where*-flexibility mechanisms in relation to air pollution. For instance, in Switzerland, there is a sectoral agreement on NO_x-emissions between the cement industry and the five cantons with cement plants on their territory (3 companies with 6 installations). The agreement was promoted by the Swiss Federal Office for the Environment (FOEN), and it defines lower emission limit values (ELV) for NO_x for cement plants than the *Ordinance on Air Pollution Control* (OAPC) does. The latter states since 2015 that the emissions shall be limited as far as it is technically and operationally feasible and economically acceptable, but at least to a maximum value of 500 mg NO_x per m³ (prior to 2015, the ELV was 800 mg NO_x per m³). The 2016 sectoral agreement states that each cement plant has to meet a yearly average value of 450 mg NO_x per m³ while all plants together must meet a yearly industry average value of 400 mg NO_x per m³. Unlike a stringent ELV, this gives flexibility to the three involved companies on where and how much to lower emissions. The cantons involved agreed on not to tighten the ELV for cement plants on a cantonal level, as long as the industry fulfils the requirements set by the sectoral agreement.

The exact definition of what is a regulated source can be important regarding *where*-flexibility – and it can have additional implications.⁹ For example, Wiseman (2019_[5]) indicated that in 2009, the US EPA found that a given plant which removes hydrogen sulfide from natural gas was a “major source” when combined with the many natural gas wells that sent gas to the plant. Classification of the plant as a “major source” would have obliged this plant to obtain a Title V operating permit under the *Clean Air Act*. The EPA made its major source determination by aggregating this plant with the natural gas wells. The plant, the gas wells and the distribution lines between the plants and wells were all owned by one company. The plant itself emitted almost 100 tonnes of several criteria pollutants (the limit for being classified as a “major source” according to the *Clean Air Act*), but did not reach the 100 tonne per year threshold without the addition of emissions from flares at the nearby natural wells. However, the Court of Appeals found that the EPA's interpretation of the regulation regarding source aggregation was inconsistent with the regulation and the EPA's previous interpretations and thus reversed the finding.

In some cases where a certain degree of *where*-flexibility is provided, there are limits to this flexibility. For example, Burtraw and Szambelan (2011_[8]) discusses the RECLAIM programme, which aims to bringing the Los Angeles Basin into attainment with the

⁹ See Dudek and Palmisano (1988_[33]) for an early discussion of the importance of the definition of a source, related to the introduction of some of the first flexibility mechanisms in the US *Clean Air Act*.

NAAQS for NO_x and SO₂. The programme covers a number of sources across two separate zones, “and sales of emissions allowances between zones are allowed to go in only one direction, so that the implicit shift in emissions does not contribute to downwind pollution”.

4.3. Who-flexibility

It was primarily in relation to air pollution regulations that the questionnaire responses provided examples of *who*-flexibility. For example, in the United States, the *Cross-State Air Pollution Rule* (CSAPR) Update – finalised in 2016 – requires electricity generating units (EGUs) in 22 Eastern States to reduce interstate transport of NO_x emissions that significantly contribute to non-attainment or interfere with maintenance of the 2008 ozone NAAQS.¹⁰ The CSAPR sets an EGU NO_x ozone-season emission budget, which is an allowable emission level, for each affected State each year. The regulation also sets up an interstate cap-and-trade programme to assure compliance and allows significant flexibility in meeting the budgets. The allowance trading programme converts the EGU NO_x emission budget for each of the 22 states subject to the regulation into a limited number of NO_x ozone-season allowances that equal the State’s ozone-season emission budget. Interstate trading and allowance banking is allowed, but the amount that the collective seasonal emissions from EGUs in a State may exceed that State’s budget is restricted. For the first few years of the programme, EGUs in each of the 22 States are required to participate in the CSAPR NO_x ozone-season allowance trading programme.¹¹

4.4. Which-flexibility

In Chile, one measure used in some *Air Decontamination Plans* regarding “big industrial sources” is to give them a cap on their annual emissions of PM, SO₂ and NO_x, based on their current emissions. Every “big industrial source” has to reduce its total annual emission (30% for the case of Santiago) over a certain time-period (4 years in the case of Santiago). Each “big industrial source” can select the process inside of their plant for which to implement abatement, and it can also compensate emissions with other sources if they want.

In the United States, according to the reformulated gasoline (RFG) rule under the *Clean Air Act*, refineries must reduce aggregate emissions of volatile organic compounds (VOCs) by 27%, but they can choose which type of VOC they reduce or remove from the fuel. However, different types of VOC have different impacts on ozone formation – the environmental problem that the RFG rule was meant to address. According to Aldy (2019^[9]), refineries have chosen to reduce emissions of VOC varieties that contributed little to ozone formation, and the *which*-flexibility that was provided did in reality undermine the environmental benefits of the RFG programme.

Concerning energy efficiency and CO₂ emissions, the questionnaire phrased the “which question” in terms of flexibility regarding *for which products* to achieve a given energy

¹⁰ As pointed out by Burtraw and Szambelan (2011^[8]), “the greatest economic impact from NO_x emissions stems from their contribution to the formation of secondary particulates concentrations and the resulting risk to human health. However, the driving forces behind NO_x emissions regulation have been concern about its contribution (along with SO₂) to the problem of acid rain and its contribution to the non-attainment of air quality standards for ozone.”

¹¹ The complete regulatory impact analysis for the *Cross-State Air Pollution Rule* update can be found at: https://www3.epa.gov/ttn/ecas/docs/ria/transport_ria_final-csapr-update_2016-09.pdf.

efficiency level, for example if a company can average the energy efficiency performance across a number of different product categories. United States provided an example regarding the rate-based light-duty vehicle performance standards that specify fuel economy (miles per gallon) and GHG (grams per mile) standards. Trading is allowed between truck and car fleets within the same automobile manufacturer, as well as between manufacturers to meet fleet-wide average fuel economy and GHG standards.

4.5. When-flexibility

The rate-based light-duty vehicle performance standards in the United States mentioned above also extended the time-period for banking of credits, thus providing a higher flexibility as regards when to improve the environmental performance of the vehicles.

As indicated above, the length of the time-period over which an average or total emission amount is calculated impacts directly on the flexibility of the regulation. The longer the time-periods, the more flexibility is granted to the regulated sources.

Such flexibility can reduce compliance costs for the regulated firms, but it can also have negative environmental implications, if the time-period in question includes moments in time when the environmental problem is small. According to Aldy (2019^[9]), some elements of the so-called “State boutique fuels program” in the United States apply only during the high-ozone season of the summer months, whereas others only covers the high-carbon-monoxide season in winter.

5. Impacts of different flexibility mechanisms

Table 1 presents some possible impacts of *hypothetical* flexibility mechanisms, focusing on whether the environmental issue is of a stock or a flow character. The subsequent sections discuss such impacts further, drawing on the available literature.

Before commenting further on possible environmental and economic impacts of the use of flexibility mechanisms in environmental regulations, it should be pointed out that such use can also have legal implications. Principles like legal certainty, the rule of law and equal treatment of different citizens should of course continue to be respected. Providing some sort of flexibility might, for example, sometimes be more economically efficient, but at the expense of such principles.

5.1. Environment and health impacts

Adding flexibility mechanisms on top of pre-existing “command-and-control” regulations can trigger both positive and negative impacts on the environment and on human health. Ellerman (2006^[11]) gives the example of the RECLAIM trading programmes for NO_x and SO₂. An explicit command-and-control programme to bring the region into attainment by 2010 – the 1989 Air Quality Management Plan – had already been developed, but its implementation would be costly and slow. Ellerman (2006^[11]) states that “Three years of negotiation between regulators and the regulated eventuated in agreement in late 1993 on two phased-in cap-and-trade programs, one for NO_x and the other for SO₂, that would achieve the desired level of aggregate emissions in ten years, or by 2003, seven years sooner than in the 1989 Plan. Facilities participating in these programs were then exempt from the prescriptive requirements contained in the 1989 Plan as concerns NO_x and SO₂ emissions.”

Table 1. Possible impacts of different hypothetical flexibility mechanisms

| | Stock issue | Flow issue |
|---|--|--|
| <i>Hypothetical examples of "command-and-control" instruments</i> | <p><i>An energy-efficiency standard for electrical appliances aiming to limit the concentration of greenhouse gases in the atmosphere</i></p> <p><i>An energy-efficiency standard for coal-fired power plants also aiming to limit the concentration of greenhouse gases in the atmosphere</i></p> | <p><i>A standard prescribing the use of a given technology to limit the noise level of motorcycles</i></p> <p><i>A standard prescribing the use of scrubbers at coal-fired power-plants in order to limit SO₂ emissions</i></p> |
| How-flexibility | An energy-efficiency standard for electrical appliances or for power plants would normally not specify how a given performance is to be achieved, but if it did include some restrictions, increased how-flexibility would not affect the environmental outcome, but could reduce economic costs of compliance. | <p>Flexibility on how to reach a given noise level could reduce economic costs and need not have negative environmental impacts – if this would not affect the enforceability of the standard.</p> <p>Replacement of the technology standard for power plants with a performance standard, allowing each plant to decide on how to reach a given performance level, could reduce costs and should not have significant environmental impacts</p> |
| Where-flexibility | <p>Where-flexibility seems to be of little relevance for electrical appliances</p> <p>A possibility for electricity producers to average energy-efficiency performance across several coal-fired plants could reduce abatement costs and would not have an impact on the GHG concentrations. A change in the location of power generation could, however, have impacts on the consequences of <i>other</i> emissions caused by the plants concerned.</p> | <p>Where-flexibility seems to be of little relevance for a noise standard for motorcycles.</p> <p>A possibility for electricity producers to average SO₂ emissions per kWh produced across several coal-fired plants could reduce abatement costs but would also change the location of where the emissions with negative health impacts takes place. Depending on the prevailing wind patterns and on the population concentrations in the affected areas, this could increase or decrease the social costs caused by the emissions.</p> |
| Who-flexibility | <p>The impacts are largely similar to those of where-flexibility.</p> <p>Perhaps a standard for coal-fired power plants could include a possibility to offset emissions linked to the plant with reduced methane emissions linked to the mining of the coal, which potentially could reduce overall abatement costs.</p> | The impacts are largely similar to those of where-flexibility. |
| Which-flexibility | <p>Not relevant for the electrical appliance standard.</p> <p>If an offset mechanism was included in the power plant standard, this could allow reductions in methane emissions to replace reductions in CO₂ emissions.</p> | Not relevant for these two standards. |
| When-flexibility | In both cases, it would be possible to look at average energy-efficiency over a certain timeframe. While this might reduce compliance costs somewhat, the environmental impacts would be very modest, as they are determined by the accumulated concentration of GHGs in the atmosphere. | <p>When-flexibility is of no relevance for a noise standard for motorcycles.</p> <p>A possibility for electricity producers to average SO₂ emissions per kWh produced over an extended time-period could reduce compliance costs somewhat. If the averaging is done within each of the plants, the impacts on the environment and on human health should be relatively modest.</p> |

Many economists have considered the introduction of the cap-and-trade¹² mechanism of the Acid Rain Program under the US *Clean Air Act* as one of the most successful implementations of economic instruments for environmental policy, cf. e.g. Stavins (1998^[12]), Schmalensee et al. (1998^[13]), Burtraw and Szambelan (2011^[8]), Schmalensee and Stavins (2013^[14]) and Patashnik (2019^[15]). This trading system provided a large flexibility for the affected power plants to limit their SO₂ emissions, and the *how-*, *where-*, *who-* and *when-*flexibility offered by this trading system triggered important cost-savings for the power plants, which “everyone” has thought was a great success.

Ellerman (2006^[11]) argues that this programme provided emissions reductions faster than what a command-and-control system likely would have done, largely due to the banking provisions it included. He also argues that the real-world emission reductions related to the trading system were larger than what they would have been if traditional regulatory instruments had been applied, because the latter category of instruments would always allow polluters with particularly high abatement costs to petition to obtain some sort of relaxation of their reduction obligation. He indicated that there were no similar mechanisms in the trading programme, as polluters with particularly high abatement costs could simply buy emission allowances in the market.

The Acid Rain Program included an opt-in mechanism, with voluntary compliance possibilities for certain non-affected sources, such as industrial plants. Such a scheme might unfortunately encourage “adverse selection”. When permit allocation is based upon historical emissions, the firms that would be most likely to volunteer would be firms that had since undertaken abatement even in the absence of the programme. Montero (1999^[16]) found that this “substitution” provision of the Acid Rain Program mostly was taken up by plants which, by doing so, were grandfathered emission permits in excess of what would have been their “business-as-usual” emissions. These plants had already – for economic reasons – reduced their emissions significantly between the base year used for permits allocations (1988) and the start of the programme in 1993. To the extent this was the case, this reduced the environmental effectiveness of the programme.

Chan et al. (2018^[2]) found that the flexibility caused by the emission trading system (compared to a system that reduced *total* SO₂ emissions by an equal amount,¹³ but with uniform emission reduction obligations for all the affected plants) effectively shifted the emissions from sparsely populated areas in the mid-West to densely populated areas in Eastern United States. This meant that a given amount of total emissions caused more health damages with the trading system than the assumed system with uniform emission reductions – and Chan et al. (2018^[2]) estimated that the costs to society of these additional

¹² Trading systems can either be based on credits earned compared to some sort of a “baseline”, meant to reflect what would happen in the absence of this mechanism, or on tradable allowances under a “cap” set by the regulator, allocated to the affected firms either for free, e.g. based on some sort of “grandfathering” or through auctioning. Participation in a baseline-and-credits system will by nature always be voluntary, whereas participation in a cap-and-trade system can either be compulsory or voluntary, through some sort of “opt-in” mechanism. OECD (2003^[35]) discusses this issue further.

¹³ One can, however, discuss the realism of this assumption. It is not given that the US Congress would have agreed to require as large emission reductions as was agreed for the Acid Rain Program without the flexibility that the emission trading system offered. In addition, one should take into account the points mentioned above, made by Ellerman (2006^[11]), regarding the timing of abatement measures, and regarding possibilities for polluters with particularly high abatement costs to petition for some sort of relaxation of their reduction obligation under a regulatory system.

health damages were in the order of ten times larger than the cost savings for the power plants.

Fowlie (2010_[17]) had previously assessed impacts of the NO_x Budget Program that limits emissions of NO_x from large stationary sources in 19 Eastern States in the United States – another programme based on the *Clean Air Act*. She found that the type of economic regulations that the different plants were subject to had important implications for how the trading system affected the distribution of emissions. Deregulated generators in restructured electricity markets were less likely to install capital-intensive pollution control technologies than similar plants that were either subject to electricity price regulation or were publicly owned and operated. Asymmetric economic regulation in the electricity industry was found to have increased the total damages caused by permitted NO_x emissions. Health and environmental damages would according to Fowlie (2010_[17]) probably have been less under symmetric economic regulation, with relatively more of the permitted NO_x emitted in relatively low-damage areas.¹⁴

As Chan et al. (2018_[2]) emphasise, the negative health impacts of a shifting of emission locations do, of course, not mean that allowing emissions trading always (or most often) will generate net social welfare losses – their finding was based on the circumstances surrounding that particular trading scheme, and so were the findings of Fowlie (2010_[17]). If, for example, wind directions in the United States had been the opposite of what they are, or if the cost structures of power plants in different regions had been different, the results of the analysis would have been different.

Further, both Chan et al. (2018_[2]) and Fowlie (2010_[17]) discussed impacts of (primarily) *where*-flexibility in relation to local or regional air pollution (flow). If the trading had affected a global issue, like CO₂ emissions, rather than a local or regional environmental issue, *where*-flexibility would matter much less. One should, however, be aware that many measures to limit CO₂ emissions would also have impact on emissions of other pollutants, for which *where*-flexibility could have larger environmental impacts.

Also *which*-flexibility can have important environmental implications. For example, according to Aldy (2019_[9]), the *which*-flexibility that was provided in the reformulated gasoline (RFG) programme in United States – which permitted refineries to choose which types of VOC they wanted to reduce emissions of – undermined the programme's environmental benefits. He concludes that

“[W]hen flexibility is permitted for a proxy for environmental and public health damage – in this case VOC emissions is a proxy for the adverse health impacts from exposure to ambient ozone concentrations – then it is important that this proxy has a clear relationship with the social damage. In this case, the weak relationship between the mix of VOCs and ozone concentrations means that performance standards could lower both costs *and* benefits.”¹⁵

¹⁴ In contrast, Fowlie et al. (2012_[37]) found that average emissions fell 20% at RECLAIM facilities in Southern California relative to the counterfactual they established. The observed changes in emissions did not vary significantly with neighbourhood demographic characteristics.

¹⁵ For additional discussion of the environmental impacts of this programme, see Auffhammer and Kellogg (2011_[30]).

5.2. Economic impacts

The primary reason for companies to argue in favour of the use of flexibility mechanisms in CAC regulations is to create possibilities for reductions in compliance costs.¹⁶ And such cost reductions can be important: According to Chan et al. (2018^[2]), the cost savings of the US SO₂ trading programme – compared to a counterfactual system with uniform emission reduction obligations of a similar overall magnitude – were around USD₁₉₉₅ 200 million. Hence, one can well understand that the coal-fired power generators were keen to get the flexibility offered by the programme.

In some cases, trading mechanisms have been introduced to help small producers to comply – making it possible for them to buy emission allowances from other plants, instead of investing in potentially expensive abatement technologies. For example, Aldy (2019^[9]) indicates that both the US RFG programme and the earlier US trading programme in relation to the phase-out of lead in gasoline “was responsive to small refineries’ needs, [and] permitted interrefinery averaging for compliance”. Addressing the needs of small producers can reduce political resistance to stricter environmental regulations.

Since 2000, Switzerland applies a budget-neutral incentive tax on VOC emissions. The proceeds of the tax are distributed as yearly lump-sum payments to the Swiss population. Side-by-side with a command-and-control *Ordinance on Air Pollution Control (OAPC)*, this instrument provides considerable flexibility and incentives to Swiss industry to lower its VOC-emissions in a cost-effective way and rewards innovative solutions to do so.¹⁷ The flexibility of the OVOC is afforded at different levels: First, companies decide themselves by which measures they reduce their emissions. If they provide evidence that the taxed VOCs were not emitted, they get a refund. Second, certain installations can be generally exempted from the tax altogether, if they lower emissions at least 50% below emission limits, have an air purification plant (APP) operational for more than 95 % of the operating time and lower the emissions that are not processed by the APP in accordance with the best

¹⁶ Dudek and Palmisano (1988^[33]) argued that “we would expect that “cheap” reductions would be taken first and that consequently, mostly economic, as opposed to environmental, benefits would develop in the early phases” after the adding of a flexibility mechanism such as “offsets” and “netting” on top of the “command-and-control” regulations of the US *Clean Air Act* at that time. The Offset Policy was introduced in 1976 and allowed new sources or major source modification to be sited in so-called nonattainment areas so long as overall emission reductions were achieved within the airshed leaving the area better off than before. Netting was introduced in 1984 and allowed the use of credits from surplus emission reductions at an existing facility to compensate for the emission increases associated with a proposed modification at the same facility.

¹⁷ Schoenenberger and Mack (2009^[32]) discussed the impacts of this tax on innovation in Switzerland. The tax does not apply to all products classed as VOCs, partly because of the excessive administrative burden on customs clearance of all substances. A “positive list of substances” (benzene, butanes, ethers, oil, etc.) in Annex 1 of the *Ordinance on the Incentive Tax on Volatile Organic Compounds (OVOC)* identifies the VOCs liable for the tax. The list is regularly updated in a consultative process with industry and includes only the environmentally and quantitatively most important VOCs. The “positive list of products” (e.g. solvents, colorants, paints, perfumes, beauty products) in Annex 2 does the same for products containing VOCs. As emissions are difficult to measure within a given firm, VOCs are taxed on entry into production and on importation into Switzerland. Imported products containing VOCs are taxed on importation according to the quantity of VOCs they contain. Exporters get a refund and industry is eligible for tax exemptions, if they prove the VOC were not emitted. Products manufactured in Switzerland are taxed indirectly through the tax already levied when VOC substances are purchased.

available technology (BAT) as prescribed and updated at five-year intervals by the ordinance. This exemption rule provides flexibility to large-scale polluters and mandates generous transition rules to adopt a new BAT standard in accordance with company-specific investment cycles. Meanwhile, the staggered limit values of the OAPC guarantee that VOC-emissions are restricted at all times according to their environmental danger, as prescribed by a substance-specific classification.

In August 2017, reacting on a proposal by the National Council (lower house chamber of the Swiss parliament, representing the population) to abolish the incentive tax, the Council of States (upper house chamber of the Swiss parliament, representing the cantons) demanded that the administration undertake an in-depth evaluation of the policy instruments in place to address VOC emissions. The purpose of the evaluation was to determine if a change of system – including an abolishment of the incentive tax – could be more cost-effective, while maintaining the same level of environmental protection. Several studies, not yet published, have been undertaken. The studies indicate that without the tax, emissions would start rising again for a number of product categories and that a part of the command-and-control policies for industry would be much less effective without it, which in turn would also make emissions rise. As a consequence, in order to keep the same level of environmental protection, stricter command-and-control-policies would have been needed for a much wider circle of facilities. These stricter policies would have led to higher costs for industry and the administration, as became clearly evident during a number of consultative workshops that were held – it was agreed by all, that this was not an attractive route to take.

The parliament was ultimately presented with a choice between (option a) a future without the VOC incentive tax, a rise in emissions and a reduction in the administrative burden; and a scenario (option b) with the VOC incentive tax and a commitment to lower the administrative burden based on past achievements in industry and a commitment to simplify administrative procedures. In the end, the Council of States decided unanimously to keep the VOC incentive tax in place – with the flexibility it provides – and to call for a reduction in the administrative burden, particularly for those facilities that had already made considerable progress in the past (option b).

Not all economic impacts of adding flexibility mechanisms to environmental regulations are positive. Building i.a. on Blackman and Mazurek (2000^[18]), O'Brien (2001^[19]) suggests that the administrative costs of implementing some flexibility mechanisms can be quite high. It is, of course, also important to take such costs into account when assessing whether to introduce, or to keep in place, a given flexibility mechanism. In addition, OECD (2014^[20]) indicate that enforcement costs can be higher under schemes with greater flexibility.

As mentioned, some programmes under the US *Clean Air Act* were designed to work when their environmental benefits will be the largest. This is particularly the case in relation to programmes addressing ozone, which primarily is an issue during the summer. Kosobud et al. (2008^[21]) indicate that in relation to the Chicago VOC trading programme, checking seasonal – as opposed to annual – emissions represented a practical difficulty, which would tend to increase the administrative costs.¹⁸

¹⁸ Evans and Kruger (2007^[34]) provides additional discussion of this programme.

6. Conclusions

The literature on the impacts of adding various types of flexibility mechanisms to CAC regulations is relatively sparse, and, unfortunately, the responses to the questionnaire used in this project revealed that very few ex post assessments of such mechanisms have been carried out.

Any addition of new flexibility mechanisms *ought* to be based on careful assessments of the related social costs and benefits, with the aim to maximise social welfare¹⁹ – taking due account of the distribution of the costs and benefits.²⁰ This project has not improved the situation in this respect a lot, other than in documenting a clear lack of in-depth assessments.

It is possible that the most important environmental and human health impacts stemming from the introduction of a flexibility mechanism in a CAC regulation is caused by provisions that provide a *where*-flexibility. As with the two US trading programmes analysed by Chan et al. (2018_[2]) and Fowlie (2010_[17]), such flexibility will change the area and population affected by the emissions – with potential positive and negative impacts for the people concerned. *Who*-flexibility can have similar consequences, to the extent that this flexibility also allows geographic relocation of emissions.

Which-flexibility can also have important environmental implications, as exemplified by Aldy's (2019_[9]) discussion of the US RFG programme. As he indicated, when flexibility is permitted for a *proxy* for environmental and public health, then it is important that this proxy has a clear relationship with the social damage. If the link between the proxy and the underlying externality is weak, allowing a *which*-flexibility to a regulation can compromise the environmental intention of the regulation.

The findings of Aldy (2019_[9]), Chan et al. (2018_[2]) and Fowlie (2010_[17]) highlight the need to make careful assessments of the various potential and realised impacts of different policy measures, both ex ante and ex post. Whereas the present project has provided clear indications that it is *not* common to do so, it is hoped that the project can serve to stimulate new CBAs in the future. Such studies will i.a. be able to draw on OECD's new book on *Cost-Benefit Analysis and the Environment*, cf. OECD (2018_[22]).

¹⁹ The intention is *not* to indicate that such modifications ought to be subject to stricter scrutiny than what is common in other policy contexts. *Ideally*, all policy instruments ought to periodically be re-assessed, with the view to consider if any modifications to them could entail net social benefits. However, in practice, there are of course limits to the capacity of administrations to conduct ex post policy analyses.

²⁰ For a discussion of the inclusion of distributive concerns in cost-benefit analyses, see OECD (2018_[22]).

References

- Aldy, J. (2019), “Promoting Environmental Quality through Fuels Regulations: Lessons for a Durable Energy and Climate Policy”, in Carlson, A. and D. Burtraw (eds.), *Lessons from the Clean Air Act: Building Durability and Adaptability into U.S. Climate and Energy Policy*, Cambridge University Press. [9]
- Auffhammer, M. and R. Kellogg (2011), “Clearing the air? The effects of gasoline content regulation on air quality”, *American Economic Review*, Vol. 101, pp. 2687-2722, <http://dx.doi.org/10.1257/aer.101.6.2687>. [30]
- Blackman, A. and J. Mazurek (2000), “The Cost of Developing Site-Specific Environmental Regulations: Evidence from EPA’s Project XL”, *RFF Working Papers*, No. 99–35–REV, Resources for the Future, Washington DC, <http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-99-35-REV.pdf>. [18]
- Böhringer, C. (2013), “Two Decades of European Climate Policy: A Critical Appraisal”, *ZenTra Working Papers in Transnational Studies*, No. 21/2013, Center for Transnational Studies (ZenTra), <http://ssrn.com/abstract=2361349>. [29]
- Böhringer, C., H. Koschel and U. Moslener (2008), “Efficiency losses from overlapping regulation of EU carbon emissions”, *Journal of Regulatory Economics*, Vol. 33, pp. 299-317, <http://dx.doi.org/10.1007/s11149-007-9054-8>. [28]
- Braathen, N. (2011), “Interactions Between Emission Trading Systems and Other Overlapping Policy Instruments”, *OECD Green Growth Papers*, No. 2011/2, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5k97gk44c6vf-en>. [24]
- Burtraw, D., K. Palmer and D. Kahn (2010), “A symmetric safety valve”, *Energy Policy*, Vol. 38/9, pp. 4921-4932, <http://dx.doi.org/10.1016/j.enpol.2010.03.068>. [10]
- Burtraw, D. and S. Szambelan (2011), “U.S. Emissions Trading Markets for SO₂ and NO_x”, in Hansjürgens, B., R. Antes and M. Struntz (eds.), *Permit Trading in Different Applications*, Routledge, Abingdon. [8]
- Carlson, A. and D. Burtraw (eds.) (2019), *Lessons from the Clean Air Act: Building Durability and Adaptability into U.S. Climate and Energy Policy*, Cambridge University Press. [1]
- Chan, H. et al. (2018), “The impact of trading on the costs and benefits of the Acid Rain Program”, *Journal of Environmental Economics and Management*, Vol. 88, pp. 180-209, <http://dx.doi.org/10.1016/j.jeem.2017.11.004>. [2]
- Coysh, D. et al. (2019), “Vintage Differentiated Regulations and Plant Survival: Evidence from Coal-fired Power Plants”, *OECD Environment Working Papers*, OECD Publishing, Paris, <http://www.oecd.org/environment/workingpapers.htm>. [36]
- Dudek, D. and J. Palmisano (1988), “Emissions Trading: Why is this Thoroughbred Hobbled?”, *Columbia Journal of Environmental Law*, Vol. 13, pp. 217-256, <https://heinonline.org/HOL/License>. [33]

- Ellerman, D. (2006), “Are cap-and-trade programs more effective in meeting environmental goals than command-and-control alternatives?”, in Freeman, J. and C. Kolstad (eds.), *Moving to Markets in Environmental Regulation: Lessons from Twenty Years of Experience*, Oxford University Press, Oxford, <http://dx.doi.org/10.1093/acprof:oso/9780195189650.003.0003>. [11]
- Evans, D. and J. Kruger (2007), “Where are the sky’s limits? Lessons from Chicago’s cap-and-trade program”, *Environment: Science and Policy for Sustainable Development*, Vol. 49/2, pp. 18-32, <http://dx.doi.org/10.3200/ENVT.49.2.18-32>. [34]
- Fischer, C., R. Newell and L. Preonas (2014), “Environmental and Technology Policy Options in the Electricity Sector: Interactions and Outcomes”, *CESIFO Working Paper*, No. 4757, CESIFO, <http://www.ifo.de/w/425KEEnVR>. [27]
- Fowlie, M. (2010), “Emissions trading, electricity restructuring, and investment in pollution abatement”, *American Economic Review*, Vol. 100, pp. 837-869, <http://dx.doi.org/10.1257/aer.100.3.837>. [17]
- Fowlie, M., S. Holland and E. Mansur (2012), “What do emissions markets deliver and to whom? Evidence from Southern California’s NOx trading program”, *American Economic Review*, Vol. 102/2, pp. 965-993, <http://dx.doi.org/10.1257/aer.102.2.965>. [37]
- Gunningham, N. (2011), *Improving the Economic Efficiency of Environmental Regulation: Scoping Paper*, OECD, Paris, [http://ENV/EPOC/WPIEEP\(2011\)9/ADD1](http://ENV/EPOC/WPIEEP(2011)9/ADD1). [3]
- Hašič, I., N. Johnstone and M. Kalamova (2009), “Environmental policy flexibility, search and innovation”, *Czech Journal of Economics and Finance*, Vol. 59/5, pp. 426-441, http://journal.fsv.cuni.cz/storage/1168_str_426_441.pdf. [7]
- Kosobud, R. et al. (2008), “Regulatory conflict in the Chicago VOC control program”, *Journal of Environmental Planning and Management*, Vol. 51/4, pp. 561-579, <http://dx.doi.org/10.1080/09640560802117093>. [21]
- Levinson, A. (2010), “Belts and Suspenders: Interactions Among Climate Policy Regulations”, *NBER Working Papers*, No. 16109, National Bureau of Economic Research, Cambridge, MA, <http://www.nber.org/papers/w16109>. [25]
- Montero, J. (1999), “Voluntary Compliance with Market-Based Environmental Policy: Evidence from the U.S. Acid Rain Program”, *Journal of Political Economy*, Vol. 107/5, pp. 998-1033, <https://doi.org/10.1086/250088>. [16]
- O’Brien, P. (2001), “Encouraging Environmentally Sustainable Growth in the United States”, *OECD Economics Department Working Papers*, No. 278, OECD Publishing, Paris, <http://dx.doi.org/10.1787/037506286027>. [19]
- OECD (2018), *Cost-Benefit Analysis and the Environment: Further Developments and Policy Use*, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264085169-en>. [22]
- OECD (2018), *Taxing Energy Use 2018: Companion to the Taxing Energy Use Database*, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264289635-en>. [31]
- OECD (2014), *Regulatory enforcement and inspections.*, OECD Publishing, PARIS. [20]
- OECD (2003), *Voluntary Approaches for Environmental Policy: Effectiveness, Efficiency and Usage in Policy Mixes*, OECD Publishing, Paris, <https://dx.doi.org/10.1787/9789264101784-en>. [35]

- Patashnik, E. (2019), “The Clean Air Act’s Use of Market Mechanisms”, in Carlson, A. and D. Burtraw (eds.), *Lessons from the Clean Air Act: Building Durability and Adaptability into U.S. Climate and Energy Policy*, Cambridge University Press. [15]
- Ruijs, A. and H. Vollebergh (2013), “Lessons from 15 Years of Experience with the Dutch Tax Allowance for Energy Investments for Firms”, *OECD Environment Working Papers*, No. 55, OECD Publishing, Paris, <http://dx.doi.org/10.1787/5k47zw350q8v-en>. [6]
- Schmalensee, R. et al. (1998), “An Interim Evaluation of Sulfur Dioxide Emissions Trading”, *Journal of Economic Perspectives*, Vol. 12/3, pp. 53-68, <http://dx.doi.org/10.1257/jep.12.3.53>. [13]
- Schmalensee, R. and R. Stavins (2013), “The SO₂ Allowance Trading System: The Ironic History of a Grand Policy Experiment”, *Journal of Economic Perspectives*, Vol. 27/1, pp. 103-122, <http://dx.doi.org/10.1257/jep.27.1.103>. [14]
- Schoenenberger, A. and A. Mack (2009), *Effects of the VOC Incentive tax on innovation in Switzerland: Case studies in the printing, paintmaking and metal cutting industries*, OECD, Paris, [http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=com/env/epoc/ctpa/cfa\(2008\)35/final](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=com/env/epoc/ctpa/cfa(2008)35/final). [32]
- Sijm, J. (2005), “The interaction between the EU emissions trading scheme and national energy policies”, *Climate Policy*, Vol. 5, pp. 79-96, <https://doi.org/10.1080/14693062.2005.9685542>. [26]
- Smith, S. (2008), *Environmentally Related Taxes and Tradable Permit Systems in Practice*, OECD, Paris, [http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=com/env/epoc/ctpa/cfa\(2007\)31/final](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=com/env/epoc/ctpa/cfa(2007)31/final). [4]
- Stavins, R. (1998), “What Can We Learn from the Grand Policy Experiment? Lessons from SO₂ Allowance Trading”, *Journal of Economic Perspectives*, Vol. 12/3, pp. 69-88, <http://dx.doi.org/10.1257/jep.12.3.69>. [12]
- Toman, M., R. Morgenstern and J. Anderson (1999), “The Economics of When Flexibility in the Design of Greenhouse Gas Abatement Policies”, *Discussion Paper*, No. 99-38-REV, Resources for the Future, Washington, DC, <http://www.rff.org/RFF/documents/RFF-DP-99-38-REV.pdf>. [23]
- Wiseman, H. (2019), “Stationary Sources, Movable Rules: Intransigence and Innovation under the Clean Air Act”, in *The Future of U.S. Energy Policy: Lessons from the Clean Air Act*, Cambridge University Press. [5]

Annex A. Survey of current use of flexibility mechanisms

In order to get a better picture of the current use of flexibility mechanisms in “command-and-control” environmental regulations, a survey was carried out among member countries. The questionnaire that was used in this survey covered three different environmental issues, namely regulations addressing air and water pollution as well as regulations addressing energy efficiency or CO₂ emissions, cf. Annex B. It asked about when the original regulation was introduced; what type of regulation it was; when the flexibility mechanism was introduced; what type of flexibility it provided; and what the main motivations for introducing this type of flexibility were.

In addition, the questionnaire sought to get a picture of what the impacts of providing the different flexibilities had been, by asking about the existence and the outcomes of ex post evaluations of the mechanisms in question.

Unfortunately, the response rate in the survey was low, and the replies that were given did not include many examples of such flexibility mechanisms.²¹ In addition, the replies received revealed that very few ex post assessments of the impact of the flexibility mechanisms have been carried out. Hence, the questionnaire responses do not make it possible to say much about what the impacts of the flexibility mechanisms have been.

This annex provides some information about the flexibility mechanisms mentioned in the questionnaire responses. However, it is emphasised that the comments below are based on responses regarding a limited number of flexibility mechanisms applied in an even more limited number of countries. Hence, one should be very careful when interpreting the findings, and not draw any clear conclusions.

Table A.1 indicates when the “command-and-control” regulation – to which the flexibility mechanism is applied – first was introduced. There were no clear patterns across the three types of environmental issues that were covered.

²¹ Calculating the exact response rate is not straightforward, as the “depth” of the replies varied much, from “we do not have any flexibility mechanisms in place”, through partial answers in relation to one or two of the environmental issues covered, onto relatively complete answers regarding all three environmental categories. Some sort of reply was received from Canada, Chile, the Czech Republic, Germany, Hungary, the Netherlands, New Zealand, Norway, Switzerland and the United States.

Table A.1. When was the original regulation introduced?

| | Air pollution | Water pollution | Energy efficiency & CO ₂ |
|--------------|---------------|-----------------|-------------------------------------|
| Before 1990 | 1 | 2 | 3 |
| 1990-1999 | 4 | 1 | 0 |
| 2000-2004 | 1 | 3 | 1 |
| 2005-2009 | 2 | 1 | 1 |
| 2010-2014 | 1 | 1 | 3 |
| 2015-2017 | 5 | 0 | 1 |
| Total | 14 | 8 | 9 |

Note: For each environmental issue, the highest absolute number(s) is put in bold.

Table A.2 presents some information on the CAC regulation to which a flexibility mechanism has been added. The majority of the regulations concerning air pollution specified a limit on emissions of a particular category. Half of the regulations addressing water pollution where a flexibility mechanism had been introduced stipulated a particular environmental standard that was to be met.

Table A.2. Description of the restriction

| | Air pollution | Water pollution | Energy efficiency & CO ₂ | |
|------------------------------------|---------------|-----------------|-------------------------------------|---|
| Proscribed an abatement technology | 0 | 1 | 0 | Proscribed use of goods produced with a particular technology |
| Proscribed a production input | 0 | 0 | 0 | Proscribed use of goods produced with a particular input |
| Restricted an abatement technology | 0 | 1 | 0 | Restricted use of goods produced with a particular technology |
| Restricted a production input | 0 | 0 | 0 | Restricted use of goods produced with a particular input |
| Specified an emission limit | 9 | 3 | 1 | Specified a max. amount of energy use for certain appliances |
| Specified environmental standard | 4 | 5 | | Not used |
| Other | 1 | 0 | 8 | Other |
| Total | 14 | 10 | 9 | Total |

Note: For each environmental issue, the highest absolute number is put in bold. The questionnaire allowed the selection of several responses to this question.

As shown in Figure A.1, almost all the air pollution regulations addressed several industrial sectors. This was also the regulated entities in the majority of the cases regarding water pollution, but the regulations that addressed energy efficiency or CO₂ emissions where a flexibility mechanism had been added mostly concerned a single industrial sector.

Figure A.1. Who are the regulated entities?

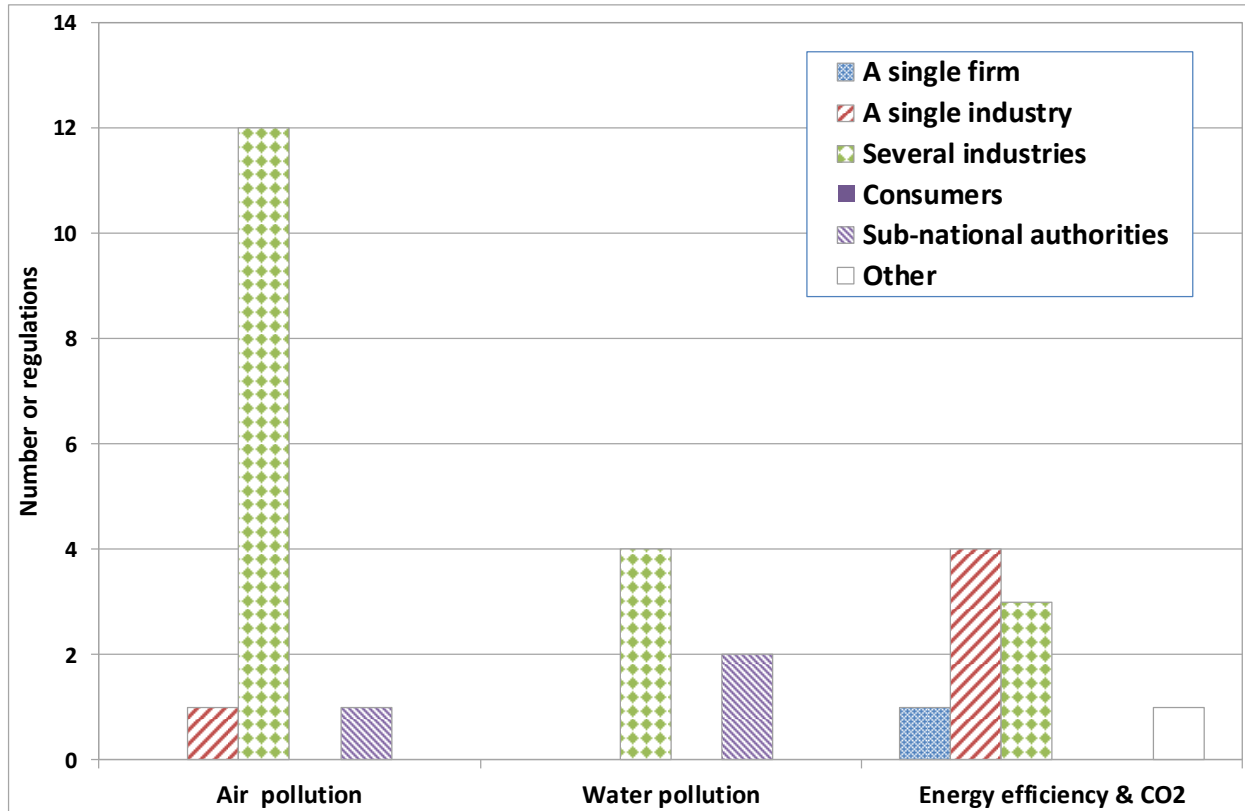


Table A.3 gives some information about the stated primary motivations behind the introduction of a given flexibility mechanism. From an economic point of view, the most frequent argument used in favour of more flexibility in environmental regulations is probably that it would reduce the costs of environmental protection, but this does not seem to have been the most important reason for the introduction of the mechanisms covered here. Instead, according to the responses received, it is rather the possibilities for achieving better environmental outcomes without raising costs significantly that mostly has motivated the flexibility mechanisms that are in place at present, at least as regards air and water pollution.

Table A.3. What were the primary motivations for using a flexibility mechanism?

| | Air pollution | Water pollution | Energy efficiency & CO ₂ | |
|-----------------------------------|---------------|-----------------|-------------------------------------|--|
| Cost-savings for emitters | 3 | 3 | 4 | Cost-savings for the appliance producers |
| Not used | | | 0 | Cost savings for the appliance users |
| Cost-savings for authorities | 4 | 1 | 0 | Cost-savings for public authorities |
| Better environmental outcomes | 8 | 6 | 3 | Better environmental outcomes |
| Better economic distribution | 4 | 3 | 3 | Better economic distribution |
| Better environmental distribution | 0 | 4 | 0 | Better environmental distribution |
| Better political acceptability | 4 | 1 | 1 | Better political acceptability |
| Other | 0 | 0 | 5 | Other |
| Total | 23 | 18 | 16 | Total |

Note: For each environmental issue, the highest absolute number is put in bold. The questionnaire allowed the selection of several responses to this question.

Table A.4 gives some information about which type of flexibility mechanisms have been included in CAC regulations in relation to the three environmental issues that were covered in the questionnaire. There is *not* a clear pattern in the few replies received, but how-flexibility was the most frequent reply in relation to both air and water pollution, and one of several most common alternatives regarding energy efficiency and CO₂ emissions.

Table A.4. Which type of flexibility mechanism has been included in this regulation?

| | Air pollution | Water pollution | Energy efficiency & CO ₂ | |
|--|---------------|-----------------|-------------------------------------|----------------------------|
| How-flexibility | 5 | 3 | 2 | How flexibility |
| Where-flexibility | 4 | 1 | 2 | Which product flexibility |
| Who-flexibility | 3 | 0 | 1 | Who flexibility |
| Which-flexibility | 1 | 1 | | Not used |
| When-flexibility | 0 | 1 | 2 | When flexibility |
| Implementation-flexibility ²² | 1 | 2 | 1 | Implementation flexibility |
| Other flexibility | 0 | 0 | 1 | Other flexibility |
| Total | 14 | 8 | 9 | Total |

Note: For each environmental issue, the highest absolute number(s) is put in bold.

²² This could, for example, refer to a case where national authorities sets common nation-wide environmental objectives, but let relevant sub-national authorities decide on which policy instruments to apply to achieve those objectives in that area.

Annex B. The questionnaire used in the survey

The text below reproduces a part of the questionnaire that was used in the survey of current use of flexibility mechanisms in “command-and-control” environmental regulations. The questions regarding the use of flexibility mechanisms in regulations addressing local air pollution are presented as an example. Very similar questions were also asked in relation to flexibility mechanisms in regulations addressing water pollution and in regulations addressing energy efficiency or CO₂ emissions.

Introduction

This questionnaire is based on the discussion of flexibility mechanisms in “command-and-control” regulations in the scoping note ENV/EPOC/WPIEEP(2017)2, presented to the WPIEEP meeting 5-7 July 2017, where it was proposed to do a survey among member and partner countries about the use of flexibility mechanisms in environmental regulations. A draft questionnaire, ENV/EPOC/WPIEEP(2017)2/ADD1, was also presented to that meeting, and the current version takes into account comments made on that draft during the WPIEEP and through bilateral contact with members of the Bureau. More explanation and examples of possible responses have been added, and two additional issues, water pollution and energy efficiency or CO₂ emissions, have been covered.

The reason for including the latter environmental issue is that CO₂ (as opposed to local air pollution and water pollution) is a *stock issue* rather than a flow issue – it is the concentration of CO₂ and other greenhouse gases in the atmosphere that causes the environmental damage, not the annual emissions of these gases. In addition, while regulations regarding the two former environmental issues mostly would address producers, energy efficiency regulations could more often have a direct impact on consumers as well. It can be of interest to try and see if these differences have an impact on the use of flexibility mechanisms in environmental regulations.

Throughout this questionnaire, the term “regulation” refers to any type of “command-and-control” environmental policy instrument, such as *compulsory* standards, norms, environmental permits, etc. The term “flexibility mechanism” refers to any sort of provision that gives the regulated entities an (increased) freedom to choose how to comply with the regulation in question. These provisions can have been introduced at the same time as when the regulation was first introduced, or at a later stage, through some sort of amendment to the original regulation.

In practice, there is a sliding scale between a very rigid regulation (for example one that stipulates that all firms in a particular economic sector have to apply a particular abatement technology, without any exceptions) and an economic instrument which gives the regulated the full freedom to choose whether to abate or not, having to pay the economic consequences of this choice in the latter case – and to choose how to abate, in the first case. The focus of this questionnaire is on mechanisms that have been *added to otherwise relatively rigid regulations*, rather than on the use of economic policy instruments as such.

Further, this questionnaire is primarily addressing *national-level* environmental regulations. Responding countries that are also member states of the European Union – where a number of environmental policy instruments are determined at a supra-national level – should focus on flexibility mechanisms that they apply in the policy instruments

they use to implement in their national law the EU-agreed instruments (to the extent that the EU-agreed instruments allow this).

If one or more of the environmental issues covered by this questionnaire is largely or fully the responsibility of sub-national authorities in your country, it would be most welcome if you could provide one or more examples on the use of flexibility mechanisms in sub-national regulations in these contexts.

General information

Given that the person best placed to answer any follow-up questions regarding the use of flexibility mechanisms in regulations in the three selected environmental areas might differ from one case to another, you have the possibility to list different contact persons below.

- Country:
- Name of contact person, air pollution:
- Affiliation of this contact person:
- Email address of this contact person:
- Name of contact person, water pollution:
- Affiliation of this contact person:
- Email address of this contact person:
- Name of contact person, energy efficiency and CO₂:
- Affiliation of this contact person:
- Email address of this contact person:

Information regarding the use of flexibility mechanisms in regulations addressing local air pollution

3.0 Please describe briefly a flexibility mechanism that your country has introduced in a regulation addressing local air pollution, and explain briefly the other main aspects of the regulation in question.

In relation to local air pollution, one example of a flexibility mechanism could be a provision that allows electricity producers to average SO₂ emissions per kWh produced across several coal-fired plants, within a regulation limiting their SO₂ emissions.

.....
.....
.....

*If your country applies several flexibility mechanisms **linked to one given regulation**, please describe each of the flexibility mechanisms separately, and please repeat questions 3.4-3.9 once for each mechanism. The reason for this request is that this will facilitate the analysis of the replies, i.a. making it easier to single-out the motivations behind and the impacts of the different mechanisms.*

3.1 When was the original regulation introduced?

.... Before 1990 1990-99 2000-04 2005-09 2010-14 2015-17

3.2 Which of the following statements best describe this regulation, prior to (or without) the introduction of the flexibility mechanism? (You may indicate several alternatives.)

- It proscribed the use of a particular abatement technology, *for example a scrubber*
- It proscribed the use of a particular production input, *for example low-sulphur coal*
- It restricted the use of a particular production technology, *for example flaring of exhaust gases*
- It restricted the use of a particular production input, *for example high-sulphur fuels*
- It specified limits on emissions of one or more pollutants, *for example maximum SO₂ emissions per kWh of electricity produced*
- It specified certain environmental quality standards that had to be met, *for example concentrations of ambient PM_{2.5} in a given geographical area.*
- Other. *If so, please provide further information describing the regulation:*

.....
.....

3.3 Who are the regulated entities? *In other words: Who are covered by the regulatory instrument?*

.... A single firm A single industry Several (or all) industries Consumers
 Sub-national authorities Other; please specify

3.4 When was the flexibility mechanism introduced?

At the same time as the original regulation? Yes No

.... Before 1990 1990-99 2000-04 2005-09 2010-14 2015-17

3.5 What were the primary motivations for introducing this flexibility mechanism? *(You may indicate several motivations.)*

..... Cost-savings for the emitters, *for example due to avoided investments in certain types of abatement equipment or due to the possibility to align environmental investments with the regular investment/replacement cycle*

..... Cost-savings for public authorities, *for example due to lower monitoring costs or other administrative costs.*

..... Possibilities for achieving better environmental outcomes without raising costs significantly, *for example if the flexibility mechanism was introduced in combination with a strengthening of the regulation.*

..... Better distribution of economic impacts, *for example if firms or plants with low abatement costs can take on some abatement obligations from vulnerable firms with high abatement costs.*

..... Better distribution of environmental impacts, *for example if the increased flexibility was expected to lead to a shift in emissions away from densely populated low-income areas.*

..... Better political acceptability, *for example due to exceptions for companies that would otherwise bear very high additional costs.*

..... Other; please specify:

3.6 Which type of flexibility mechanism has been included in this regulation?

(In line with what was indicated in question 3.0, please select only one type. If the regulation in question includes several types of flexibility mechanisms, please repeat questions 3.4-3.9 once for each mechanism.)

..... Flexibility regarding *how* to reduce emissions, *for example if a technology standard is replaced by a standard stipulating a maximum emission concentration.*

..... Flexibility regarding *where* to reduce emissions, *for example if a company with several production plants can choose in which plant to secure compliance with an emission limit covering the whole company.*

..... Flexibility regarding *who* should reduce emissions, *for example if two or more regulated companies can share the overall abatement burden.*

- Flexibility regarding *which* pollutants to reduce emissions of, *for example if a plant can chose to reduce either its primary PM emissions or its NO_x emissions (which i.a. contribute to the formation of secondary PM).*
- Flexibility regarding *when* to reduce emissions, *for example if the regulation stipulates an emission intensity limit as an average of a period of several years, for example via some sort of “banking” mechanism.*
- *Implementation-related* flexibility, *for example where national authorities sets common nation-wide environmental objectives, but let relevant sub-national authorities decide on which policy instruments to apply to achieve those objectives in that area.*
- *Other.* *If so, please provide additional information describing the type of flexibility mechanism you apply.*

Please provide any additional information about the design of this flexibility mechanism:

.....

3.7 Have public authorities in your country carried out an ex post evaluation of the impacts of this mechanism?

..... Yes No

If “Yes”, what were the main findings of that evaluation? *(Please provide one reply for each of the specified impact categories – economic, environmental and distributional.)*

- The flexibility mechanism contributed to a better **economic impact** than what status quo would have led to, *for example because of savings in abatement costs or administrative costs for polluters, consumers or public authorities.*
- The economic impacts were about the same as if the flexibility mechanism had not been introduced, or could not clearly be quantified.
- The flexibility mechanism contributed to a worse economic impact than what status quo would have led to, *for example because abatement or administrative costs for polluters, consumers or public authorities increased.*
- The flexibility mechanism contributed to improved **environmental quality**, *for example because the reductions in abatement costs where so important that the polluters chose to abate more, or because of positive synergies with environmental issues that were not the target of the regulation (e.g. climate, noise, biodiversity, waste, etc.)*
- The environmental impacts were about the same as if the flexibility mechanism had not been introduced, or could not clearly be quantified.
- The flexibility mechanism contributed to reduced environmental quality, *for example because the added flexibility allowed polluters to circumvent the intentions of the regulation fully or partly, because pollution was shifted from air to other environmental media, or because of unintended side-effects with environmental issues that were not the target of the regulation (e.g. climate, noise, biodiversity, waste etc.)*
- The flexibility mechanism contributed to a better **distributional impact** than what status quo would have led to, *for example because changes in abatement costs and environmental outcomes had favourable distributional impacts.*

..... The distributional impacts were about the same as if the flexibility mechanism had not been introduced, or could not clearly be quantified.

..... The flexibility mechanism contributed to a worse **distributional impact** than what status quo would have led to, *for example because changes in abatement costs and environmental outcomes had unfavourable favourable distributional impacts.*

3.8 Has someone else carried out an ex post evaluation of the impacts of this mechanism?

..... Yes No

If “Yes”, what were the main findings of that evaluation? *(Please provide one reply for each of the specified impact categories; see the examples given for the previous question.)*

..... The flexibility mechanism contributed to a better **economic impact**

..... The economic impacts were about the same as with status quo

..... The flexibility mechanism contributed to a worse economic impact

..... The flexibility mechanism contributed to a better **environmental impact**

..... The environmental impacts were about the same as with status quo

..... The flexibility mechanism contributed to a worse environmental impact

..... The flexibility mechanism contributed to a better **distributional impact**

..... The distributional impacts were about the same as with status quo

..... The flexibility mechanism contributed to a worse distributional impact

Please provide any additional information about the foreseen or unforeseen impacts of this flexibility mechanism that other countries can learn from – and please attach a copy of the evaluation, if possible:

.....

3.9 Has an ex post evaluation contributed to a modification of the flexibility mechanism?

.... Yes No Not yet decided

If “Yes”, please provide further information about the modification made:

.....

Please repeat questions 3.1-3.9 for any other major flexibility mechanisms that your country has introduced in **other** regulations addressing local air pollution, starting with a brief description of each mechanism.