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ENERGY GENERATION – ANAEROBIC DIGESTION

ADVICE FOR PLANNING OFFICERS AND APPLICANTS SEEKING PLANNING PERMISSION FOR ANAEROBIC DIGESTION WHICH MAY IMPACT ON NATURAL HERITAGE

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Introduction

Anaerobic digestion (AD) is a technology which is used to treat waste products, or with purpose grown crops to provide energy. It can play an important role in dealing with organic waste, recovering energy and producing nutrients.

Anaerobic digestion of waste materials, in some circumstances, can have an impact on the surrounding environment. This standing advice sheet is to aid local authorities in their decision making and to highlight those cases where NIEA need to be involved.

The process involved in anaerobic digestion is the bacterial fermentation of organic waste from farms, sewage or food waste in warm, oxygen-free conditions (the anaerobic digester or 'bio-digester'). This process converts complex organic molecules into an inflammable gas comprising methane (typically 65%) and carbon dioxide (typically 35%), leaving liquid and solid residues, which are normally used as a nitrogen-rich fertilizer on the farm that it was produced on. The gas produced is called biogas and is very similar to natural gas. There may be a flare stack on larger plants. The residual digestate contains valuable plant nutrients such as nitrogen, phosphate and organic humus and can be spread on land as a bio-fertiliser in place of expensive artificial fertiliser. Almost any biomass can be used as feedstock for an AD plant, including food waste; slurry and manure; plant residues, silage, and energy crops.

Types of Development

There are two main types of plant: on-farm AD and centralised AD.

On-farm AD can range from small facilities to larger ones (above 2MW) and use farm organic materials. This type of facility caters for one farm. Centralised AD are typically agricultural based and use farm products (livestock manures and crops) as the main feedstocks, as well as other organic material from, for example, food processing. They typically involve a number of farms within 10km of a plant.

All agriculturally based AD should distribute digestate back to agricultural land, normally that of the supplying farms. Nutrient management is a major issue for consideration when considering any AD scheme. Centralised AD plants have major potential to assist in managing and redistributing plant nutrients in slurry.

Legislation

The Habitats Directive (92/43/EEC), transposed by the Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 (as amended), requires that every public body to consider the implications of a proposal, such as AD plants on European designated sites and make an appropriate assessment where there are any likely significant effects.

The Wildlife and Natural Environment Act (Northern Ireland) 2011 (known as the WANE Act) introduced a biodiversity duty on public bodies in Northern Ireland. It states that it is the duty of every public body, in exercising any functions, to further the conservation of biodiversity so far as is consistent with the proper exercise of those functions.

AD plant including associated silos and storage tanks must also comply with the minimum standards set out in The Nitrates Action Programme (NAP) Regulations (Northern Ireland)

2014. As well as design, construction and storage capacity standards, the Regulations require that any new (or substantially altered) silage, slurry and agricultural fuel oil stores are located at least 10 m from any waterway.

Policy

Planning Policy Statement 2, Natural Heritage (Policies NH1, NH2 NH3 and NH5) and the Strategic Planning Policy Statement apply to all cases that have the potential to impact on designated sites, protected species and priority habitats.

Environmental Impacts

The main environmental impacts from AD relate to the potential for water pollution and impacts on sensitive habitat from air pollution generated from storage of feedstock on site and the spreading of digestate.

Water Pollution

There is a risk for AD facilities to cause direct and indirect pollution of waterways if mitigation is not designed into the scheme through its location from watercourses and correct containment systems. It is therefore important to make adequate provision on site for the safe collection and storage of feedstock and dealing with dirty water that may arise as a result of operations on the site, and any waste oil products generated by servicing of the engines on site.

All storage and handling of feedstock and digestate should be undertaken on impermeable surfaces and within areas with an engineered site containment and drainage system designed to contain all contaminated runoff. Silage stores must have an impermeable base provided with impermeable channels constructed to collect all effluent and run off which must be drained to a tank. Making and storing silage in a field clamp (heap) without a constructed impermeable base and effluent system is prohibited. Baled silage may be stored on open ground but not within 10m of an open watercourse. Proposals should incorporate measures for dealing with the management of dirty water and other liquid contaminants arising from the unit. In particular it is necessary to ensure that dirty water does not enter the storm drainage system. This can be achieved through collection and storage in a suitably sized tank.

Air Pollution – Impacts on Habitat

The primary product of AD is biogas consisting of methane (60-70%) and carbon dioxide (30-40%) gases which are generally collected and combusted on site. Methane emissions are reduced as a result of the combustion and therefore impacts from methane on sensitive habitats are unlikely. However ammonia emissions from the storage of silage and other

waste stock on AD facilities is increased if large amounts of material such as silage, pig and poultry litter are stored on site or where digestate is spread. The deposition of ammonia onto sensitive habitats can occur in close proximity to the source or be blown over a long distance before deposition takes place usually by rain.

Ammonia is a source of nitrogen, a nutrient in plants and when it is deposited from the atmosphere onto land it can enrich the nitrogen content of habitats (DEFRA). Nitrogen enrichment or terrestrial eutrophication can impact on valuable ecosystems such as bogs, upland and lowland heath, semi-natural grassland and woodlands by changing the mix of species present. Additionally if nitrogen is deposited in large amounts, soils, streams and lakes can become acidic and aquatic biodiversity can be adversely affected.

Physiological Effects on Vegetation

The toxic effects of ammonia gas can result in the damage and death of plants. Some species are very sensitive to high ammonia levels. Lichens and mosses (lower plants) are the most sensitive, but there is also evidence of a damaging effect on some trees and shrubs (higher plants).

Direct damage to sensitive species by ammonia gas can include:

- leaf discolouration, bleaching observed in *Sphagnum* moss species at high concentration (1 µg Ammonia per m-3);
- increase in algal growth over *Sphagnum* mosses; and
- suppression of root uptake of cations (positive ions) such as calcium, magnesium and potassium leading to nutrient imbalances.

The concentration of nitrogen in foliage increases with increasing levels of nitrogen deposited from the atmosphere onto soils and vegetation and can show the following;

- may increase plant sensitivity to stress (frost, drought and insect damage);
- has contributed to changes in the mix of plant species growing in a range of semi-natural habitats (e.g. heathland moorland and bogs) in many parts of UK through loss of sensitive species;
- bramble, holly and ivy appear to be insensitive to high ammonia concentrations so these species can become dominant; and
- there may be epiphyte absence and layer of algal slime on trees indicating extreme eutrophication and damage to lichens and bryophytes.

Ecosystem Effects

The habitats that are most susceptible to the effects of ammonia are bogs, heathlands, woodlands and low nutrient grasslands (see Appendix 1 for more details). However the impacts from a specific proposal on a habitat are highly dependent on the distance from the habitat, as well as wind speed and wind direction. Standing water can also be affected, where eutrophication can lead to algal blooms that block out light to other aquatic plants and deoxygenate the water.

Sources of Information

Spatial information

- **NIEA Protected Sites**
    - Designated sites
        - Special Areas of Conservation (SACs)
        - Special Protection Areas (SPAs)
        - RAMSaR sites
        - Areas of Special Scientific Interest (ASSIs)
- **NIEA Biodiversity Hazard Mappings** showing areas likely to be of significance for priority habitats containing
    - Local Wildlife sites
    - Mapped priority habitats
    - Some sensitive birds sites (often displayed as 1km² area grids)

Critical Level

Critical levels (Cle) 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" (APIS, 2017 cited at UNECE, 2003*).* The concentration in air is expressed in microgrammes per cubic metre (µg/m^3) e.g. 1 µg/m^3 for lichens. The exceedance of a critical level is defined as the atmospheric concentration of the pollutant above the critical level. See Table 1 for critical level for specific habitats.

Table 1: critical levels for habitats of concern – data source www.apis.ac.uk

Habitat Type	Critical Level For Ammonia µg/m^3
Bogs	1
Coniferous Woodland	3
Broadleaved , Mixed and Yew Woodland with priority lichens and bryophytes	1
Broadleaved , Mixed and Yew Woodland	3
Calcareous Grassland (Lichens and bryophytes)	1
Calcareous Grassland (Higher Plants)	3

Air Pollution Background Data

Ammonia levels have been reducing in the United Kingdom except in Northern Ireland. Monitoring in Northern Ireland has shown that atmospheric ammonia is increasing across NI. Monitoring of European habitats has found that most habitats are at risk from high ammonia levels which will affect the vegetation of the habitat and its conservation status (JNCC, 2013).

Models

Although dispersion modelling software can have uncertainties associated with them, they are used to help predict the impacts of gases or particulates on receptors. Historical weather data from Aldergrove is used to inform the dispersion model. The results of the modelling

can be used to support judgements on whether a planning application is likely to impact on receptors such as habitats and species. More details are given in Appendix 2.

Mitigation

The above impacts can be mitigated by ensuring that there are sufficient buffers to watercourses (a minimum of 10m), no direct drainage to watercourses, adequate bunds and collection tanks, impermeable hardstanding and all stored materials are covered.

In order to address mitigation that may be needed, local authorities will need the following information in relation to each AD plant:

- the type and scale of the proposal including power output;
- the type and amount of waste material it will be treating, and where this material is to be sourced;
- a Site Drainage Plan showing the arrangements for the management of dirty water arising from the development (this plan should detail how drainage of contaminated areas is separated from drainage of uncontaminated areas. All details of infrastructure which will be in place to deal with run-off and spillages on site. All drainage should be indicated and a collection system detailed. There should be no direct links to watercourses;
- a map or block plan indicating the position of the proposal in relation to any nearby waterways. There should be a 10m buffer to all watercourses on the site;
- the type of flare stack that may be proposed. This should not be placed near trees or buildings that have potential to be used by bats. Landscape impacts also need to be considered by the local authority;
- details on the storage arrangements for feedstock prior to input to the digester. Larger proposal should have covered facilities; and
- all proposals should have at least a 500m buffer to designated sites and priority habitats or be assessed for their impacts.

The following surveys that may also be required:

- Smooth Newt - if a pond is within 250m of the proposal due to potential for acidification of the waterbody.
- Consider additional standing advice on priority and protected species if any landscape features are to be removed.

Current Position

As most of the designated sites and priority habitats in Northern Ireland have reached or exceeded their critical level of ammonia, NIEA have adopted a working position for the assessment of applications in relation to facilities that produce ammonia.

It is the current working position of NIEA to only accept applications that produce up to 10 % of the CLe for all designated sites that could be impacted. This includes potential cumulative and in combination impacts with other applications and installations that could also produce ammonia pollution.

Outside designated sites the current position is to allow for up to 50% of the CLe for a

priority habitat.

Please note that this position is under review and these levels may reduce.

Procedure for Applications

Water Quality Screening

Where a proposal is within an N2K river catchment, a Habitats Regulations Assessment is required. NIEA should be consulted on all proposals greater than 5MW.

Air Quality Screening

All applications which emit ammonia gas must be screened for their potential to impact on designated sites or priority habitat. This is achieved by undertaking a spatial check for designated sites and priority habitats near the proposal.

Planning officers must check to see if there are designated sites within 2km of the proposal. Where the proposal includes the storage of slurry, poultry litter or manure it should be treated as an agricultural development and a screening distance of 7.5 km must be applied. See NIEA website for a map of all designated sites. These sites have the potential to be impacted upon by the proposal.

All priority habitats that could be impacted within 500m must also be considered. NIEA provides Northern Ireland Biodiversity Hazard Mapping which identifies a significant proportion of potential priority habitat for Northern Ireland. See appendix 1 for priority habitat types that can be significantly impacted by ammonia deposition.

In order to adequately assess an application it is important that there is sufficient information on which to base a decision. The following is required for a complete application.

A SCAIL (Simple Calculation of Atmospheric Impact Limits) check of designated sites within 2km and priority habitats within 500m must be undertaken for each application.

If the SCAIL is 1% or over of the CLe for designated sites, or 10% or over for priority habitat then there is the potential for significant effects and the application may require more detailed air quality modelling. A detailed air impact assessment (modelling) is always required where the designated site or priority habitat has reached its capacity regarding permitted input or that the initial SCAIL screening has exceeded permitted input.

Before undertaking any further assessment the applicant should be made aware that the general area is exceeding the critical load for a number of airborne pollutants including those that can result in nitrogen deposition. NIEA has a commitment to the EU Strategy: ‘Our life insurance, our natural capital: an EU biodiversity strategy to 2020’, to ensure that all designated sites are in favourable status by 2020. The existing high ammonia levels could hinder progress towards achieving this. NIEA advise that all applications which result in nitrogen deposition are considered in respect of this commitment. The applicant may therefore wish to fully consider the additional expense of the information required to further this application if additional modelling is requested**.**

NIEA should then be consulted with the air quality modelling to provide further advice on environmental effects.

Informatives for Decision Notices

The applicant's attention is drawn to The Nitrates Action Programme (NAP) Regulations (Northern Ireland) 2014. All livestock manure, slurry, silage effluent and dirty water must be stored in accordance with these regulations. For more information please see https://www.daera-ni.gov.uk/articles/about-nitrates-action-programme-nap-2011-2014-and-phosphorus-regulations or contact Northern Ireland Environment Agency, Water Management Unit (Telephone: 028 9262 3100).

The applicant is informed that it is an offence under Article 7 of the Water (Northern Ireland) Order 1999 (as amended) to knowingly or otherwise discharge or deposit any poisonous, noxious or polluting matter so that it enters a waterway or water contained in any underground strata. The penalty if found guilty of an offence under this Article can be imprisonment for a term not exceeding 2 years or a fine or both. For further information on pollution prevention please contact Northern Ireland Environment Agency, Water Management Unit (Telephone: 028 9262 3100).

References

APIS, 2017. *Critical Loads and Critical Levels - a guide to the data provided in APIS*. (Online) Available at: http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm#_Toc279788056 (Accessed 23 May 2017)

DEFRA (2011) Anaerobic Digestion Strategy and Action Plan – A commitment to increasing energy from waste through Anaerobic Digestion.

JNCC. 3rd UK Habitats Directive Reporting 2013. Joint Nature Conservation Committee

UNECE (2003): Empirical Critical Loads for Nitrogen - Expert Workshop, Berne 2002, Eds. Acherman and Bobbink. Environmental Documentation No. 164, SAEFL

Process to consider for applications when dealing with the natural heritage impacts on anaerobic digestion

Does the proposal have full mitigation for impacts on water quality and all stored materials are covered?

Yes → Ensure all details are on plans and send to Shared Environmental Service if within an N2K catchment or within 2km of an N2K site. Consult NIEA if proposal is greater than 5MW.

No ↓

Request mitigation as detailed within this standing advice. Undertake SCAIL screening if the proposal is within 500m of a designated site or priority habitat if no mitigation is provided.

If SCAIL is 1% or over of the CLe for a designated site, or 10% or over of the CLe for a priority habitat request detailed modelling of the proposal where the background CLe for the habitat is already exceeded as the proposal has potential for significant effects

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Send to internal Shared Environmental Service for Habitats Regulations Assessment to confirm if modelling is required for designated sites

Has modelling been included?

No → Proposal could be contrary to policy due to lack of information and potential to cause harm to a designated site and/or priority habitat

Yes ↓

Consult NIEA with SCAIL assessment and modelling report to provide advice as development has the potential to impact on a designated site and/or priority habitat

Appendix 1

Greater detail on habitat effects - source www.apis.ac.uk

BOGS and HEATHLANDS – effects and implications

- Ammonia exposure will predispose sensitive plants to stress much faster than wet N deposition ie. at lower N loads.
- Effects will vary depending on the exposure concentrations, the length of time of exposure and whether phosphorus and Potassium (PK) deposition has also been increased, e.g. dust from point sources.
- Direct damage to sensitive species, e.g. bleaching and leaf discoloration, observed in *Sphagnum* species and lichen *Cladonia portentosa* at high >20 µg m^{-3} concentrations. Bleaching is a particularly likely consequence of NH_3 exposure. Breakdown of *Sphagnum* hummocks and increase in bare peat which can increase the likelihood *of ero*sion and surface oxi*dation.*
- Increase in algal growth over *Sphagnum* especially where PK also enriched.
- Reduced ability of stomata to close under drought *conditio*ns, leading to plant water stress (Van Hove et al. 1991, Erisman and Draaijers 1995) highly visible as greatly increased amount of grey foliage in *Calluna* a consequence of winter desiccation (Sheppard et al 2008; 2011).
- Changes in the composition of ground-flora, bryophyte and lichen communities.
- There may also be subtle changes in plant morphology, physiology and biochemistry which not only increases growth, but also increases sensitivity to environmental factors such as wind, frost, drought and pests (e.g. increased tissue N concentrations can predispose plants to insect attack).

BROADLEAVED, MIXED and YEW WOODLAND – effects and implications

- Direct damage to foliage, e.g. leaf discolouration, premature senescence and loss.
- Increased sensitivity to drought and spring frost and increased risk of pest and pathogens attack
- Reduced ability of stomata to close under drought conditions, leading to plant water stress (Van Hove et al. 1991, Erisman and Draaijers1995).
- Loss of mycorrhiza and fruit bodies.
- Changes in the composition of ground flora, bryophyte and lichen communities. Changes in the understorey, increase in grasses and ruderal species.
- Nitrification will be stimulated, increasing soil acidity.
- Effects likely to be exacerbated if leaf area, canopy increases

CONIFEROUS WOODLAND – effects and implications

- Direct damage to spruce and pine tree foliage, for example, leaf discolouration, premature senescence and loss.
- Increased sensitivity to drought and frost and increased risk of pest and pathogens attack
- Reduced ability of stomata to close under drought conditions, leading to plant water stress (Van Hove et al. 1991, Erisman and Draaijers1995).
- Loss of mycorrhiza and fruit bodies.
- Increased rates of litter loss

- Changes in the composition of ground flora, bryophyte and lichen communities. Changes in the under storey, increase in grasses and ruderal species.
- Nitrification will be stimulated, increasing soil acidity.

CALCAREOUS GRASSLAND – effects and implications

- Reduced species richness and diversity
- Change in species composition
- Loss of rare or endangered species.
- Loss of characteristic calcicolous mosses and lichens at risk from shading and N accumulation, if over storey species are stimulated.
- Increased risk of drought effects.

References

Erisman, J.W.; Draaijers, G.P.J. 1995 Studies in Environmental Science 63 Amsterdam: Elsevier

Hove, L.W.A.; Vankooten, O.; Vanwijk, K.J.; Vredenberg, W.J.; Adema, E.H.; Pieters, G.A. 1991 Physiological-effects of long-term exposure to low concentrations of SO2 and NH3 on poplar leaves Physiologia Plantarum 82 32-40

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Sheppard, L.J.; Leith, I.D.; Crossley, A.; Dijk, N.; Fowler, D.; Sutton, M.A.; Woods, C. 2008 Stress responses of Calluna vulgaris to reduced and oxidised N applied under 'real world conditions' Environmental Pollution 154 404-413

Sheppard, L.J.; Leith, I.D.; Mizunuma, T.; Cape, J.N.; Crossley, A.; S., L.; Sutton, M.A.; Fowler, D.; Dijk, N. 2011 Dry deposition of ammonia gas drives species change faster than wet deposition of ammonium ions: evidence from a long-term field manipulation Global Change Biology 17 (12) 3589-3607

Appendix 2 – modelling details

Initial Model Used for Screening

SCAIL (http://www.scail.ceh.ac.uk/) - Simple Calculation of Atmospheric Impact Limits is a simple online screening tool that can be used to estimate the effect of an agricultural emission (manure storage) on a habitat (e.g. ASSI). This estimate may then be used to determine the exceedance or non-exceedance of the habitat's impact limit and will help users in deciding whether more detailed modelling or site specific investigation is required.

Information Required

Information	**Detail**
Source Location	Easting and Northing
Source Type	Litter/Manure Storage
Tonnes of Fresh Manure	Tonnage
Area of Storage	M^2
Slurry Detail	Rigid Cover, Floating, etc
Livestock Number	Number of Animals
Type	Manure, Slurry etc
Designated Site Details	Detail
Search Radius	Kilometres
User Specified Site	Detail
Site Name	Name of Site
Site Location	Easting and Northing
Habitat Within Site	Acid grassland, Bog etc

Use the APIS website (Air pollution Information System)(http://www.apis.ac.uk/)) to identify the Critical Level of each sensitive species/habitat: It is important to distinguish between a critical load and a critical level. The **critical load** relates to the quantity of pollutant **deposited** from air to the ground, whereas the **critical level** is the gaseous **concentration** of a pollutant in the air. (For more detail on Critical Loads/Levels go to: http://www.apis.ac.uk/overview/issues/overview_Cloadslevels.htm#_Toc279788050)

More detailed dispersion modelling could be provided by the following models:

ADMS

ADMS is a dispersion model used to model the air quality impact of existing and proposed industrial installations. It has been developed by Cambridge Environmental Research Consultants (CERC) in collaboration with government bodies. The model predicts wet and dry deposition using meteorological data and typography. It covers dispersion from point, area, volume and line sources with a straight-line plume trajectory from source to receptor or grid point. Concentrations are modelled on an hour by hour basis using an appropriate regional meteorological data set. This modelling software is the industry standard in the United Kingdom.

AERMOD

AERMOD is another dispersion modelling software package which was produced by American Meteorological Society/United States Environmental Protection Agency. It is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

NIEA (2015) 'Guidance for Operators on producing an Air Dispersion Modelling Report for a PPC Farming Application' will provide more detail on the type of information required when published.

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