

Defra project AQ0834 - Identification of Potential “Remedies” for Air Pollution (nitrogen) Impacts on Designated Sites (R.A.P.I.D.S.)

Appendix 4 - Mechanisms for the delivery of reduced NH_x and NO_y emissions, concentrations and deposition

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1. Introduction

The aim of this chapter is to identify mechanisms in the UK and its Devolved Administrations through which measures identified in **Appendix 3** could be implemented. This includes incentive, advice, regulatory and other possible financial based schemes, including those that focus on strengthening the nitrogen green economy (Green economy aims for improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities¹). Instruments have been identified through review of relevant policy and literature and discussions with experts within Defra and other relevant organisations. Organisations who provided information used in this section are listed in Table 1.

Table 1. Organisations who contributed information on mechanisms in the UK and Devolved Administrations through which measures could be implemented.

Organisation
Defra (Air Quality and Local Environment Team)
Defra (Biodiversity)
Department of Environment Northern Ireland
Environment Agency
Forestry Commission
Joint Nature Conservation Committee
Natural England
Natural Resources Wales
Scottish Government
Scottish Natural Heritage
Welsh Government (Radioactivity and Pollution Prevention Branch)

¹ Sutton M.A., Skiba U.M., van Grinsven H.J.M., Oenema O., Watson C.J., Williams J., Hellums D.T., Maas R., Gyldenkaerne S., Pathak H. and Winiwarter W. (2014) Green economy thinking and the control of nitrous oxide emissions. *Environmental Development* 9. 76-85.
10.1016/j.envdev.2013.10.002<http://nora.nerc.ac.uk/504621/1/N504621JA.pdf>

2. Regulatory Drivers and Mechanisms

Regulatory measures provide an important driver for reducing emissions, concentrations and deposition of oxidised and reduced nitrogen. Regulatory mechanisms provide important permitting processes for point sources that can prevent emissions thresholds and critical loads for nitrogen deposition being exceeded at individual sites. At a broader scale regulatory mechanisms also maintain national emissions ceilings and ambient air quality. As a member of the EU, the UK is bound to comply with the Directives set down. As a member of the international community, the UK may also commit to other legally binding agreements. Thus EU Directives and International Conventions tend to be the drivers of national policy related to environmental protection in general and nitrogen pollution in particular. On the basis of international regulation to which it is obliged to comply the UK and its Devolved Administrations, pass legislation which provides the basis for the introduction of incentives/initiatives which aim to meet the targets set down in the Directives and Protocols.

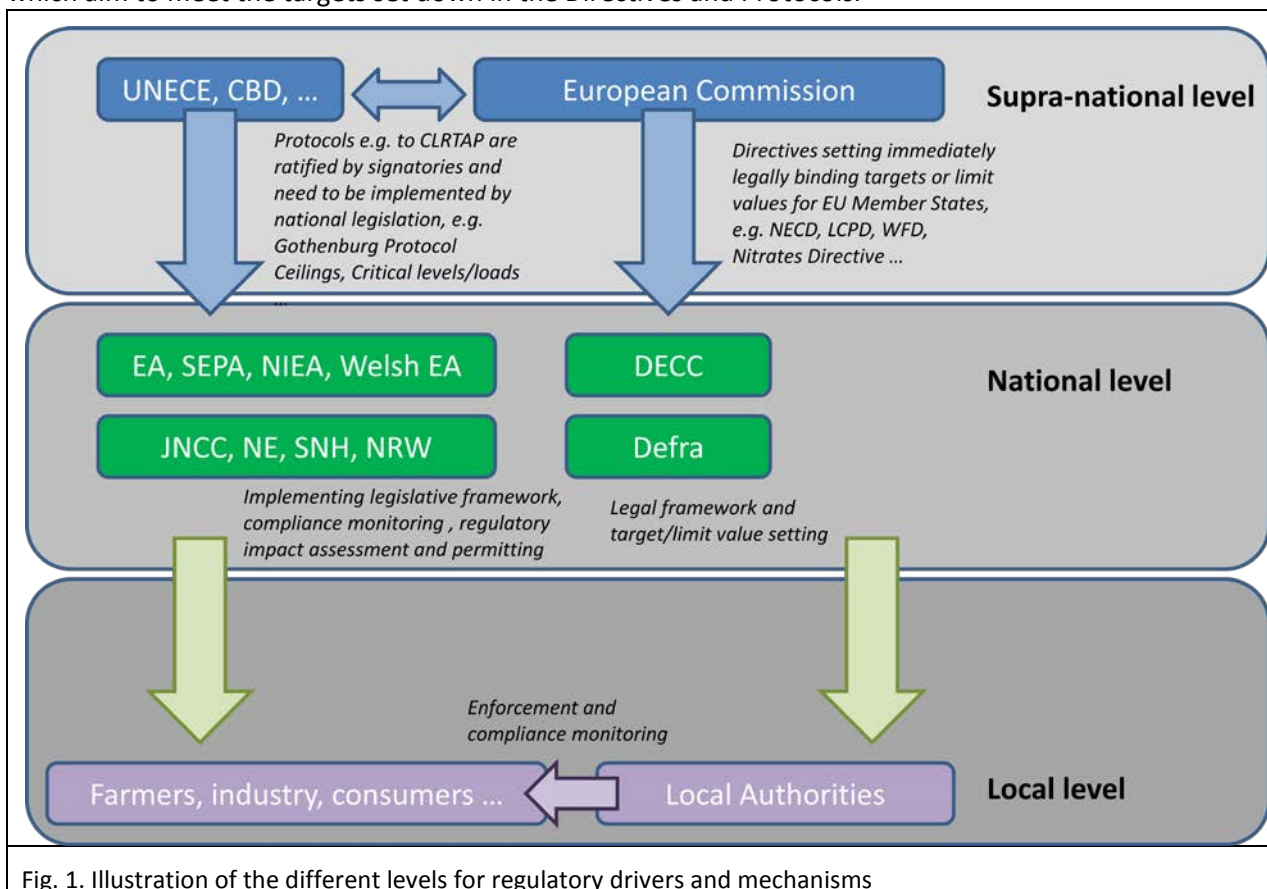


Fig. 1. Illustration of the different levels for regulatory drivers and mechanisms

2.1. Supra-national level

Convention on Long-range Transboundary Air Pollution (CLRTAP)

Policy outline: Established in 1979, the Convention on Long-range Transboundary Air Pollution provided the first legally binding instrument for dealing with the problems of air pollution. Fifty-one parties are signed up to the Convention which has been extended through eight Protocols. The most recent Protocol from the Convention is the 1999 Gothenburg Protocol to abate acidification, eutrophication and ground-level ozone. The protocol was substantially revised in 2012, with the entry into force of the revised protocol now awaiting ratification by the Parties which typically requires several years. The objective of the Protocol is to “control and reduce emissions of sulphur, nitrogen oxides, ammonia and volatile organic compounds that are caused by anthropogenic activities and are likely to cause adverse effects on human health, natural ecosystems, materials and crops”. It sets a basic obligation to reduce emissions below specified levels, and for member Parties to monitor emissions, ambient concentrations and deposition of sulphur, nitrogen and volatile organic compounds and emissions and ambient concentrations of ozone. Parties are also required to collect information on the effects of ambient concentrations and deposition of these pollutants on human health, terrestrial and aquatic ecosystems and materials.

The Gothenburg Protocol also sets out critical loads and levels for air pollutants. A critical load is defined as “a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge” (Nilsson & Grennfelt, 1988; ICP Modelling and Mapping, 2004). Critical levels are based on atmospheric concentrations of pollutants. Critical levels are defined as “concentrations of pollutants in the atmosphere above which direct adverse effects on receptors, such as human beings, plants, ecosystems or materials, may occur, according to present knowledge” (ICP Modelling and Mapping, 1996).

Relevance of instrument: The convention establishes critical loads which provide an essential tool in the assessment of site based impacts. There is pressure to ensure atmospheric concentrations and deposition are kept below critical levels (for concentration) and critical loads (for deposition). The convention is implemented in the UK through the National Emission Ceilings Directive (NECD) and the National Emission Ceilings Regulations 2002, together with equivalent regulations for Scotland and Northern Ireland. Compliance monitoring is conducted by the UNECE CLRTAP through the annual emission reporting requirements to the Centre for Emission Inventories and Projections (<http://www.ceip.at/>) on the basis of national total emissions (in accordance with the reporting guidelines developed by the UNECE Task Force on Emission Inventories and Projections and adopted by the EMEP Executive Body).

European Clean Air Package

To mark the end of the EU “year of air” the Commission published a European Clean Air Package on 18th December, 2013. This was made up of the following main components:

1. A Clean Air programme for Europe

The programme announced supersedes the existing 2005 Thematic Strategy for Air Pollution (TSAP) and provides a strategic framework for air quality policy until 2030. This is a “high level” commission communication stating overall ambition. As such it is not a negotiable position, although other elements of the package will require sign off by member states.

2. National Emission Ceilings Directive (NECD)

The National Emission Ceilings Directive (2001/81/EC) builds upon the Gothenburg Protocol seeking to reduce emissions of pollutants that cause acidification, eutrophication and ground-level ozone. The NEC Directive sets limits for air pollutant emission which are equal to, or in some cases, more ambitious than

the LRTAP Convention. It should be noted that the technical annexes listing mandatory measures of the Gothenburg Protocol are not included in the NEC Directive, as in most cases these are addressed elsewhere EU air quality or other legislation. However, there are gaps. For example Annex IX of the Gothenburg Protocol (on measures to reduce ammonia emissions from agriculture) has not yet been adopted into EU legislation (only the provisions related to large pig and poultry housing are adopted, through the Integrated Pollution Prevention and Control Directive (1996) [now superseded by the Industrial Emissions Directive, 2010/75/EU]).

Relevance of instrument: This directive is important for regulating the levels of ambient air pollution emissions at the UK scale. In the England and Wales this is enacted through the National Emission Ceilings Regulations 2002, together with equivalent regulations for Scotland and Northern Ireland. The directive requires Member States to draw up a National Programme² which includes information on adopted and envisaged policies and measures and quantified estimates of their effects on the emissions. The UK national programme mainly builds on European measures (e.g. for vehicles, fuels, industrial emissions) as implemented in the UK, and the national Air Quality Strategy (see below).

The **new proposal** would repeal and replace the existing 2001 NECD. It will set new emission ceilings (emission allowances) for sulphur dioxide, ammonia and non-methane volatile organic compounds for 2020 and 2030. It will also extend the provisions of the Directive to cover emissions of small particulate matter (PM_{2.5}) from 2020 and methane from 2030. The ceilings for 2020 reflect the levels already agreed by member states under the Gothenburg protocol (see below). For example the UK will have to achieve a 55% reduction in emissions of the oxides of nitrogen by 2020 (from the 2005 position). By 2030 a 73% cut is proposed. For ammonia the UK will have to deliver an 8% cut by 2020 (compared to 2005) by 2030 the level of ammonia reduction proposed is 21%, compared to the situation in 2005. The NECD claims that by 2030 the new ceilings will result in an 85% fall in the extent of acidification with a more moderate (35%) reduction in the extent of eutrophication, again compared to 2005. The control of ammonia emissions from agriculture has been widely discussed in Europe. Although the NECD does not outline prescriptive approach for ammonia it does contain in Annex III a list of measures that member states should consider to control ammonia emissions.

Member states will be required to produce National Emission reduction plans to set out how they plan to achieve the ceilings and these plans will need to be updated every two years.

3. A Proposal for a Directive on Medium sized Combustion Plant.

This proposal is intended to bridge the gap between the Eco-design Directive, which regulates emissions from combustion plants under 1 Megawatt (MW) and the Industrial Emissions Directive (IED) which regulates combustion plants greater than 50MW. The majority of medium sized plants are likely to be small power station units for domestic or industrial properties. It is hoped to transpose the Directive in 2018/19. Existing plant greater than 5MW would have to register for inclusion in 2025 and units under 5MW by 2030.

Relevance of instrument: This directive is important for regulating the levels of ambient air pollution emissions at the UK scale. In the England and Wales this is currently enacted through the National Emission Ceilings Regulations 2002, together with equivalent regulations for Scotland and Northern Ireland. The directive requires Member States to draw up a National Programme³ which includes information on adopted and envisaged policies and measures and quantified estimates of their effects on the emissions. The UK national programme mainly builds on European measures (e.g. for vehicles, fuels, industrial emissions) as implemented in the UK, and the national Air Quality Strategy (see below).

⁴ http://jncc.defra.gov.uk/pdf/UK_Post2010_Bio-Fwork.pdf

⁴ http://jncc.defra.gov.uk/pdf/UK_Post2010_Bio-Fwork.pdf

Large Combustion Plant Directive 2000/80/EC (LCPD)

The Large Combustion Plant (LCP) Directive aims to control emissions of sulphur dioxide, nitrogen oxides and particulate matter. The Directive applies to combustion plants above 50MW thermal input using any fuel type. New plants must meet the limits set out in the Directive. For existing plants, member states can choose to either meet the emission limit values or operate under a National Plan. The LCP Directive requires licensing of combustion plants that fall within the remit of the Directive, where the licences must ensure compliance with emission limits set out in the Directive.

Relevance of instrument: The licences issued by the Environment Agency (for England, and equivalent bodies in the DAs) under this directive regulate large combustion plants and thus are important for protecting conservation sites in their vicinity (via Environmental Impact Assessment), as well as further afield by reducing long-range transport of N air pollution from NO_x emissions. This regulation is implemented through limit values for NO_x. However, compliance with the limit values itself does not automatically mean there is no impact on habitats.

Ambient Air Quality Assessment and Management Directive 2008/50/EC (AAQM)

The aim of the ambient air quality assessment and management Directive (2008/50/EC which supersedes 96/62/EC, and its daughter Directives (1999/30/EC, 2000/69/EC, 2002/3/EC) with daughter Directive 2004/107/EC still effective, is to assess ambient air quality in relation to different targets for the major pollutants, primarily in relation to long term harm to human health, but also in relation to the environment as a whole. Where air quality is of a sufficient standard the Directive aims to maintain it at current levels but, where ambient air quality is not of a sufficient standard in relation to the targets, it aims to improve it. The directive works by setting air quality concentration limits that should not be exceeded, requiring management actions to be taken at a local level where these thresholds are exceeded. It is important to note that while this legislation includes an air quality limit value for NO_x, there is currently no EU air quality limit value for ambient NH₃ (Sutton et al., 2011).

Relevance of instrument: This directive is important for regulating the levels of ambient air pollution, allowing flexibility to include measures that reduce emissions as well as those that improve the spatial distribution of emissions to reduce the extent of threshold exceedance. It is enacted through the Air Quality Standards Regulations for each devolved government. Delivery is via Local Air Quality Management Plans.

Integrated Pollution Prevention and Control Directive 96/61/EC and 2008/1/EC (IPPC) and the Industrial Emissions Directive (2010/75/EU)

The original Integrated-Pollution Prevention and Control Directive (IPPC) aimed to reduce emissions of a range of pollutants throughout Europe with a focus on the application of Best Available Techniques (BAT) in industrial installations. It was concerned with emissions to air, water and land together with waste generation and energy efficiency. In the UK (enacted through the Pollution Prevention and Control Regulations 2007 and the devolved equivalents) this means that not only do industrial sources of air pollution require permits, but also intensive pig and poultry facilities with more than 40,000 places for poultry; 2,000 places for production pigs (over 30 kg); or 750 places for sows.

The IPPC directive was repealed with effect of 7 January 2014 in favour of the Industrial Emissions Directive (IED) (2010/75/EU), which represents a major recasting several pieces of legislation, including the IPPC Directive. The major principles, however, continue to be those of the IPPC Directive, and in the case of agriculture (pig and poultry) do not alter the previously established thresholds. The IED came into force in 6 January 2011 and was required to be transposed into national legislation by 7 January 2013.

The Directive was primarily concerned with installations for which permits can only be issued subject to appropriate environmental impact assessment. As part of the environmental assessment, all sources of pollution requiring permitting should be considered alone and in combination with other local regarding whether thresholds for significant adverse effects on the environment are exceeded. Best available technology is applied to all emission sources and updates through Best Available Technology Reference documents. In England and Wales, permitting is managed by the Environment Agency and local authorities as part of the Environmental Permitting Regulations (2007), in Scotland by the Scottish Environment Protection Agency (SEPA) and in Northern Ireland by the Northern Ireland Environment Agency and in Wales by Natural Resources Wales (NRW). Although an integrated approach is intended in both the IPPC and IED, the extent of integration in practice has been questioned (Sutton et al., 2011). For example, although low-emissions manure spreading techniques are listed in the BAT Reference document for pig and poultry, there has not been unanimous agreement in member states that the application of such measures (also in regard of manure transported off site) must be adopted.

Relevance of instrument: The IED is key in providing protection for sites of conservation importance in the vicinity of major point sources since the permitting process can be used to prevent concentrations and deposition exceeding the critical level and load on a site due to existing installations, new developments or expansion of existing sites. Permits are issued by the Environment Agency considering the impact on nearby sites of conservation importance. Emissions and deposition to sites of conservation importance are modelled and, if critical loads are exceeded, permits can be refused or NH₃ reduction plans required. A Review of Consents is carried out by the Environment Agency on a regular basis.

Environmental Impact Assessment Directive 2011/92/EU (EIA)

The Environmental Impact Assessment Directive of December 13, 2011 applies to the assessment of the environmental effects of those public and private projects which are likely to have significant effects on the Environment. (Article 1) provides a definition of the range of projects covered. Annex I defines projects that require mandatory EIA. Annex II contains a potentially useful provision for intensive livestock developments. Although no thresholds are prescribed in the **Directive** they are in the transposition into **UK regulations**. The 2011 regulations in Schedule 2 (<http://www.legislation.gov.uk/uksi/2011/1824/schedule/2/made>) set a range of thresholds. For example, an EIA will be required on agricultural development with a floor space greater than 500m² where the proposal is in or close to a sensitive site (as defined in Schedule 3 of the regulations) for example SAC/SPA/A/SSSI national Park or Nature reserve. The EIA would be carried out by the relevant local authority.

Relevance of instrument: The EIAs required under this directive provide the opportunity to ensure protection from nitrogen sources which are not otherwise considered as part of the permitting regulations (e.g. under LCP or IED), so can be used to prevent concentrations and deposition exceeding the critical level and load on a site due to new developments and expansion of existing sites. Guidance accompanying the EIA Regulations (which transpose the Directive into UK law) includes indicative thresholds therefore nitrogen sources falling outside the permitting processes may well also fall below these thresholds.

Strategic Environmental Assessment (SEA) Directive (2001/42/EC)

The focus of the SEA Directive is the specification of environmental assessment for large scale plans and programmes. A list of conditions apply that require an EIA under this directive, including the requirement to inform other Member States of possible transboundary impacts of proposed plans or programmes.

Most importantly, the SEA Directive specifies that assessment should be made in relation to regional plans. Under Article 3, paragraph 2 is written: *“Subject to paragraph 3, an environmental assessment shall be carried out for all plans and programmes, (a) which are prepared for agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use and which set the framework for future development consent of projects listed in Annexes I and II to Directive 85/337/EEC,…”*

Relevance of the Instrument: This directive has the potential to review the impacts of nitrogen emissions more widely, including both NO_x emissions from roads and NH₃ emissions from agriculture, and incorporate it into regional planning. For example, where a regional plan specifies an area as being targeted for agricultural activities rather than urban or other development, then it has been argued that this choice should be assessed in relation to the protection of the Natura 2000 network (Sutton et al., 2011). Such assessments are essential, especially since the N deposition threat to many SACs and SPAs will result from the cumulative effect of many farms (including small farms) from the surrounding region. There can be linkages between separate SEA topics, such as air quality and biodiversity.

The Conservation of Natural Habitats and of Wild Fauna and Flora Directive 92/43/EEC (The “Habitats Directive”)

The Habitats Directive promotes the maintenance of biodiversity by requiring Member States to take measures to ensure habitats and wild species are in a favourable conservation status. Within the Directive, conservation status of a natural habitat means “the sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species within the territory” so it provides an integrated view of impact. It also introduces the designation ‘Special Area of Conservation’ (SAC) and brings to SACs the precautionary principle i.e. that new ‘plans or projects’ can only be permitted if they have no adverse effect on the integrity of the site. Member States are required to undertake surveillance of the conservation status of the natural habitats and species and produce a report every 6 years. Nitrogen concentrations and deposition is currently identified as a pressure / threat to many habitat types and in the most recent reporting was often a contributing factor to unfavourable conservation status (Clare Whitfield, JNCC personal communication). Existing pressures and threats must be acted upon by Member states so that deterioration of habitats and significant disturbance is prevented. Member states must also establish the necessary conservation measures that correspond with the ecological requirements of the protected habitats and species.

Relevance of instrument: The Habitats Directive is key for the protection of sites of conservation importance. If a site can be identified as under threat from nitrogen deposition or nitrogen concentrations the Habitats Directive can be used to protect it. In practice, such protection operates for new projects and plans through links to other legislative instruments, such as permitting under the IED directive and planning regulations, where a threat to one or more SACs and be considered as grounds for limiting future development or for refusing licences to operate.

For the impacts of existing N concentrations and deposition, the directive requires appropriate steps to prevent deterioration and (in the long term) to reach the conservation objectives. It leaves flexibility as to the measures and mechanisms to be used. Based on the current high level of critical load exceedances, there remains a clear gap in remedies and delivery mechanisms with respect to N and Natura 2000. For example, there is currently no dedicated mechanism in relation to protected sites specifically to reduce impacts of N (in contrast to with diffuse water pollution or water level management where plan-based mechanisms do exist). The RAPIDS report (inc. appendices) collates information on a range of the most promising measures and possible delivery mechanisms.

The Water Framework Directive 2000/60/EC (WFD)

The Water Framework Directive aims to attain and/or maintain good status of all inland and coastal waters. It will do this through the establishment of environmental objectives and ecological targets and developing a programme of measures for water bodies not yet at the required standard. River Basin Management Plans must be produced for river basin districts every six years setting out the state of the water and actions that will be taken to address the pressures. The WFD is noteworthy for broadening the scope of control measures to include diffuse as well as point source pollution affecting water bodies. As such, it was the first piece of legislation to introduce a catchment-wide approach to controlling pollution inputs to water.

Relevance of instrument: River Basin Management Plans may provide an opportunity to install mitigation measures that provide co-benefits for both water quality and air quality. In particular measures aimed at reducing Diffuse Water pollution are delivered through Catchment Sensitive Farming (see Catchment Sensitive Farming below for specific delivery mechanisms).

Nitrates Directive (1991) (91/676/EEC)

The Nitrates Directive aims to protect water quality by preventing nitrates from agricultural land polluting ground and surface waters and through the promotion of good farming practices. The directive requires that water polluted or at risk of pollution by nitrates be designated as Nitrate Vulnerable Zones (NVZ). Within NVZs, Nitrates Action Programmes must be established which require compulsory action by farmers in relation to the land application of all nitrogen-containing materials (including livestock manures and chemical nitrogen fertiliser) and the storage of livestock manures. Measures include restrictions on the timing, amounts and application methods of livestock manure (limited to 170 kg N/ha/yr) and chemical fertiliser applications to land. Outside of NVZs, member states must establish Codes of Good Agricultural Practice to be implemented by farmers on a voluntary basis. Some of the measures considered under associated Nitrates Action Programmes agreed with the Commission may contribute to minimizing pollution swapping including via ammonia volatilisation from surface broadcasts. For example in England:

- Slurries and poultry manures must be incorporated into the ground within 24 hours (unless using precision spreading equipment);
- Promotion of precision spreading equipment (such as use of band spreading/shallow injection/trailing shoe) which allows organic manure to be spread more close to a watercourse in an NVZ (6 m rather than 10 m) if precision spreading equipment is used may encourage the use of precision spreading equipment thereby also reducing ammonia emissions.

Farmers can apply for a derogation which means that, subject to meeting certain key measures, fertilisers and manures can be applied above the limits. Removing this derogation would potentially have positive results for reducing N pollution

Relevance of instrument: Although focussed on nitrate losses to water, there is a requirement that farms in NVZs produce nutrient management plans may provide a tool for identifying and fostering low emission measures with co-benefits for reducing N air pollution emissions (including NH₃, NO_x and N₂O). The directive also reduces nitrogen inputs to land within NVZs by its restriction of manure and fertiliser inputs.

European Emission standards (EES)

Defined by a series of directives the European Emission standards set acceptable limits for exhaust emissions of new vehicles sold in EU member states. Emissions of NO_x are included in this legislation. Compliance is determined through type approval for new vehicles by running vehicles (for passenger cars and light duty vehicles) respectively the engine (for heavy duty vehicles and buses) through a

standardised test cycle. In 2014, the introduction of the EURO 6 standard will lead to a further reduction of NO_x emissions of ~ 55% compared to EURO 5 compliant diesel passenger cars and light commercial vehicles, while no further reduction is planned for gasoline vehicles. The introduction of the EURO VI standard for heavy goods vehicles (HGVs) in December 2013 has established a 80% reduction of NO_x emissions compared to EURO V HGVs, but the longer commercial lifetime of HGVs will lead to a slower fleet uptake and substantial reductions from this source group will take several years to materialise.

Relevance of instrument: Emission standards help to maintain lower emissions from vehicles which impacts on background concentrations and deposition. In the past, substantial differences between emissions established in test cycles for type approval and real-world emissions have been observed for all vehicles, but in particular for HGVs ('cycle beating'). This has led to an underestimation of NO_x emissions from HGVs of more than 30% in the early 2000s. Compliance monitoring and on-road measurements are important to determine the real contribution of road transport sources to concentrations and deposition near major roads to account for potential differences between calculated and real-world emissions.

Best Available Techniques Reference Documents (BREFs)

The EU BREF documents provide information on the current techniques and processes, which are used in individual industrial/agricultural sectors. Best available techniques (BAT) and emerging technologies/measures to reduce emissions are described in detail reflecting mandatory requirements under the IED, including indications on effectiveness, in order to help emission sectors comply with relevant legislation and standards. The BREF documents were a requirement of Article 13(1) of the Industrial Emissions Directive, which aims to promote the exchange of information between EU Member States and industries, which may benefit from BAT. As part of this exchange of information the BREFs provide an additional source of information for voluntary action beyond the IED requirements.

Relevance of instrument: The guidance applicable to a wide variety of industrial and agricultural activities, in particular sector-specific techniques for mitigating N emissions. In the case of agriculture, the main emphasis is on low emission housing and manure storage techniques (with the BREF document for agriculture currently being revised, 2014).

2.2. National Level

Water resources (control of pollution) (silage, slurry and agricultural fuel oil) (England) regulations 2010

These regulations set out requirements for the design, construction and maintenance of new, substantially reconstructed or substantially enlarged facilities for storing silage, slurry and fuel oil. The regulations provide a set of rules on how slurry and silage must be stored with a focus on maintaining water quality. Factsheets provide detailed instructions for farmers on how these substances should be stored.

Relevance of instrument: Appropriate storage of slurry has the potential to reduce emissions of ammonia via volatilization. However, the regulations do not currently include all measures that could reduce losses to the atmosphere.

2.3. Local level

Planning permissions

If an Environmental Impact Assessment is not required, Local Planning Authorities must take protected sites into consideration in their planning permissions and make a habitat regulations assessment where relevant. They seek advice from conservation bodies in doing this. In practice the potential N aspects of

smaller agricultural initiatives are not always recognised and some activities fall outside planning, or are permitted development.

3. Incentive based approaches

3.1. National level

Options related to taxes on pollution

The regulator has a suite of options available to reduce emissions. In the following, we illustrate the key issues using agricultural nitrogen pollution as an example. In this context, a regulator can use command and control, e.g. NVZ where farmers are restricted in how much and when they apply fertiliser, taxes or voluntary schemes. In the case of agriculture, where the main type of pollution is of a diffuse nature, taxes on measured emissions are not easily implementable. The reason for this is because it is too costly for the regulator to observe emissions at source. Hence, if taxes are to be used they would be applied on inputs related to pollutants of concern, e.g. nitrogen fertiliser, or would need to be based on choice of practices linked to different characteristic pollution emission rates

In the most efficient regime taxes would vary according to the marginal damage imposed by a particular farmer's use of the fertiliser. This will depend on level of use and choice of practices, but also on environmental conditions, so that marginal damages will vary across farmers. The establishment of differentiated taxes leading to differentiated prices for the same fertiliser could be argued to be unimplementable unless markets can be separated (e.g. airline seats). As a consequence, input taxes would tend to be uniform irrespective of the way they are used or local environmental conditions. Such taxes on fertiliser have been used in Scandinavia but not in the UK. In terms of existing fertiliser controls in the UK (N.B. not related to environmental issues), in Northern Ireland the use of ammonium nitrate fertiliser is tightly controlled because of its potential use for bomb-making.

Another type of tax that has been suggested in the literature is the 'tax-subsidy ambient scheme', which has been used in relation to ambient nitrate pollution levels (Segerson, 1988). The target level of nitrate concentration in a water-body is set and if the realised level exceeds that threshold then all farmers within the catchment are taxed based on gap between the actual level of pollution and the target level. This scheme has been devised in the context of moral hazard in teams whereby a team of polluters are responsible collectively for the pollution level but it is prohibitively costly attribute responsibility to individuals. The moral hazard arises because of the inability of the regulator to observe emissions at source. However, this approach remains only a textbook suggestion as the political will does not so far appear to exist to hold a group of farmers responsible for each member's action. More problematic is the role of stochastic factors such as rainfall which can affect the realised level of pollution and thus the liability of the group. For example, it could be argued to be unfair to punish the group for factors outside its control, while conversely equally giving the group benefit for factors operating in the other direction.

As a result of such issues, and a lack of willingness to engage in such schemes, especially in the agricultural sector, the use of voluntary schemes such as agri-environmental schemes has proved more popular.

Agri-environment Schemes

Agri-environment schemes are managed at a national level with each of the devolved agencies running their own schemes. CAP reform is expected to result in changes in current schemes in the near future (see section 4.5 below). The rationale underlying such schemes is that farmers obtain payments for providing environmental services. Thus, the implicit assumption is that the property right lies with the farmer in that they have the right to carry out the most profit-maximising activity on the land (subject to meeting statutory requirements, e.g. rules applying to Nitrate Vulnerable Zones) and must be compensated for changes in farming practices that may imply a better quality environment but which imposes costs on the farmers through a reduction in profits (Hanley et al., 1999). Although policy is moving in the direction of recognising the rights of others to a clean environment, this scheme in so far

as it compensates farmers for the costs of providing additional environmental services, still supports the view that the balance of rights lie with the farmer.

England: In England there are currently two options Entry Level Stewardship (ELS) and Higher Level Stewardship (HLS). ELS contains several relevant options, hedgerow tree buffer strips on cultivated land are currently used to protect water quality but in the correct location could also be extended as tree belts to help reduce air pollution impacts on specific receiving ecosystems. Another option is permanent grassland with very low inputs which could reduce emissions. HLS contains a range of options that can be selected to accrue payment. Relevant options include Maintenance of woodland, restoration of woodland, and creation of woodland which may provide the opportunity to create buffers around sources if located correctly, although currently these measures are located with a focus on biodiversity potential rather than emissions mitigation. Other relevant options are arable reversion to unfertilised grassland and a nil fertiliser supplement which would reduce emissions. Future options could be directly related to the minimization of ammonia emissions, such as reducing (or avoiding) emissions from urea fertilizer, and the adoption of measures to reduce ammonia emissions from manure spreading.

Wales: The Welsh agri-environment scheme is currently called *Glastir*. This has two principal components, *Glastir Entry* and *Glastir Advanced*. Other components cover woodlands, common land and agricultural investments which are designed to improve resource efficiency. The current *Glastir Entry* scheme is available throughout Wales and includes options under which farmers can commit to slurry injection on improved grasslands, substantially reducing ammonia emission losses through volatilisation. There are also a large number of habitat options involving limits on the use of manure and inorganic fertilizer, which can help to further reduce emissions. By contrast, *Glastir Advanced* uses a system of GIS-based data layers to target those locations where application of certain prescriptions will bring about the greatest benefit. This part of the Scheme holds out more potential for developing programmes which are designed to reduce ammonia emissions from point sources, especially in the vicinity of sites of conservation importance which are at risk from N deposition. Meanwhile, the current system of *Glastir Efficiency Grants (GEG)* provides financial support (40-50% of eligible expenditure) for capital items such as new slurry stores. These help to expand on-farm slurry storage capacity; enabling better timing of manure applications and more use of precision spreading. Finally, it should be noted that the *Glastir* Scheme is currently under review as part of developing the new Rural Development Plan for Wales. This will take effect at the start of 2015, following which there is likely to be a gradual shift in favour of the Advanced Scheme by comparison with Entry. The available management prescriptions are unlikely to change substantially, but an increased focus on targeting will mean that all agri-environment contracts (both Entry and Advanced) will have to meet Welsh Government priorities to a greater extent than is currently the case.

Scotland: Scotland currently operates two levels of agri-environmental scheme. Land Managers Options is the lower level scheme, which includes the adoption of nutrient management plans (closed to applicants since 2010) and small scale woodland creation (closed to applicants since 2010). The higher level scheme is the Rural Priorities scheme, which also included option for manure and slurry storage (including covering slurry stores) and use of renewable energy which have the potential to reduce emissions.

Northern Ireland: The main agri-environment schemes in Northern Ireland are currently the Northern Ireland Countryside Management Scheme (NICMS), the Environmentally Sensitive Areas Scheme (ESAS) and the Countryside Management Scheme (CMS). All farmers participating in these schemes must produce and implement a Farm Nutrient and Waste Management Plan and meet Cross-Compliance requirements. The schemes also include a number of habitat management options which restrict nutrient inputs and therefore reduce emissions, for example semi-improved grassland. Management of heather moorland prevents drainage, reclamation and peat cutting which reduces potential emissions of carbon dioxide. Native trees planted along grass margins absorb carbon which helps to compensate for carbon dioxide emissions. Within the Northern Ireland Rare Disease Partnership 2007-2013, the

Manure Efficiency Technology Scheme provides capital grant to farmers to encourage uptake of advanced slurry spreading systems with the potential to reduce emissions.

Payment for Ecosystem Services (PES) Schemes

PES schemes are incentive mechanisms that match the beneficiaries of ecosystem services to suppliers of these services. They can take different forms, deal with a range of ecosystem services, and involve different types of beneficiaries and suppliers. PES schemes are a relatively new incentive mechanism, but are becoming more common in the UK, and have been applied at large scale internationally, e.g. payments for water supply in Mexico. They typically focus on a particular goal where an ecosystem service can be provided or improved through activities undertaken by a sector of land managers, and crucially, where an organisation is willing to provide payments for those actions. The majority of such schemes so far in the UK are based around catchment management to improve water quality. For example, a consortium of organisations including water companies such as South West Water are funding farmers to alter their land management to reduce pollution and sediment loads in streams in south west England thereby reducing water treatment costs, as well as achieving a range of environmental benefits. PES schemes can form part of other incentive mechanisms, for example ecosystem services thinking is incorporated within the Glastir scheme. The same principles could be applied to reduce N emissions.

Woodland Grant Schemes

National woodland grant schemes (English Woodland Grant Scheme, Glastir Woodland grants, DARNI Woodland Grant Scheme, Scottish Farm woodland schemes and forestry grant schemes) provide grants for woodland improvement, management, regeneration and creation.

Relevance of instrument: Schemes are generally small with limited funding but have the potential to provide incentive for the creation of woodland as buffers and tree barriers around sources or woodland creation between sources and protected sites.

Woodland Carbon Code

The woodland carbon code provides guidance on woodland creation that facilitates opportunities for carbon trading. New woodlands which meet the standards set out in the Woodland Carbon Code could provide an alternative to agricultural income.

Relevance of instrument: Planting of woodland in as buffers and tree barriers around sources or woodland creation between sources and protected sites.

Catchment Sensitive Farming (CSF) Capital Grant Scheme

The Catchment Sensitive Farming scheme provides advice to farmers in England to help them implement management changes that reduce the risk of water pollution (see also under section 4.4). The capital grant scheme helps farms tackle diffuse water pollution by providing funding for relatively low cost infrastructure investments.

Relevance of instrument: Some measures which provide benefit to water quality may also provide co-benefits to nitrogen emissions. Such schemes could be extended to explicitly consider both atmospheric and water pollution issues.

4. Advice based approaches and wider strategies

4.1. Supra-national level

UNECE Guidance Document for the prevention and control of ammonia emissions.

The 1999 Gothenburg Protocol also established the requirement for a Guidance Document on preventing and controlling ammonia emissions. Following earlier editions, this document has recently been comprehensively revised and adopted by the LRTAP Convention (http://www.clrtap-tfrn.org/webfm_send/475).

Relevance of Instrument: The document provides a detailed description of the measures and costs available to reduce ammonia emissions from agriculture covering a broad European perspective, as a basis to foster international uptake of the most cost effective measures. The document is primarily aimed at national ministries and advisers. An update of the UNECE Framework Code of Good Agricultural Practice for Prevention of Ammonia Emissions is underway, which is a shorter document designed for farmers and their advisers.

4.2. National level

UK Biodiversity Framework

The UK Biodiversity Framework⁴ was published in 2010 in response to the goals and targets set in October 2010, when 192 governments and the European Union came together in Nagoya, Aichi Province, Japan, to reach an agreement to take action to halt the biodiversity declines. The UK framework is designed to identify actions needed to build upon national biodiversity strategies in pursuit of Aichi targets. In particular the framework has an activity focussed on air pollution⁵ and sets milestones to have established methods to provide future evidence of impacts (and recovery) via broad-scale vegetation surveillance, identify 'remedies/actions' feasible to reduce pressure from air pollution on protected sites, and establish methods to assess air pollution policy impacts on ecosystem services and provide valuation by 2015. Biodiversity is a devolved matter and each of the four countries has its own strategies. In England the approach to conserving biodiversity and ecosystems is set out in Biodiversity 2020 where there is emphasis on a landscape-scale approach through, for example, the creation of Nature Improvement Areas. NGO-led landscape scale initiatives also exist across the UK and include RSPB FutureScapes and The Wildlife Trusts 'Living landscapes'.

Relevance of instrument: If impacted sites contain threatened species or habitats (and poor status can be linked to nitrogen deposition and concentrations) then the Biodiversity Framework could be used in conjunction with national strategies to provide a lever to reduce emissions.

National Biodiversity, land use and environment strategies

National strategies for biodiversity, the environment and land use have been developed by the UK government and devolved administrations. Commonly, these strategies provide actions related to specific legislation. For example, national biodiversity action plans all set a target of local action plans as required under the Habitats Directive. These strategies may set specific national targets and recognise particular problems.

⁴ http://jncc.defra.gov.uk/pdf/UK_Post2010_Bio-Fwork.pdf

⁵ http://jncc.defra.gov.uk/pdf/UKBioFwk_ImpPlan_November2013.pdf

Relevance of instrument: National strategies and plans may act as levers to reduce emissions and protect sites of conservation importance.

National Air Quality Strategy (2000) and the Air Quality Strategy Review (2007)

The Air Quality Strategy for England and Wales sets out the UK air quality strategy for meeting all European obligations and national objectives. It covers a wide range of pollutants including nitrogen deposition, nitrogen dioxide and ammonia. The AQS states 'standards' based on the assessment of effects on health and ecosystems and policy targets ('objectives') that are expressed as either the maximum permitted number of exceedances of a concentration or a maximum concentration within a specified timescale. The AQS includes a NO_x objective for the protection of ecosystems and vegetation, but does not include an NH₃ objective. The Environment Agency has to give regard to the strategy when discharging its pollution control functions.

Relevance of instrument: This strategy is important for regulating the levels of ambient air pollution so, if levels are exceeded, it could provide a lever to reduce emissions.

Codes of good agricultural practice (CoGAP)

All of the devolved administrations produce codes of good agricultural practice. These take the form of detailed practical advice to farmers, growers and land management on how land can be managed for environmental protection. They may be targeted at specific problems such as the Scottish advice scheme 'Farming for a Better Climate'. National codes include advice that has the potential to reduce emissions. For example the Department of Agriculture and Rural Development in Northern Ireland has published 'The Code of Good Agricultural Practice for the Prevention of Pollution of Water, Air and Soil'. This provides advice on reducing ammonia emissions from farm buildings and slurry spreading and reducing nitrous oxide emissions. It should be noted that while the provisions of the Gothenburg Protocol (1999, Annex IX) make it mandatory for parties to establish clearly labelled codes of practice to reduce ammonia emissions, the implementation of/adherence to these mandatory codes is entirely voluntary. Codes are currently under review in Wales.

Relevance of instrument: Codes of good agricultural practice could be more widely used to provide advice to farmers on how to minimise emissions from agriculture.

The Design Manual for Roads and Bridges (DMRB)

The Highways Agency (HA) DMRB provides guidance in the design, assessment and operation of new and existing road networks. It outlines the level of environmental impact assessment required for maintenance and construction schemes, and describes the procedures, which must be followed for new road schemes and improvements/changes to existing roads above certain thresholds of size and potential impacts to air quality. The manual also demonstrates how to estimate a scheme's potential impact on local and regional air quality, using the HA DMRB Screening Method spreadsheet.

Relevance of instrument: Screening for air pollution effects is mandatory for certain projects of a given size or possible exceedance of Air Quality Strategy (AQS) emission thresholds. The DMRB presents advice on how to minimise these impacts through a series of suggested design alterations and mitigation measures following construction.

Greenhouse Gas Action Plan (GHGAP)

The Greenhouse Gas Action Plan (GHGAP) sets out the work that the agricultural industry is undertaking to reduce greenhouse gas emission. The industry has a target of reducing emissions by three million tonnes of CO₂ equivalents by 2022 without compromising domestic production. Priority actions for

reducing carbon emissions include more efficient crop and grassland production with specific advice related to nutrient management and more efficient management systems for livestock with specific advice to use appropriate slurry and manure management.

Relevance of instrument: There is considerable potential for co-benefits in terms of nitrogen emissions if the priority actions suggested in the plan are followed.

4.3. Local level

Air Quality Management Areas (AQMA)

Under the UK Air Quality regulations set up to implement the European Air Quality Directive, local authorities measure air quality and aim to ensure that national air quality objectives are met. In areas where objectives are not likely to be achieved local councils must declare Air Quality Management Areas and put in place a Local Air Quality Action Plan. The focus of AQMAs to date has been on human health protection rather than ecosystem protection.

Relevance of instrument: If national air quality objectives are not met in the vicinity of a protected ecosystem site then an Air Quality Management Area could also be declared. If a site is within an existing Air Quality Management Area then the Local Air Quality Action Plan could provide a lever to reduce emissions and deposition to natural habitats. Establishment of an NH₃ objective concentration (for example over the domain of Special Areas of Conservation) would be a necessary precursor to establishing AQMAs for ecosystem protection from exceedance of the NH₃ critical level.

Environmental Management Systems (EMS)

Environmental Management Systems are increasingly used within large companies and SMEs to ensure environmental compliance and reduce waste.

Relevance of instrument: Companies responsible for emissions in the vicinity of sites of conservation importance may benefit from the use of EMSs to reduce emissions.

Local, National and Catchment based advice schemes (Catchment)

All of the devolved administrations run schemes for the protection of water quality in priority catchments which give advice and support for capital items to land managers in these areas. These schemes include Catchment Sensitive Farming (England), River Basin Management Planning Northern Ireland, Priority Catchments (Scotland). The Welsh Catchment Initiative has been closed and is subsumed within Glastir Advanced and Glastir Energy Efficiency.

Other advice schemes such as LEAF (Linking Environment and Farming) and Farming Connect provide advice to farmers.

Relevance of instrument: Some measures, such as reviewing N use on farms and improving slurry storage facilities, provide benefit to water quality and may also provide co-benefits to nitrogen emissions.

5. Ongoing developments

5.1 . Supra-national level

Clean Air Policy Package

The European Commission announced its proposals for a new clean air policy package in December 2013. This package includes a new Clean Air Programme for Europe with measures to ensure that existing targets are met and objectives up to 2030. It will include a revised National Emission Ceilings Directive with stricter national emission ceilings (see below) and a proposed new directive to reduce pollution from medium-sized combustion installations.

Relevance of instrument: This new package has the potential to reduce emissions of nitrogen and is concerned with both nitrates and ammonium. It will be particularly important in reducing ambient concentrations and deposition, pending its final adoption (potentially during 2015).

Revision on the National Emission Ceilings Directive

Revision of the NEC Directive will reduce limits set for nitrogen oxides and ammonia under the NEC Directive with a view to reducing emissions by 2030. The directive is still subject to negotiations and decisions.

Relevance of instrument: This directive is important for regulating the levels of ambient air pollution and nitrogen deposition. Current proposals indicate that there will be a focus on reducing air pollutant emissions (ammonia and particulates) from agricultural activities.

Common Agricultural Policy (CAP) reform

Recent CAP reforms will have implications for the way that agri-environment schemes operate across the EU. From 1 January 2015, 30% of the Direct Payments made to farmers will be dependent on upon the adoption of three “greening” measures. While every measure is not applicable to all farms, the three main measures are: crop diversification, ecological focus areas (EFA) and the maintenance of permanent grassland. In particular, farmers with more than 15 ha of arable land must maintain at least 5% of that area of land as an EFA. The four UK Governments are obliged to define activities which can count towards meeting the EFA requirement, drawing from a list provided in the EU Regulation on Direct Payments. Potentially farmers can be directed towards activities most likely to reduce nitrogen emissions or deposition, with farming advice being a requirement of CAP.

The Rural Development Regulations now allow rural development funds to be used for measures to reduce ammonia emissions. In England, the potential for including such measures within the new RDPE is being explored (including tree buffers, low emission spreading techniques and covers on manure/slurry stores).

Relevance of instrument: RDP schemes are likely to be the main incentive based mechanism for reducing ammonia concentrations or deposition. Revisions to the CAP will be very important in helping direct money towards air quality improvements relevant to point sources and ambient pollution levels.

Shipping Emission Control Area

The International Maritime Organisation and the International Convention for the Prevention of Pollution from Ships provide for the possibility to designate emission control areas, in order to reduce air pollution from shipping. In some areas these have been used to reduce nitrogen oxide emissions. The North Sea including the English Channel is already designated for sulphur, and this is due to come into force in January 2015.

Relevance of instrument: Although there are no current plans to designate emission control areas for nitrogen around the UK, they provide a mechanism that could be used to further reducing ambient concentrations and deposition.

5.2. National level

Catchment Sensitive Farming Ammonia pilot study

A pilot study investigating the potential to provide farmers with advice on ammonia management via the Catchment Sensitive Farming scheme in England is currently being commissioned by Natural England under the IPENS programme⁶ and is due to report in summer 2014.

Relevance: Some measures which provide benefit to water quality may also provide co-benefits to reduce atmospheric N emissions and deposition at designated sites. The pilot study will investigate this approach, with future CSF schemes potentially encouraging parallel mitigation of atmospheric and water N pollution.

Natura 2000 Theme Plan

Nitrogen deposition is an environmental problem which is often difficult to address at a single site level and as such a Theme Plan is being developed by Natural England. This plan will identify solutions to address nitrogen deposition across the Natura 2000 network of sites. Plans will be published in December 2014.

Relevance of instrument: Incorporating the outputs of this and other projects the atmospheric nitrogen deposition thematic plan will set out a strategic approach to reducing nitrogen deposition to sites.

Review of Local Air Quality Management in Scotland

A review of Local Air Quality Management in Scotland is currently underway. The review aims to identify areas where improvements could be made and support efforts to reduce the impacts of air pollution on human health.

Relevance of instrument: Although focussed on human health, this review may provide opportunities for introducing measures to improve ambient air quality and reduce emissions from point sources with complementary benefits for natural habitats.

⁶ Improvement Programme for England's Natura 2000 sites
<http://www.naturalengland.org.uk/ourwork/conservation/designations/sac/ipens2000.aspx>

References

- Hanley, N., Whitby, M., Simpson, I. (1999) Assessing the success of agri-environmental policy in the UK. *Land Use Policy* **16**, 67-80.
- ICP Modelling and Mapping (2004) Manual on methodologies and criteria for Modelling and Mapping Critical Loads & Levels and Air Pollution Effects, Risks and Trends.
- Nilsson, J. and Grennfelt, P. (1988) Critical loads for sulphur and nitrogen. Report from a workshop held at Skokloster, Sweden, 19-24 March 1988. Copenhagen: Nordic Council of Ministries.
- Segerson K. (1988) Uncertainty and incentives for nonpoint pollution control, *Journal of Environmental Economics and Management*, **15**(1), 87-98.