European Union Network for the Implementation and Enforcement of Environmental Law

Public nuisance of industrial odours

Supporting IED implementation project, WG4, under expert team of Industry and Air 2022-2024

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Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the EU Member States, acceding and candidate countries of the European Union and EEA countries. The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

During the previous years IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 7th Environment Action Programme and the Recommendation on Minimum Criteria for Environmental Inspections, and more recently in the General Union Environment Action Programme to 2030 and EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil'.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at: www.impel.eu

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Executive Summary

This report is the result of IMPEL working group on public nuisance issues of industrial odours. Odours are a tricky issue from an environmental supervisory perspective because odours can be experienced differently by individuals. Although there is a lot of standards and guidelines available, there are only a few regulations for odours, which makes environmental supervision challenging. Odour issues are handled in very different ways in different countries and even within the country, depending on, for example, industrial activity, municipality, or differences in regional administrations.

The main aim of this report is to map the different practices and share the best experiences between IMPEL members. This report utilise results of the questionnaire and information collected from the literature as well as during the site visit in the pulp mill and oil refinery.

Online platforms are good for collecting odour complaints and communicating with the local community. Online platforms for air quality monitoring are also useful tools for environmental monitoring, both for the competent authority and the surrounding area. Moreover, a general conclusion is that good communication with the operator and the surrounding area helps in conflicts.

The new IED 2.0 (2024/1785/EU) should shed some light on odour issues, as it should clarify that odour pollution should be considered when determining best available techniques and when granting or revising permits.

Disclaimer

This report is the result of a project within the IMPEL network. The content does not necessarily represent the view of the national administrations or the Commission.

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1. Introduction

Odours have received a lot of attention due to people's growing interest in the environment and quality of life. Odours are also a common cause of complaints. Both residents and employees may find odours from industries such as wastewater treatment, livestock farming, composting plants, landfills, paper and pulp mills, or the petrochemical industry disturbing. In addition, their potential health effects arouse public concern.

Odour issues and regulation is indeed a complex task. Although there is a lot of standards and guidelines available, there are only a few regulations for odours. Odour issues are handled in very different ways in different countries and even within the country, depending on, for example, industrial activity, municipality, or differences in regional administrations.

The main aim of this report is to map the different practices and share the best experiences between IMPEL members. This report utilise results of the survey and information collected from the literature as well as during the site visits.

1.1 Odours and terminology

An odour compound (**odorant**) causes olfactory response, while **odour** is a sensation due to stimulation of the olfactory organs (**olfaction**). Individuals perceive odours in different ways. The differences can be due to, for example, age, gender, allergies, and smoking habits. Perceptible odours can have a significant impact on individuals and affect moods. An odour can be associated with a certain experience - the same odour can be pleasant for one person, while another finds it unpleasant. When it comes to odours, we often talk about **odour threshold**, although what we really mean is **odour detection threshold**, which indicates the concentration at which 50 percent of a human panel can detect an odour or the presence of an odour without characterizing the stimulus. In addition, the third term used is **recognition threshold**, which means the concentration at which 50 percent of the human panel can identify the odorant or odour.[1,2]

European Standard EN 13725:2022 defines the odour concentration as "the number of European odour units in a cubic metre of gas at standard conditions". Therefore, the odour concentration is measured in "European Odour Units per cubic metre" and its symbol is "ou_E/m^3".

Industrial activities cause a lot of odour nuisance. The assessment of unpleasant odours emitted by industries is a highly relevant issue, as they can have a significant impact on air quality and

public health. In the industry sector, there might be different emission limit units, such as frequency of odour occurrence, odour concentration, odour cleaning efficiency, or indirectly, such as a TRS (total reduced sulphur, the sum of the following reduced malodorous sulphur compounds generated in the pulping process: hydrogen sulphide, methyl mercaptan, dimethyl sulphide and dimethyl disulphide, expressed as sulphur) emission limit concentration of the pulp and paper industry and the TRS concentration of air quality. Odour nuisances are sometimes very difficult to prevent, because even negligible amounts of some odorants are sensed by humans. Hydrogen sulphide and mercaptans for instance can be sensed in concentrations far below concentrations which are harmful to human. Due to human ability to detect odorants in very small concentrations, otherwise insignificant air pollution sources (valve and joint leakages, small spills, evaporation from wells, sewers, or open basins) may give rise to complaints from neighbours. Table 1 contains some of the typical industrial odours and their detection thresholds.

Table 1 Examples of industrial odour characteristics and detection thresholds.[1]

Odorant	**Characteristic odour**	**Detection threshold, ppm**
Ammonia	Urine or sweat	5 to 53
Chlorine	Pungent, suffocating	0.1
Hydrogen sulphide	Rotten eggs	0.0005 to 0.3
Methyl mercaptan	Rotten cabbage	0.002
Sulphur dioxide	Pungent, irritating	0.3 to 5
Benzene	Sweet, aromatic, gasoline-like	1.5 to 4.7

[1]Powers, W. (2004) The Science of Smell Part 1: Odor perception and physiological response, in Environmental Quality 4-1, Iowa State University, University Extension.

[2] Guadalupe-Fernandez, V., De Sario, M., Vecchi, S., Bauleo, L., Michelozzi, P., Davoli, M., Ancona, C., (2021). Industrial odour pollution and human health: a systematic review and meta-analysis. Environ Health. 2021 Sep 22;20:108.

1.2 Survey

A survey was conducted through a questionnaire which aimed to identify odour problems in IMPEL countries and highlight the best practices in permitting and controlling odours. It only addressed industrial odours- not commercial or private sources. The survey was open January 27th - February 28th, 2023, and run with Webropol survey and reporting software. The questions are shown in Annex I.

Background of the respondents

In total 35 responses from 12 different countries were received (Figure 1). The answers were distributed as follows: Austria (1), England (1), Finland (1), Germany (10), Greece (9), Italy (4), the Netherlands (1), Portugal (2), Romania (1), Slovakia (2), Slovenia (1) and Spain (2). Inspectorates, permitting authorities, specialists and civil servants responded to the survey. It should be noted that some (most) of the responses where from regions of different countries, so they may not give the view of the whole country itself but of certain regional governments.

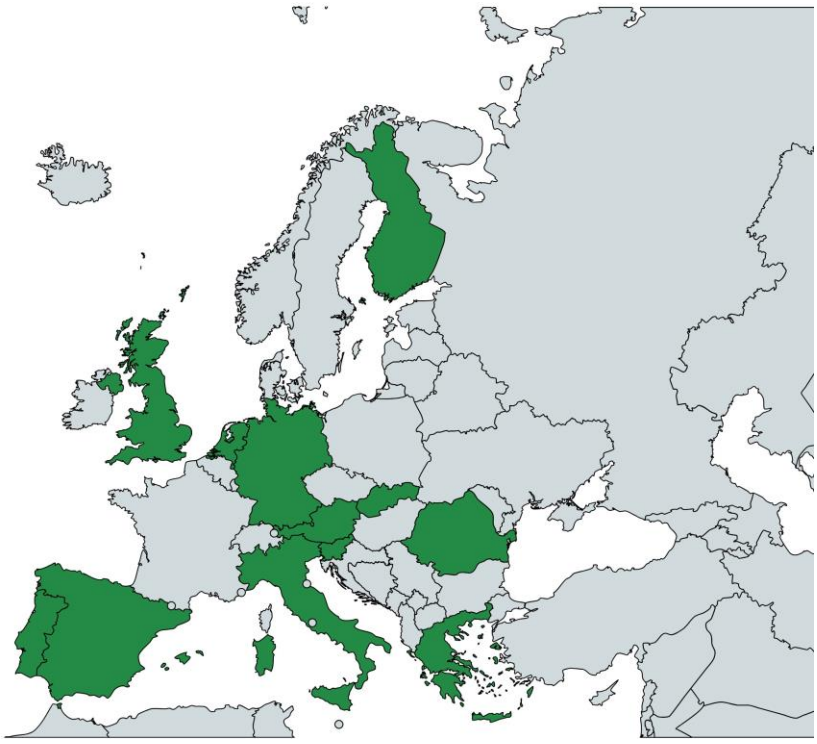

Figure 1 Countries answered to survey. Map is created using MapChart.

The answers are analysed anonymously. Due to the lack of data, a comprehensive analysis cannot be made, but the report highlights, how odour issues are regulated in different countries and highlights some best practices applied in several countries.

2. Regulation

For example, a project report by Izquierdo et al. (2021)[3] provides an overview of odour regulations in several countries around the world. The report also covers countries like China, Japan, New Zeeland, and Chile, but not Finland, Estonia, and Latvia, which are also discussed in this report.

2.1 Odour regulation

According to the respondents, the regulation of odour issues varies between countries. Most of the answers show that the odour issues are regulated by national legislation, and in most cases EU level as well. In some countries (**Austria**, **England**, **Netherlands**, **Romania**, **Slovenia**) odour issues are also regulated by national laws. However, Romania declare that the odour regulation bases only regional law either nationally or EU level. Based on the answers it should be also stated that there is no odour regulation in Portugal.

Table 2 summarizes some useful links and notes collected from the survey concerning odour regulation of the respondent countries.

[3]Izquierdo C., Diaz C., Anton A., Kavanagh R., Capelli L., Arias R., Salas Seoane N., Burbano J., Francis L. (2021). Analysis of existing regulations in odour pollution, odour impact criteria 2, D-NOSES, H2020-SwafS-23-2017-789315.

Table 2 Links to odour regulation in different countries.

Country	Useful links	Notes
England		Statutory Nuisance (regulated by local authorities); Pollution Prevention and Control; Waste Management Licensing
Finland	https://www.finlex.fi/fi/laki/kaannokset/2014/en20140527; https://www.finlex.fi/fi/laki/alkup/2017/20170079_20190049.pd; https://www.finlex.fi/fi/laki/alkup/2015/20150064	
Greece	https://www.et.gr/api/Download_Small/?fek_pdf=20130201450; https://www.et.gr/api/Download_Small/?fek_pdf=20120100052	
Italy	https://www.gazzettaufficiale.it/dettaglio/codici/materiaAmbientale	
Slovakia		European Union. Odour management plan, specific requirements for selected activities.
Slovenia	http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED4056	
Spain	BOE-A-2007-19744 Ley 34/2007, de 15 de noviembre, de calidad del aire y protección de la atmósfera.; Decreto 239/2011, de 12 de julio, por el que se regula la calidad del medio ambiente atmosférico y se crea el Registro de Sistemas de Evaluación de la Calidad del Aire en Andalucía. (juntadeandalucia.es)	The applicability is restricted to cases where an odour nuisance at sensitive receptors is expected and/or has been substantiated.

In **Germany**, according to §1 Federal Immission Control Act FPCA (German BImSchG), people must be protected from harmful environmental effects and their occurrence must be

prevented. Odours can also be a harmful environmental impact within the meaning of §3 FPCA (German BImSchG) if they represent a considerable nuisance. Odour exposure is usually classified as a 'considerable nuisance' if the immission limit values are exceeded. These limit values are specified in Annex 7 of Technical Instructions on Air Quality Control (TA Luft) 2021. Exceptions are odours that cause disgust or nausea. As these odours pose a health hazard, facilities that emit these odours must be closed.

Odour problem in **Greece** is considered as part of the wider environmental ambient air quality "issue" which is regulated by the following regulations, dealing among others with odorous substances: Joint Ministerial Decision 14122/549/E.103/2011, Ministerial Decision 22306/1075/E103/2007 (Gazette 920b/08-06-2007)), Presidential Decree 1180/1981, Joint Ministerial Decision 6164/2018, Joint Ministerial Decision 36060/1155/E.103/2013 in compliance with IED.

2.2 Specified odour limits (mandatory requirements)

Four countries (**Germany**, **Italy**, **Netherlands**, **Slovenia**) declare that there are specified odour limits in place (mandatory requirements). On the other hand, most countries (8 of 12) indicated that there are no specified odour limits in place.

In **Germany**, there are limit values for odours both in ambient air (immission limit values) and directly at the source (emission limit values). The emission limit values (GE/m³) apply to certain types of facility and are set out in the Technical Instructions on Air Quality Control (TA Luft) 2021. However, limit values can also be specified in permits for facilities. The immission limit values are based on the concept of odour hours and are relative frequencies of odour hours in relation to one year. Places where people are not only temporarily present (e.g. residential areas or workplaces) are assessed. Different limit values have been set for different types of areas depending on the protection requirements. The immission limit values are also specified in TA Luft 2021 (Annex 7). The limit value for residential and mixed areas is 0.10, which means that odours may be perceptible in these areas for 10 % of the annual hours. The 10 % refers to all odours that affect the area. The immission limit value for commercial and industrial areas and village areas is 0.15. In general, a value of 0.25 should not be exceeded under any circumstances.

Slovenia: Emission limit value is 500 ou_E/m^3.

2.3 Legal procedures related to odours

Based on the answers collected, six countries (**England**, **Finland**, **Germany**, **Italy**, **Slovakia**, **Spain**) report that there are legal procedures relating to odours. On the other hand, there are

no common legal procedures for odours in **Greece**, but only if it is foreseen as a specific term in the permit or when the deterioration of quality of life is documented to happen due to industrial odours release and it relates to insufficient preventive measures from the side of the industry.

Slovakia and **England** state that legal procedures are based on BAT requirements. In addition to that, England mentioned that appropriate measures required for waste licensed sites and abatement notices for statutory nuisance.

In **Germany**, odours are assessed both in approval and inspection procedures for plants and in urban land-use planning. Odours can be determined on the emission side using olfactometric emission measurements in accordance with DIN EN 13725 or static plume measurements in accordance with DIN EN 16841 Sheet 2. Odours in ambient air are determined using dispersion calculations or grid inspections in accordance with DIN EN 16841 Sheet 1. TA Luft is used to verify compliance with the respective limit values.

In **Spain**, some permits (landfill and paper industry) have established some requirement for the control of odours and instalation of treatments, but without any emission limit values. The answers pointed out that it would be necessary to have limits for better control and reduction of the impact.

In **Finland**, *Government Decree on the limitation of emissions into the air from certain activities and installations that use organic solvents* (https://www.finlex.fi/fi/laki/alkup/2015/20150064, unofficial English translation: https://www.finlex.fi/fi/laki/kaannokset/2015/en20150064.pdf) and *Government Decree on air quality* (https://www.finlex.fi/fi/laki/alkup/2017/20170079) include some legal procedures related to odours.

Italy: https://www.brocardi.it/codice-dell-ambiente/parte-quinta/titolo-i/art272bis.html?utm_source=internal&utm_medium=link&utm_campaign=articolo&utm_content=nav_art_prec_top#:~:text=Articolo%20272%20bis%20Codice%20dell'ambiente&text=La%20normativa%20reionale%20o%20le,di%20cui%20al%20presente%20titolo.

2.4 Other remarks

In Finland, Environmental Protection Act (527/2014) section 89 subsection 2 states "…Additionally, the permit authority shall, on application by the supervisory authority, the relevant authority protecting the public interest or a party suffering harm, or a registered association or foundation referred to in section 186, amend the permit, if…"

At least one case example can be found, where the party suffering harm has applied for the amendment of an environmental permit of factories located in Oulu (dnro PSAVI/5399/2022). According to the party suffering harm, the environmental permit of the companies operating in Oulu's Nuottasaari factory area should be amended, because the pollution caused by the operation differs substantially from what was previously estimated and the operation causes a consequence prohibited by the Environmental Protection Act, i.e. continuous air pollution. As a result, there is a bad smell downwind, although according to companies operating in the area, there are no malfunctioning causing harm. According to the party suffering harm, the initiative applied to all companies operating in the area. The facilities' environmental permits must be amended so that the permits do not allow the smell to spread outside the factory area. The party suffering harm has complained about 14 odour nuisances in the last 14 months. The smell penetrates inside the apartment along with the ventilation and is a disturbance to the peace of the home. The regional state administrative agency rejected this initiative, i.e. it did not amend the environmental permits of the facilities operating in the area. The permit decision can be found here: https://ylupa.avi.fi/fi-FI/asia/2220001.

3. Permits and BAT conclusions

3.1 Specified odour conditions in permits

In **Austria**, there is no standardised procedure for the assessment of odour immissions. A guideline published by the Office of the Styrian Provincial Government in 2021 is intended to remedy this situation and provide a comprehensive and well-founded basis for assessment based on the latest technical principles from immission technology and environmental medicine. The guideline provides a procedure-independent (e.g. Construction Law, Trade Regulations Act, Waste Management Act, Environmental Impact Assessment Law, Mineral Resources Act) tool for an odour assessment that is as clear and comprehensible as possible.

In Austrian legislation, odour immissions are limited on the one hand by the concept of reasonableness or materiality (e. g. §77 Trade Regulations Act) and on the other hand by local custom (e.g. §95 Styrian Construction Law). The concept of the reasonableness of an odour impact is the subject of evidence to be examined in official proceedings. In this context, it is particularly important to note in the various material laws that the reasonableness (or materiality) of an odour immission is based on a healthy, normal child or adult. This implies that subjective characteristics of individuals, which undoubtedly play a significant role in a possible odour nuisance, are not part of the evidence in official proceedings.

To determine the frequency of an odour immission, the concept of the odour hour has essentially become established, with an indication of the so-called annual odour hours in percent, depending on a certain odour threshold, in odour units per cubic metre [GE/m³].

The guideline values for odour applied in Styria are defined in such a way that 'healthy, normally perceiving persons' are protected from unreasonable nuisance. The guideline values assume that approx. 10 - 20 % of the population have an above-average sensitivity to odours. The guideline values protect 80 - 90 % of the population from unacceptable nuisance, i. e. the proportion of the population that is normally to slightly sensitive to odours. For industrial odour sources, maximum annual odour hours are defined according to their nuisance potential (low, medium, high, very high). For the assessment of agricultural emission sources (cattle, pigs, chickens, silage, biofilters), maximum annual odour hours are defined in conjunction with the potential nuisance (low, medium, high) and the neighbouring zoning (residential areas, village areas, open land). Studies, e.g. from Iceland, show that residents of agricultural areas 'tolerate' a higher proportion of annual odour hours than people living in purely residential areas due to habituation.

In England, no offensive odours beyond the site boundary, as perceived by an authorised officer unless the site is using all appropriate methods for odour control.

In **Finland**, for example the following odorous compounds are often specified in the permits: TRS, sulphur dioxide, volatile organic compounds, methane, and ammonia.

In **Germany**, specific odour conditions can be specified in permits. Requirements can be specified for individual sources or for the entire facility. Emission limit values (ou_E/m^2) can be specified for individual sources of a facility or exhaust gas cleaning installations. Some of these limit values are listed for certain types of installations in the TA Luft. For example, the emission limit value for biofilters is 500 ou_E/m^3. These limit values are regularly inspected after commissioning of the facility and as required during monitoring. Precise requirements are specified in ancillary provisions when the facility is permitted. The olfactometric measurements of the odour-emissions are carried out in accordance with DIN EN 13725; the olfactometric measurements are repeated every 3 years. As a rule, a facility is only authorised if the immission limit values are complied with in terms of total odour exposure. Ancillary provisions can specify the proportion of the total odour exposure in ambient air that a facility may have. Compliance with the limit values can be checked using dispersion calculations or grid measurements in accordance with DIN EN 16841 Part 1.

In **Greece**, in some cases, general, qualitative terms in the meaning of preventive measures are imposed to avoid or reduce odour nuisance of paricular activities. Regarding IED units, permits incorporate the limit values of odorous substances (e.g benzene, VOCs) imposed through the below-mentioned legislation.

Joint Ministerial Decision 14122/549/E.103/2011
Ministerial Decision 22306/1075/E103/2007 (Gazette 920b/08-06-2007)
Presidential Decree 1180/1981
Joint Ministerial Decision 6164/2018

In **Italy**, emission limits are often expressed as ou_E/m^3 for example, odour concentration in emission (i.e. biofilter 300 ou_E/m^3 or lower if the model shows it's not enough to guarantee 1ou/m3 in residential building close to the industrial site). Odour abatement efficiency. Technical and management prescriptions; participation in technical tables in the event of complaints from the population.

In the **Netherlands**: odour units/ en in afstanden (meters).

In **Romania**: In establishing the parameters regarding odours, the Health Department uses SR EN 16841, SR EN 13725. Also, BAT conclusions are used in permits and air protection legislation (both national and international standards).

In **Slovakia**: technical measurements based on BAT.

In **Slovenia**: minimum distance to residential areas, construction and operational requirements, emission limit values, frequency of odour measurements.

In **Spain**: Usually there are no odour limit values on permits. If the odour can be related to a chemical (TRS, sulphur dioxide or ammonia, for example) then it would have a value limit for it. Also, the permit would have specific measures to avoid odour emissions, the obligation to measure odours on a regular basis, or to model odour dispersion, or even a value limit of the efficiency of the odour abatement system. For example, in pulp mills one of the value limits is "90% of efficiency on the biofilter, if the emission odour concentration is over $1000uo_E/Nm^3$".

In **Portugal**, the parameters are not specified in the permits, but conditions related to treatment and measures to minimize nuisance complaints. There are some cases that installations IED or EIA have specific requirements concerning odours, such as implement an odour management plan, monitor odour emissions, or implement specific measures to reduce odours.

3.2 BAT conclusions

The following chapters summarise the most of BAT conclusions that deals with odours. It should be kept in mind that this chapter shows data that is collected under Industrial Emission Directive (2010/75/EU). The authors of this report are aware that the IED 2.0 (2024/1785/EU) Article 3 is amended to include term “odours”.

- BAT conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for the refining of mineral oil and gas (2014/738/EU) such as:
    - BAT 6. BAT is to monitor diffuse VOC emissions to air from the entire site by using all of the following techniques: (i) sniffing methods associated with correlation curves for key equipment; (ii) optical gas imaging techniques; (iii) calculations of chronic emissions based on emissions factors periodically (e.g. once every two years) validated by measurements.
    - BAT 18. Techniques in order to prevent or reduce diffuse VOC emissions-III. Techniques related to plant operation: Use of a risk-based leak detection and repair (LDAR) programme in order to identify leaking components, and to repair these leaks.
    - BAT 20. Techniques in order to reduce emissions to water from the hydrofluoric acid alkylation process.

- BAT 21. In order to reduce the emissions to water from the sulphuric acid alkylation process, BAT is to reduce the use of sulphuric acid by regenerating the spent acid and to neutralise the wastewater generated by this process before routing to wastewater treatment.
- BAT 49. In order to reduce VOC emissions to air from the storage of volatile liquid hydrocarbon compounds, BAT is to use floating roof storage tanks equipped with high efficiency seals or a fixed roof tank connected to a vapour recovery system.

- BAT conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for common wastewater and waste gas treatment/management systems in the chemical sector such as:
  - BAT 20. In order to prevent or, where that is not practicable, to reduce odour emissions, BAT is to set up, implement and regularly review an odour management plan, as part of the environmental management system.
- BAT conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for production of pulp, paper and board such as:
  - BAT 11. BAT is to regularly monitor and assess diffuse total reduced sulphur emissions from relevant sources.
  - BAT 20. In order to reduce odour emissions and total reduced sulphur emissions due to strong and weak gases, BAT is to prevent diffuse emissions by capturing all process-based sulphur containing off-gases, including all vents with sulphur-containing emissions, by applying all of the techniques given below.
  - BAT 21. In order to reduce SO2 and TRS emissions from a recovery boiler, BAT is to use a combination of the techniques given below: increasing the dry solids (DS) content of black liquor, optimised firing, wet scrubber.
  - BAT 24.
  - BAT 25.
  - BAT 28.

4. Methodologies and monitoring

There are available direct and indirect methods to characterise odours. For example, in JRC BREF the following approaches are mentioned: dynamic olfactometry, dispersion models, field inspection, electronic noses, and odour surveys. These techniques are mainly *sensorial techniques* from which only electronic noses can be classified as *analytical methodology*. Other possible analytical methodologies are gas chromatography-mass spectrometry and identification of specific compounds.

European Standard EN13725 specifies a method for the objective determination of the odour concentration of a gaseous sample using dynamic olfactometry with human assessors and the emission rate of odours emanating from point sources, area sources with outward flow and area sources without outward flow. The primary application is to provide a common basis for evaluation of odour emissions in the member states of the European Union.

Almost all countries (except Austria and Romania) indicate that measurements play a key role in odour control. All countries follow at least EN 13725 standard method for measurements. In addition, EN 16841 Part 1 and EN 16841 Part 2 standard methods are utilized in odour measurements at least in Germany, Italy, Netherlands, and Romania. Eight countries (Austria, Finland, Germany, Greece, Italy, Netherlands, Slovakia, and Spain) indicate that odour modelling is utilised.

4.1 Odour monitoring

Four countries (**Germany**, **Greece**, **Netherland,** and **Slovenia**) indicated that odour monitoring is done on a regular basis and when it is specified in the permits. Odour monitoring is done in **Finland** and **Italy** when it is specified in the permit. In **England**, Germany, Greece, Italy, and Slovakia odour measurements are also done during routine or non-routine inspections. In Slovakia, odour measurements are done during regular rounds of critical places and the entire source, checking whether all measures are implemented, measuring markers, measuring odour units etc.

Most of the answers indicated that the odour monitoring should be done at the source and in the living area.

Based on the answers of the survey, there is no odour monitoring in **Austria**, **Portugal**, **Romania,** and **Spain**. In Austria, measurements are carried out mainly for scientific questions.

4.2 Responsible for conducting odour measurements

In **Austria**, **Italy** and **Romania**, public authorities are responsible for odour measurements. In **England**, inspectorates and operators may be required to undertake emissions monitoring. Moreover, operators are responsible for odour monitoring in Romania and **Spain**.

In **Finland**, operators and accredited laboratories are responsible for odour measurements. Continuous self-monitoring is the prevailing technique. In these cases, the environmental permit describes how often an external, accredited laboratory must perform inspection measurements. Public authorities do not conduct odour measurements at sources, but they might be responsible for odour measurements in the living areas.

In **Germany**: inspectorates, public authorities, operators, accredited laboratories. Within the scope of approval procedures, the plant operator is obliged to prove compliance with the legal requirements by submitting expert reports. In cases of justified suspicion, the authorities request the plant operator to provide corresponding expert evidence on the odour problem (evidence of compliance with the legal requirements or monitoring of issued requirements of a permit notice). The preparation of expert opinions and corresponding subordinate plume inspections are thus carried out by external expert offices. The monitoring authorities receive assistance in the assessment of odours and expert opinions from the respective state environmental offices.

In **Greece,** so far odour measurements are conducted by accredited laboratories employed by public authorities or by the operator. Public authorities also monitor odours in the sense of air quality emissions.

Based on all the answers, it can be stated that the person performing the measurements must be qualified and accredited. Some of the countries (the **Netherland**, **Portugal**, **Slovakia,** and **Slovenia**) state that only accredited laboratories are responsible for odour measurements. It should also be pointed out, that there are no odour measurements in the Azores (Portugal). Only **Italy** did not give any indication that the measurer must be an accredited professional.

4.3 Methodologies used for odour measurements

In **England** BSEN13725 must be undertaken by MCERTS accredited sampling companies when undertaking stack emissions monitoring. No accreditation for field sniff testing.

In **Germany** EN 13725 is used to determine odour concentrations (ou_E/m^3) at the source. EN16841 Part 1 is used to measure odour pollution (relative frequency) in ambient air. EN 16841 Part 2 is used to determine a plume size and for subsequent recalculation to the source

strength. Other odour parameters, such as hedonics, intensity, or hedonic effect, are determined using VDI guidelines 3940 sheets 3 and 4.

In **Greece** EN standards applies. EN 16841-1 for field measurements and EN 13725 for emission samples.

In **Portugal** accredited laboratories follow EN 13725 requirements.

In **Italy** source sampling and dynamic olfactometry measures are applied. Odour monitoring according to EN 13725 or EN 16841 are not performed.

In **Romania** CSN EN 16841-2 and CSN EN 16841-1 are used. In **Slovenia** the standard EN13725 is used. The same standard EN 13725 is also used in **Spain**. In addition, there is a recent methodology: UNE 77270 *Standard Building collaborative odour maps through citizen science*. Although it is not a measurement standard, it could be useful tool for other regions or countries, and it is summarized in Annex II of this report.

4.4 Case example of air quality monitoring

Forestry is one of Finland's most significant industries, so there are TRS measuring stations in Finland. It should be kept in mind that TRS is only one parameter describing odour and it is very strongly related to the pulp and paper industry, therefore useful tool describing odour nuisance in Finland. The webpage https://ekilmanlaatu.net/ is an example of regional page for South Karelia. The map in Figure 2 shows real-time air quality data monitoring stations for the Imatra and Lappeenranta areas. Four measuring stations are in Imatra and six in Lappeenranta.

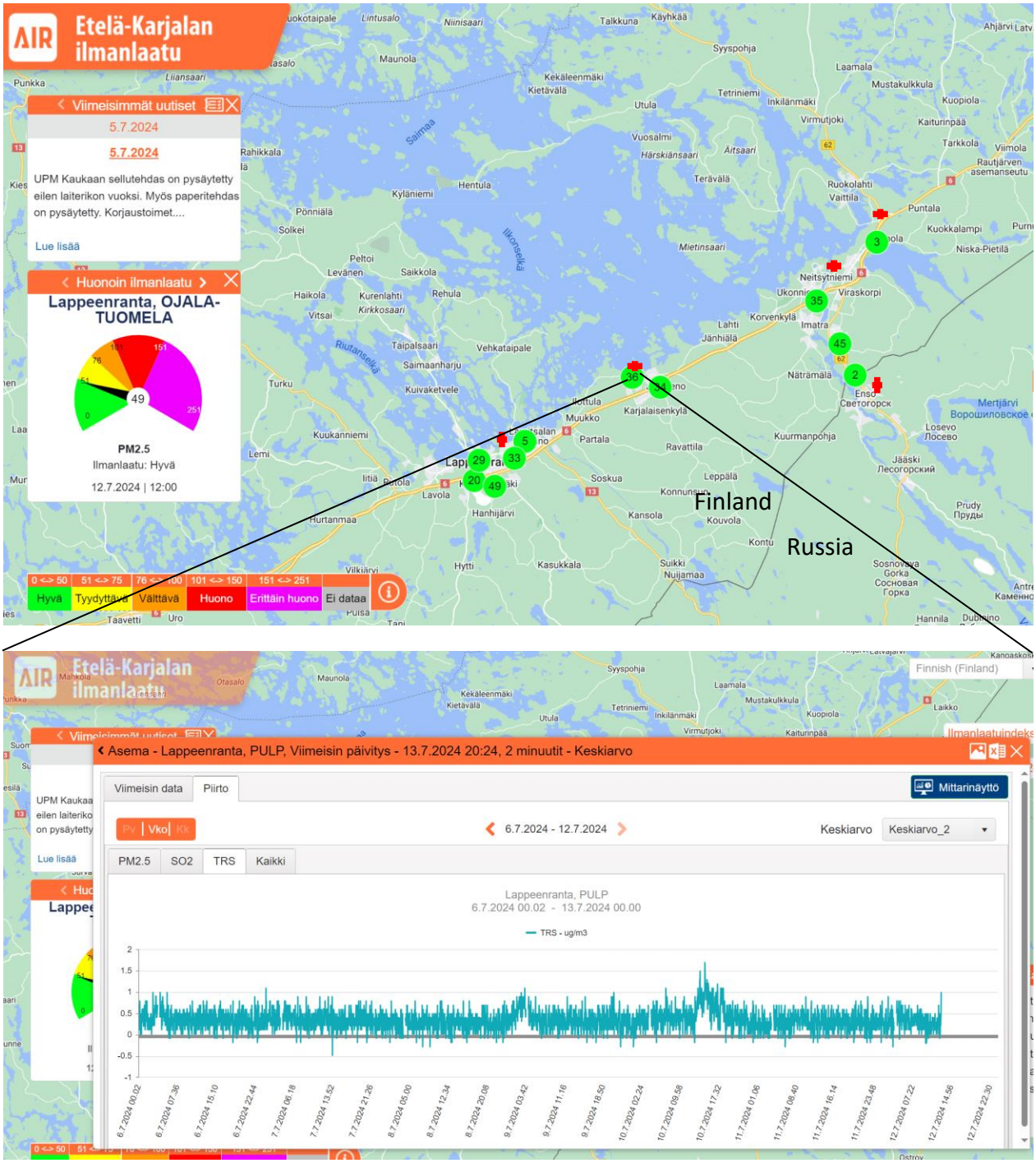

Figure 2 Locations of air quality measuring stations in South Karelia (Finland) and an example of TRS data from the station named PULP. Red symbol shows locations of pulp and paper mills.

5. Inspections

In general, inspections can be divided into routine inspections and non-routine inspections. Routine inspections are carried out based on a risk assessment, for example, every 1-5 years, while non-routine inspections are carried out, for example, after complaints and require a quick response from the inspector.

5.1 Odour inspections

Routine inspections

Depending on the risk, environmental inspections are carried out at intervals of 1-5 years, in **Germany**. If odour emissions are limited in the permit, regular measurements of odour emissions must be carried out. These measurement reports are checked during environmental inspections. In the event of complaints about odour emissions, an environmental inspection may be carried out for special reasons. The procedure in this case is described in Chapter 6.3. In the event of many odour complaints, preliminary odour inspections are carried out in individual cases in accordance with VDI Guideline 3883 Sheet 4, Appendix C. This assessment of odour pollution forms the basis for further measures of the authorities.

As in Germany, routine inspections are carried out in **Slovakia** within the same interval. In Italy, the routine odour inspections are carried out according to IPPC (DLgs 152/2006), and in Spain the interval depends on the number of complaints. Only **Romania**'s answer differs because there the inspections are done a couple of times a year.

Non-routine inspections

Citizen's complaints are the main trigger for non-routine inspections **almost in all countries** (England, Germany, Greece, Italy, the Netherlands, Portugal, Romania, Slovakia, Slovenia, Spain) answered the survey. In some cases (Germany, Romania, and Slovakia), the complaints might come from employees as well. Abnormalities in the measurement data of air quality or monitoring of installation may also lead to non-routine inspections in Germany, Greece, Italy, Portugal, Romania, and Slovenia.

Only **Austria**, **Finland**, **Germany,** and **Italy** indicate that inspections related to odour issues are not carried out. The background of the respondent and a lack of data may explain some of the answers. For example, in Finland, permitting authority does not usually carry out inspections whereas the supervisory authority is responsible for inspections.

5.2 Detection of odours during inspection

Following Table 3 summarises the method used to detect odours during inspections. Almost all responses showed that the inspector's own sensations are the most used tool for detecting odours, i.e. so-called qualitative or indicative measurement.

Table 3 Methods used to detect odours during inspections.

Country	Detection of odours during inspections			
	Without device[a]	Taking samples (on-site) and dynamic olfactometry in the laboratory	Taking samples (on-site) and conducting chemical analysis in the lab	Collaborating with an accredited laboratory
England	×			
Finland	×	×	×	×
Germany	×	×		×
Greece	×			×[b]
Italy	×	×		
Netherlands	×			×
Portugal	×			
Romania				×
Slovakia	×			×
Slovenia				×
Spain	×			×

[a]Indicative (" Inspectors' nose") or inspectors don't make measurements or sampling.

[b]in exceptional cases when a persistent odour problem occurs.

5.3 Actions in the case of non-compliance

The environmental permit conditions may be revised in Austria, Finland, Germany, Greece, Italy, Netherlands, Romania, Slovakia, Spain, if the activity does not meet the permit limits. In addition, the public authority can impose a penalty to the operator in Austria, Finland, Germany, Greece, Italy, Netherlands, Portugal, and Romania.

5.3.1 Odour management plan

Another key action in the case of non-compliance is to impose an odour management plan. The criteria for the establishment of odour management plan are summarised below.

England: Actual odour pollution or a high-risk activity.

Finland: If permit conditions have not been met, the company/farm/actor will be set demands to modify the operations so that the permit conditions are met.

Germany:

1. The aim is to comply with the immission values, considering the proportionality of the measures.
2. a management plan is established when the odour immission exceeds the legal immission limits.

Greece: In severe cases, when a facility causes a persistent odour nuisance, then an odour management plan is imposed, according to BAT for prevention or BAT for odour elimination, depending on the source of the odours, as described at the environmental permit/law.

Italy: according to BAT

Portugal: The odour management plan is imposed by the permitting authority. Only when specified conditions are included in the permit it is possible to apply penalty.

Romania: multiple citizen complaints, measurements from the accredited laboratory show anomalies in their analysis.

Slovakia: permanent citizen´s complaints about odour.

Spain: no criteria yet. case by case. In facilities affected by the emissions directive with published BAT, odour regulation will be included in the environmental authorizations. This is only applicable in cases where odour nuisance to sensitive receptors is expected and/or has been demonstrated (areas that need special protection, such as: — residential areas; — areas

where human activities take place (e.g. (for example, workplaces, schools, daycares, recreational areas, hospitals, or nursing homes).

When there are nuisances due to odours and their existence has been proven, the company is obliged to carry out a complete odour study, dispersion model and olfactometric characterization. This study will give us the initial concentration of the odour.

Subsequently, if the discomfort continues, they will be asked to implement an odour management plan as the best available technique. This plan will contain: a protocol of actions and deadlines, an odour monitoring protocol, a response protocol to incidents detected in relation to odours, for example complaints, an odour prevention and reduction program that determines the source or sources, measure or estimate exposure to odours, characterize the contributions from the sources and implement prevention and/or reduction measures.

Once implemented, this plan is applied to reduce odours. Since there is no limit value, we cannot apply fines for not reaching certain odour values, but we still can demand that the action plan can be complied with, and we can follow if there is a decrease in complaints until they disappear or even measure again odours.

5.3.2 Responsible for the establishment of odour management plan

England: The Environment Agency has guidance on the development of Odour Management Plans. These plans are written by operators and approved by the EA.

Finland: The supervising authority at first. If they consider that the operations are too far from the permit conditions, they can demand that a change of environmental permit must be applied. Then either the supervising authority or the company will apply for a change in permit and during the process, information about odour management plan will be given.

In **Germany**, the competent authority and operator are responsible for the establishment of odour nuisances' prevention plan.

Greece: The environmental authorities (centralized or decentralized) dictate the preparation of an OMP, including it in the environmental terms. The operators are responsible to implement it. Then they must submit it to the environmental authorities.

Italy: Regional authority.

Portugal: The permitting authority to impose the implementation of an odour plan, which is implemented by the operator.

Romania: The National Agency for Environmental Protection.

Slovakia: operator

Spain: operators have the responsibility to propose a plan; the administration validates it or demands improvements; It is then implemented by the operator and tracked by the administration.

5.3.3 Other actions

In **England** improvement conditions are required and enforced. In **Portugal**, recommendations to minimize odours are given whereas in **Slovenia** an administrative decision with measures are given. The authorities may conduct investigations in the **Netherlands**. In **Italy**, a report to the competent authority is send.

Germany:

1) Bring the plant operation into the legally permissible framework or the approval status by means of regulatory measures (orders).

2) By the supervisory authority "orientierende Geruchskontrollen" (orienting odour tests) are carried out. If odours are perceptible, the Landesamt für Natur- und Umweltschutz (State Office for Nature and Environmental Protection) is commissioned with an "official" odour test.

3) technical measures to reduce odour emissions.

In Spain, a plan on how to make compliance of the limits is asked. It can be sanctioned if the operator does not respond to the request to submit a plan, or if it does not take the necessary measures to reduce diffuse emissions, for example, as this is an obligation of its authorisation that may be directly related to the emission of odours.

5.4 WG4 site visits

IMPEL working group organised two site visits during ToR 22-24. The first visit was to Stora Enso Sunila pulp and paper mill located in Kotka, Finland, and the second visit was to Hellenic Energy refinery in Thessaloniki, Greece. Both locations were good case examples from an odour perspective. The pulp and paper sector is a large industry, especially in Northern Europe, and odour nuisances caused by this industry are common. The Sunila mill also had a good online system for monitoring odour situations. Hellenic Petroleum was selected as the second site because they have had a lot of odour problems in the past and the situation has now been brought under control through good cooperation between operators, authorities, and residents.

The detailed reports of the site visits are shown in Annex III and IV.

6. Complaints

Industrial activities cause odour nuisances and odour complaints keep environmental inspectors busy everywhere. Nowadays, many different online platforms have been developed to receive and process odour complaints.

6.1 Odour complaints

Table 4 summarises typical sources of odour complaints. The information was collected from the survey. As can be seen, intensive farming is the most common industry causing odour complaints. Landfills (LF), composting plants, waste treatment (WT) and wastewater treatment plants (WWTP) are also common sources of the odour complaints. The pulp and paper industry causes odour nuisance in Finland, Portugal, and Spain. The forest industry is one of Finland's most significant industries, so this explains the answer. The mills are often located very close to the population and in places in the city centre, so there are a lot of odour complaints about this industry. Therefore, one of the visits of IMPEL working group was to the pulp mill located in Kotka, Finland. The report of this visit is presented in the Annex III.

Table 4 The most typical sources of odour complaints.

Country	LF	Composting plants	WT	Food industry	Intensive farming	Pulp & Paper	Refineries	WWTP	Mining industry	Chemical industry	Iron & Steel
Austria		×			×						
England	×	×	×	×	×						
Finland			×		×	×		×	×		
Germany		×	×	×	×		×			×	×
Greece	×		×	×	×		×	×		×	×
Italy	×	×	×		×		×			×	
Netherlands				×				×			
Portugal	×		×	×	×	×		×			×
Romania				×	×			×			
Slovakia					×					×	
Slovenia	×	×			×						×
Spain	×	×	×	×	×	×	×	×		×	

∑	6	6	7	7	11	3	4	6	1	5	4

Just to demonstrate, for example the amount of odour complaints in **England** may vary a lot: landfill 12k, biowaste 3.8k, Waste Treatment 2.2k, Food 1.6k, Intensive Farming 1.1k. These are averages since 2014, Reports are highly variable from year to year.

In **Germany** (different answers):

1) > 100 per year
2) southern part of the town of Cologne. It could go up to more than 100 complaints a year.
3) This varies greatly and cannot be answered in a generalized way. Some complaints can only be concluded with difficulty regarding the respective perception of odours by humans. Here, neighbours feel regularly affected, although immission values are not always exceeded.
4) I receive no complaints. Complaints go elsewhere.
5) My authority is not the right contact point for complaints. These are handled by the public order offices, among others. That is why I cannot say anything about the frequency.
6) in 2010 the number of complaints (Odour) were 700 per year in Nordrhein-Westfalen (18 million inhabitants); current numbers are not available.

In **Greece** there is an average 70% of complaints for industrial sector, a 20% for Waste Landfills and a 10% for the other sectors. Complaints mostly originate from Urban Areas.

In **Italy**, animal farms 59%, Industrial plants 13%, Waste management 10%, Others 18%, Data: 2021 -Total complains about 350. Crude oil deposits: 630, farms: 540, waste treatment plants / biogas plants: 110.

In **Portugal** 25-30 complaints per year: 15% - 20% of the complaints. In 2020: 39 complaints, in 2021: 25 complaints, in 2022: 15 complaints, the districts with the highest number of complaints, in descending order, are Aveiro, Santarém, Lisbon, Porto, Braga and Setúbal.

In **Romania** approximately 50 complaints per year. In **Slovakia** the number of complaints depends yearly and character of the installation.

In **Spain**, the number of episodes (one episode can contain from 1-10 number of people complaining) of complains are approximately: Landfills (10/year), paper industry (20 year), refinery (40/year), water treatment plant (5/year), fish and meat manufacturer industry

(5/year). As for biogas plants, in Spain there are citizen platforms against these facilities, mainly due to the rejection of the unpleasant odours. There are also platforms against intensive farms and among the reasons are bad odours.

6.2 Methods for collecting complaints

Complaints can come through many channels. For example, in Finland, you can contact the environmental inspector or the factory directly by phone or email. In Finland, a centralized environmental service is also available, which you can call or send an e-mail about environmental notifications. A few countries also use different online systems to collect public notices. A few systems are introduced in the following paragraphs.

6.2.1 Azores (Portugal)

In the Azores, environmental complaints can be addressed to Government environmental organizations by several ways.

In the case of the Regional Inspectorate of the Azores, each complain received (by phone, email, letter ou electronic form) is registered in an online platform.

The Secretariat for the Environment and Climate Action manage an online platform and App where citizens can report any environmental occurrence.

In NAMINHAILHA (https://naminhailha.azores.gov.pt) citizens can register a complaint with the location, (browsing it in the map and click on the location of the occurrence they wish to report).

After the location is selected, citizens can select the subject of the complaint and fill a form to describe the nuisance, and they can also add photos.

All complains received are analyzed to provide an answer to the complainer. The citizens can check the status of the complaints directly on the website/App.

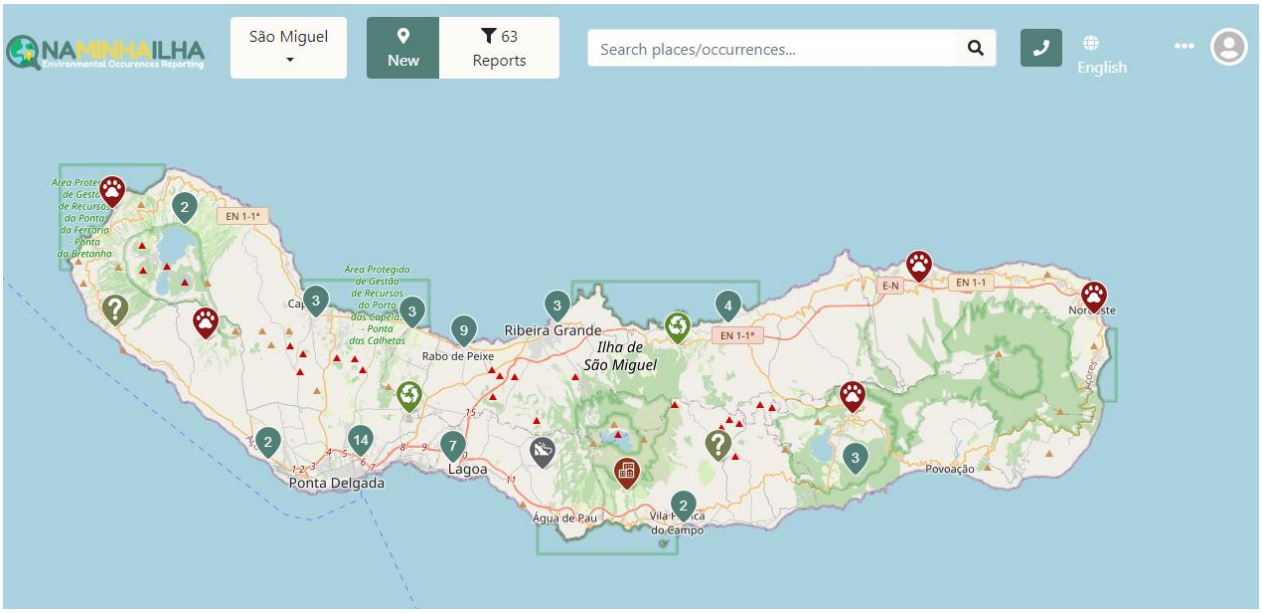

Figure 3 An illustrative example of NAMINHAILHA.

6.2.2 Finland

Environmental complaints can be submitted to governmental environment authority by several ways: by phone call, direct E-mail to an inspector, E-mail to registry etc. ELY Centre for Pirkanmaa is responsible for a centralized environmental service, where people can call or send E-mails about environmental notifications. Sometimes public announcements go directly to the municipal authority. The municipal authority directs the contact to the state authority if the report concerns the operation of a state-supervised installation. Complaints can also go directly to the facility in which case the operator handles the communication directly. All in all, regardless of the means of way of arrival, public inquires must be recorded in the systems. Received public inquiries are usually reviewed at a general level during annual inspections or annual reporting.

6.2.3 Latvia

Citizens can contact the State Environmental Service directly by different channels (telephone, e-mail, and mobile application). The department of several experts, called The Operational Coordination Centre is responsible for registering and coordinating complaints.

The Operational Coordination Centre processes all applications and operates 24/7 to handle complaints. Employees register applications in a unified system and transmit the information to inspectors. If a complaint is not within the competence of the State Environmental Service, it can be forwarded to other institutions such as local governments or the Health Inspectorate.

Among the channels for filing complaints, it is worth mentioning the mobile application Vides, which can be used to send a photo and coordinates of the alleged violation. Information about submitted applications and their status is publicly available at https://www.videssos.lv/

Figure 4 An illustrative example of Vides.

On the map you can select the period of the complaint and its status. By clicking on a specific point, you can see the inspector's comments on the complaint.

6.2.4 Spain

Citizens can address municipalities and environmental and health administrations, each complaint/complaint can be submitted in any form, oral, written, or electronic, nominative or anonymous. At present, there is no specific register of complaints to be used for the whole Country.

In Andalucia autonomous region, odour polluting activities have, in most cases, environmental authorizations issued by the Junta de Andalucía. In these cases, when a complaint is received, environmental agents are sent to the area and the air quality department is informed. Depending on the facility, this complaint is transferred to the City Council or processed by the Junta de Andalucía. If it is known which industry is polluting by odours, at the request of the air quality department, the company is obliged to report the odour episode and the techniques it is going to use to reduce it. This obligation is usually expressed in its environmental authorization. In the subregion of Granada, problems are usually with oil refineries, pig farms and a meat industry.

In the Basque Autonomous Region, complaints are mainly received by either by mail, or by electronic registration, or by phone in working hours. If the complaint is in non-working hours,

or if the odour is so strong that the person that complains feels needs to be acted urgently, they call 112, and we have an internal procedure where Emergency services contact the environmental inspector on duty. If the citizen has addressed the complaint to the local Council, that administration either acts itself or sends the complaint to the regional authorities (depending on the source of the odour, the competence to act can be municipal or regional). The complaints are registered in a program that does not have so far geolocation.

6.2.5 Greece

Currently, citizens can contact the environmental inspectorate or the local authorities directly by phone or email. Though, an Environmental Reports/Complaints Management System (ERMS) is under development, as part of an Integrated Information System for Combating Environmental Crime, which will manage environmental inspection cases, in accordance with N. 4014/2011 (Government Gazette 209/A 21.09.2011), as amended and in force, and integrating the entire workflow in a digital way. At the same time, it will interoperate with existing information systems of the Ministry of the Interior Affairs, that will feed data for environmental licensing and waste management. The Environmental Reports/Complaints Management System (ERMS) will be applied to report and make complaints regarding environmental issues and possible violations, committed by activities mostly subjected to environmental licensing and inspection, using geospatial data. Each report/complaint will be submitted in any form, oral, written, or electronic, by name or anonymously. Complaints received, after been submitted and registered in an electronic form, will be subjected to a First (A') Level Evaluation and then either they will be forward to the next evaluation stage (Second (B') Level Evaluation) or they will be archived. Depending on the evaluation result of a complaint, specific management actions will automatically be suggested. If at the end of the evaluation the complaint is characterized as "Important", a regular environmental inspection is planned immediately.

6.2.6 Germany

Citizens can contact the Environmental Agency directly by telephone or e-mail. During office hours, the call will be forwarded to the person responsible. Outside office hours, there is an on-call service that decides whether an on-site visit is necessary; in connection with odour complaints, usually only the report of the complaint is forwarded to the person responsible.

The complaint management system collects several data, contact details of the person making the complaint, specific characteristics of the odour, weather conditions (meteorology) and the suspected polluter. Anonymous complaints are also possible.

6.3 Actions in the case of complaints

All countries communicate with the operator and carry out inspections in the case of complaints. In addition, the other measures to be taken in the event of a complaint are listed below.

In **England**, normally, only apparently serious odour incidents are investigated.

In **Finland**, in the case of complaints, usually, the inspector contacts the facility and asks the operator for an explanation of the situation and the possible cause of the odour nuisance. Before that the inspector also checks the prevailing weather conditions, such as the direction and speed of the wind, so that the odour communication can be assigned to the right facility. The state environmental inspectors do not carry out the odour measurements, but they can require the operator to do additional measurements. The Environmental Monitoring Guidelines (Ministry of the Environment of Finland, 2016) state that the inspector shall react within 30 days and inform the person who made the complaint, what actions have been made.

In **Germany**, the person responsible at the environmental authority analyses the circumstances of the odour immission and provides the complainant with feedback within one month. This normally requires an on-site visit or at least written contact with the suspected polluter (company). Particular attention is paid to whether the odour emissions are due to special operating conditions. Furthermore, a comparison of the operating conditions of the plant with the license is carried out. See also Annex V of this report.

In **Greece,** measurements conducted by accredited labs, compliance measures and fines are actions in the case of non-compliance.

In **Italy**, measurement campaigns in living areas by a continuous monitoring of chemicals concentrations (H_2S, NH_3, mercaptans, BTEX...) are carried out.

In the **Netherlands**, an investigation carried out to determine whether the established standard has been exceeded.

In **Portugal**, articulation with competent authorities (sending communications requesting feedback, for example).

In **Slovakia**, a non-routine inspection focuses on the conditions of the integrated permit related to the review of the complaint. The compete authority request documents for the period, and according to the findings, they may invite the operator to submit applications due to some

necessary change, impose a fine, impose corrective measures, or determine the compliance of the operation with the issued permit.

In **Spain**, 1) request the company to install corrective measures, 2) a local operator (normally council police) goes in site to check if the origin is confirmed.

7. Conclusions

Environmental awareness and odour complaints have increased in recent years. In densely populated and industrialised countries, odour is one of the main causes of complaints. However, odour is a difficult subject; some people find some odours annoying, while others do not care at all.

To deal with these complaints, legislation and standards are needed that allow odour complaints to be assessed. It is also difficult to supervise if there are no odour regulations or limits. The requirements for monitoring odour emissions are quite variable and depend on the permit conditions of individual sites. Furthermore, odour can be challenging for environmental supervision, as for example TRS limits are usually expressed as daily and annual averages. This means that the odour period may be only one or two minutes and the effects are noticeable throughout the day, but the operator complies with the permit conditions because the limits are daily averages.

It is emphasized that even in the countries involved in the study, the legal provisions for odour assessment and handling of odour complaints vary greatly. Ultimately, countries must decide whether different regulations are necessary and useful in each country.

However, a general conclusion is that good communication with the operator and the surrounding area helps in conflicts. Online platforms are good for collecting odour complaints and communicating with the local community. Online platforms for air quality monitoring are also useful tools for environmental monitoring, both for the competent authority and the surrounding area.

The new IED 2.0 (2024/1785/EU) should shed some light on odour issues, as it should clarify that odour pollution should be considered when determining best available techniques and when granting or revising permits.

Annexes

Annex I. Questionnaire

European Union Network for the Implementation and Enforcement of Environmental Law

QUESTIONNAIRE ABOUT INDUSTRIAL ODOURS

☐ Mandatory questions are marked with a star (*)

This questionnaire is carried out by European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL, https://www.impel.eu/en) Expert Team 'Industry and Air'. Your answers will help identify odour problems in IMPEL countries and highlight best practices in permitting and controlling odours. It deals only with industrial odours, but not commercial or private sources.

BACKGROUND INFORMATION

1. Your name (first name, surname)

_____

2. Email

_____

3. Country *

_____

4. Organization

SECTION 1- REGULATION

5. Are odour issues regulated by law in your country?

- ◯ Yes
- ◯ No

6. What kind of regulation is used for the establisment of odour control?

- ☐ European Union
- ☐ National
- ☐ Regional
- ☐ Another. Please specify _____
- ☐ Please provide a link to the national regulation or documents if available. _____

7. Are there specified odour limits in place (mandatory requirements)?

- ◯ Yes
- ◯ No

8. What are the values? Please specify. Is it a target value or an emission limit value?

9. Are there any legal proceedings related to odours (i.e. regulation, monitoring, auditing)? Please share link if possible

SECTION 2- PERMITS AND BAT CONCLUSIONS

10. Do you have odour conditions specified in permits?

- ◯ Yes
- ◯ No

11. What kind of parameters are specified in permit conditions?

12. Are the BAT conclusions applied or not?

- ◯ Yes
- ◯ No
- ◯ I don't know

SECTION 3- INSPECTIONS

13. Does your organiztion conduct inspections on odours?

- ◯ Yes
- ◯ No

14. Do you conduct routine inspections on odours?

- ◯ Yes. What is the frequency of routine inspections? _____
- ◯ No

15. Do you conduct non routine inspections? What is a trigger for them?

- ☐ Citizens' complaints
- ☐ Employees' complaints
- ☐ Measurements data
- ☐ Another. Please specify _____

16. How do inspectors detect odours? What kind of instruments inspectors use? (Multiple choices are possible)

- ☐ Without measuring device. Indicative (" Inspectors' nose") or inspectors don't make measurements or sampling.
- ☐ Indicative devices
- ☐ Taking samples (on-site) and dynamic olfactometry in the lab
- ☐ Taking samples (on-site) and conducting chemical analysis in the lab
- ☐ Collaborating with an accredited laboratory
- ☐ Other methods (please specify) _____

17. What do you do in case of non-compliance? (Multiple choices are possible)

- ☐ Revision of the permit conditions
- ☐ Impose an odour management plan
- ☐ Penalty
- ☐ Other. Please specify

18. What are the criteria for the establisment of odour management plan (if any)?

19. Who is responsible for the establisment of odour nuisances' prevention plan?

SECTION 4- METHODOLOGY OF DETECTING ODOURS

20. Is there any odour monitoring in your country?

- ◯ Yes
- ◯ No

21. When is an odour monitoring carried out?

- ☐ On a regular basis
- ☐ When specified in the permit
- ☐ During routine or non-routine inspections
- ☐ Other. Please specify

22. Where the monitoring should be made?

- [ ] At source
- [ ] In the living area
- [ ] Elsewhere. Please specify _____

23. Who is responsible for conducting odour measurements?

- [ ] Inspectorates
- [ ] Public authorities
- [ ] Operators
- [ ] Accredited laboratories
- [ ] Another. Please specify _____

24. Do competent organizations need an accreditation to perform odour measurements?

- [ ] Yes
- [ ] No

25. Do you have methodologies for odour measurements? Please share link if possible.

_____

_____

_____

_____

_____

26. How is odour concentration controlled in terms of the mandatory requirement?

- [ ] Measurements

☐ Modelling

☐ Other methods. Please specify _____

27. Which kind of measurements according to European standards have been used?

☐ EN 13725 (… olfactometry …)

☐ EN 16841 Part 1 (… grid measurements …)

☐ EN 16841 Part 2 (… plume measurements …)

SECTION 5- COMPLAINTS MANAGEMENTS

28. Which are the main sectors from where you get the most odour complains?

_____

_____

_____

_____

_____

29. For these sectors, how many complaints (approximately) per sector do you receive (if available) per year? Designate the district in which these complaints occur.

_____

_____

_____

_____

_____

30. What are the actions in case of complaints?

☐

- [ ] Inspection
- [ ] Communication with operator
- [ ] Any other actions.Please specify _____

SECTION 6- OPEN FEEDBACK

31. You can tell us here if you want to bring up something else that we haven't been able to consider in the survey

_____

_____

_____

_____

_____

TERMS AND CONDITIONS

32. Do you accept IMPEL's Terms and Conditions? *

- ○ I have accepted the terms and conditions in the IMPEL privacy policy https://www.impel.eu/privacy-policy/
- ○ No, I do not accept. I will inform the IMPEL Secretariat by email to info@impel.eu of my objections.

Annex II. A short summary of UNE 77270

UNE 77270 Standard Building collaborative odour maps through citizen science. Short summary.

In Spain in October 2023, UNE, the Spanish standardisation body published its first Standard in Spain based on citizen science: It has been developed by a technical committee during 5 years of work and it sets a precedent at international level.

The text starts with definitions, among which are the following interesting ones (some of the definitions are based on the German standard VDI 3882-2:1994):

- **odour episode**: grouping of two or more records with the same odour character in a maximum period of four hours.
- **intensity**: strength with which an odour is perceived. It is a subjective descriptor that is reported within a range of 0 (absence of odour) to 6 (extremely strong).
- **hedonic tone**: level of pleasantness of a smell. It is evaluated according to the following categorical scale: extremely unpleasant (-4), neutral (0) and extremely pleasant (+4)

According to the proposed methodology, the first thing is to create the action group (AG). There are four possible parties involved: potentially affected people, activities that may be a source of odour, public entities, and experts. For this work, at least two of these four parts must be involved, the first of them always being essential, although ideally all four should be present. The AG has to define Direction, Coordination, roles of the participants, design an internal and external communication plan, find ways of promoting participation, and draft a collaboration agreement that includes all of the above. The agreement will also include the obligation to carry out an action plan with a proposal for future actions to mitigate the impact of odour.

Once the action group is created, the study area has to be delimited. In the case of emission sources with heights greater than 20 meters (h≥20m), a circle will be marked where the centres coincide with the location of the source and whose radius is equal to or greater than 30 times the greatest height of the chimney emission. If the source is at a lower elevation (h<20m), it will be at least 600 meters. It may be necessary to expand the study area based on existing records or prevailing winds.
Then, the document offers guidance on how to create the participating citizenship panel, the number of participants being based on the demographic characteristics of the study area. Thus, for example, for areas with less than 1000 inhabitants, between 3 and 15 people will be chosen; for areas ≥30,000 inhabitants or density ≥100 inhabitants per square kilometer, between 61 and 90 participants will be selected. After, training and information sessions are held for participants.

Forms and reports have to be designed, and the document gives advice and registration models with the minimum data that should be registered.

The study should be carried out for at least three months, although it would be ideal to continue up to twelve months to take into account annual meteorological variability.

The standard has a section with tools for checking the plausibility of the odour episodes (meteorology, transport models (backtracks), dispersion models, chemical sensors...), and also offers a way to calculate the degree of annoyance of each odour episode, as a value resulting from the correlation between the intensity of the odour and the hedonic tone of the odour, for each person who has reported the annoyance. In that way, it provides objective data for odour episodes to be compared over time, during the project and even in future projects in the same location.

Annex III. Site visit, Stora Enso Sunila

Case study: Stora Enso Sunila mill, Finland

The pulp and paper industry is the third largest industry sector in Finland and the mills are often located in the city centres close to lakes and sea. The sulphate pulping process is a process which converts wood into wood pulp (almost pure cellulose fibres), the main component of paper and cardboard. The process uses large volumes of chemicals for example sulphuric acid, and delignification releases considerable amounts of emissions to waters and air. In the case of pulp and paper production, TRS is the most interesting odour component, and the emission limits are presented in BATC of PP BREF. The emission limits are usually expressed as daily average for example 1-10 mg/Nm^3 at 6 % O_2. Therefore, the first site visit of IMPEL WG was in the pulp mill.

Stora Enso Sunila pulp mill (Kotka, Finland) was in operation in 1938-2023. The location of the mill can be seen in Figure 1. The main products were bleached softwood pulp, lignin, turpentine, and tall oil. The annual capacities were following: 375 000 tons of pulp and 50 000 tons of lignin.

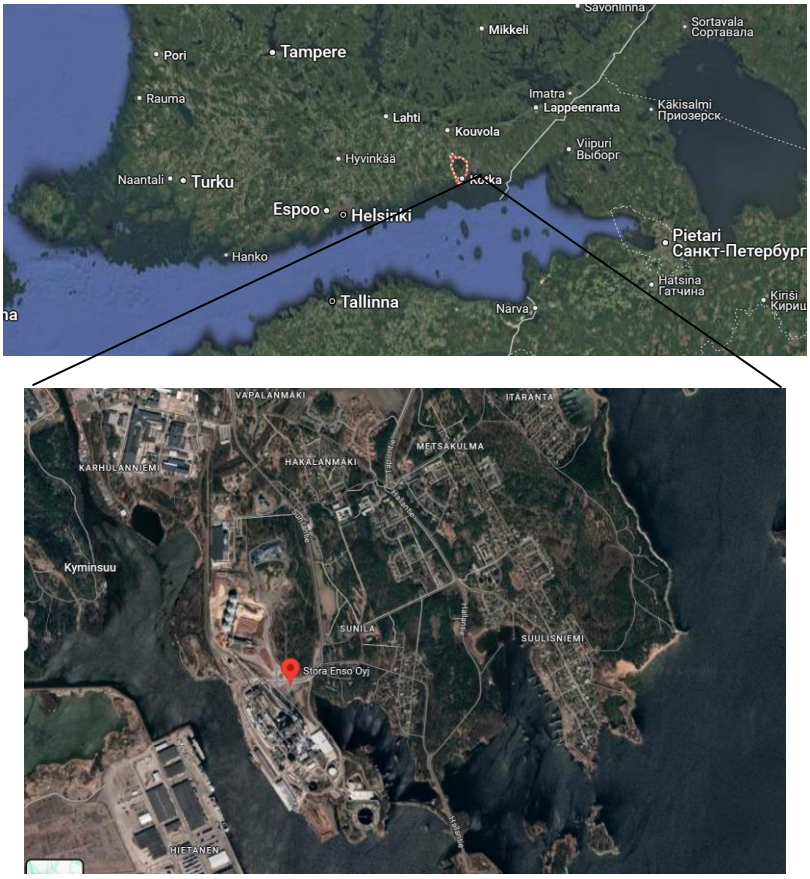

Figure 1 The city of Kotka is in the Southern Finland next to the Baltic Sea.

The agenda for the site visit (16.5.2023) was following:

- A brief introduction to IMPEL network
- A brief overview of Sunila mill's operations
- Odours and odour sources (what, where and why)
- How to deal with odours
- How the odours are monitored
- Public complaints
- Site visit

TRS compounds were continuously monitored from the recovery boiler, the odorous gas boiler and the lime kiln. The operator reported emissions to water and air monthly and the environmental supervisor checked that the operation met the permit conditions. In addition, the permit regulations require the Sunila plant to participate in the air quality monitoring of the city of Kotka, which is based on measurements and modelling at virtual stations. TRS data is published every five minutes on an online platform available athttps://online.purenviro.com/public.php?k=e981b23e34ed5ace3c4b554a5e24d45f&n=2016&r=12.

Monthly reports and the online platform are very useful tools for environmental monitoring. In the case of odour complaints, the supervisor can check the wind direction and speed and TRS concentration on the online platform before responding to the complaint. Sunila mill responds quickly to complaints, which maintains good communication with the neighbourhood. The number of odour complaints has decreased in the recent years and for example in the year 2021 there were 10 complaints related to odours.

TRS is a tricky component because limits are usually expressed as daily and annual averages. This means that the odour period may only be one or two minutes and the effects are noticeable throughout the day, but the operator will meet the permit conditions because the limits are daily averages.

Annex IV. Site visit, Hellenic Petroleum

Case study: Dealing with odour nuisances in Hellenic Petroleum Refinery in Western Thessaloniki, Greece

The Region of Central Macedonia (RCM) is the second most populous in Greece after Attica. RCM is also a very important region in terms of economic development producing various agricultural products, hosting industrial activities, services and tourism. One of the refinery plants of Hellenic Petroleum is in the region and very close to the metropolitan area of Thessaloniki, the second biggest city in Greece (1.000.000 people).

The refinery was established in 1966 and the population at the close area at that time was ca. 5.000. Now days the population is ca. 100.000 (census 2011) in an area of 13 km2 and the current distance from the urban area is less than 500m. The social characteristics of the area comprise of working class consisting of people who are employed for wages, especially in manual or industrial work, with an average GDP per capita of 14.000€.

Starting 2016, a large number (>30) of citizens complains about “difficulties in breathing, smell of oil and LPG, burning eyes and throat” coming from the western area of the city of Thessaloniki and more specific the municipality of Kordelio, was brought under consideration of the authorities.

In 2017, complains became more and more intense, a citizens' group called "Breathing is a Right" was formed and the Citizen's Advocate was involved. Under that pressure, the Regional authority of Central Macedonia assigned to the Environmental Pollution Control Laboratory of the Chemistry Department of the University of Thessaloniki the conduct of a 12-month –till April 2019- Research Program under the title of "Determination of mercaptans in the greater area of Thessaloniki ", the purpose of which was to measure and evaluate the levels of odorous volatile organic compounds in Western Thessaloniki , where residents are often bothered by odour episodes. A total of 312 routine and non-routine samplings were carried out. On of the main conclusions of the Research Progran was that in HELLENIC PETROLEUM refinery all the odorous compounds which, according to the international literature, are typical emissions of refineries, and the highest concentrations of mercaptans from all the industrial activities located W-NW of Kordelio were detected and their subject is related to the possible emission of sulphurous volatile organic compounds. On sampling dates, high concentrations of mercaptans were observed in some refinery units, mainly in the sludge dewatering unit and the wastewater treatment unit, which were much higher (up to 20 times) than the average concentration found at the same time in Kordelio. Since mercaptans and other odorous compounds are volatile and easily transported through the air, these units appear to be potential sources of odour for the urban area of Kordelio when weather conditions are favourable for transport.

Table 1 Aggregated measurements of odorous compounds in industrial activities near Kordelio and in the 3 sampling points within the urban are of Kordelio, (μg/m^3).

A/A		Date	Σ_8Mercaptans	Σ_7Sulphides	Σ_5Thiophenes	Σ_{22} aromatics	Σ_{13}Aldehydes	Σ_7Phenols
SAMPLING POINTS IN URBAN KORDELIO								
1.	EDPAR STATION (AVER. VALUE)	27/04/2018 till 23/04/2019	1,348	16.060	0.154	7.735	18.86	
2.	OLD TOWNHALL (AVER. VALUE)		1.548	17.210	0.092	11.10	20.80	
3.	3RD GYMNASIUM (AVER. VALUE)		1.483	12.290	0.088	7.662	17.88	
INDUSTRIAL ACTIVITIES								
1.	**HELLENIC PETROLEUM**							
	SLUDGE TREATMENT UNIT	31/10/18	10.780	0.190	0.061	9.953	7.350	
		06/12/18	**38.040**	3.539	0.015	**258.400**	218.90	0.452
	MERCAPTAN STORAGE TANK	31/10/18	10.160	2.787	0.011	64.530	18.370	
		06/12/18	0.740	4.944	0.048	17.810	49.420	0.796
	WASTE WATER TREATMENT UNIT	31/10/18	2.640	10.49	0.038	**117.800**	34.300	
		06/12/18	**33.270**	5.739	0.666	**184.000**	52.400	0.011
	PRODUCT LOADING-UNLOADING STATION	31/10/18	0.490	4.679	0.044	1.640	14.020	
		06/12/18	1.990	1.299	ND	41.500	28.770	0.094
	CENTRALPUMP STATION	06/12/18	**27.410**	2. 008	0.434	9.560	23.390	0.239
	CRUDE OIL PUMP (BOOSTER)	21/06/20	0.827	0.410	0.248	9.501	6.441	0.314
	TORCH CONDENSATES SEPARATOR	21/06/20	0.645	0.090	0.018	3.960	2.085	0.167
	CRUD OIL PUMP STATION	21/06/20	**28.548**	1.268	0.937	**134.800**	14.060	0.023
	DEODORISATION FILTER WWTP	21/06/20	**16.158**	1.678	2.765	68.050	6.778	0.002
	TK-803 (SE BORDER)	21/06/20	0.217	1.286	0.004	0.896	1.810	0.242
2.	**ELPEDISON**	28/11/18						
	POWER PLANT		0.169	13.187	ND	0.504	19.168	0.214

	GAS STATION		0.183	1.128	0.024	1.579	4.621	0.035
	STACK		0.726	4.126	ND	1.330	9.620	0.094
3.	**PETROGAS**							
	STORAGE TANKS	21/01/19	0.544	1.542	0.003	7.901	10.310	
	LOADING STATION	03/10/19	0.242	0.201	0.009	1.319	19.,640	0.022
	BOTTLING STATION	03/10/19	0.540	0.237	ND	20.820	20.190	0.080
4.	**DESFA (NATURAL GAS PLANT)**	29/01/19						
	THT STORAGE TANK		0.411	0.027	29.140	1.421	0.292	0.005
	THT ADDITION INSTALLATION		0.473	0.036	0.271	1.929	0.700	0.002
5.	**PRIMAGAS**	06/06/19						
	PUMP STATION		0.171	0.544	ND	1.190	7.208	0.183
	BOTTLING STATION		0.177	0.528	ND	1.238	6.308	0.112

Odours in a petroleum refinery are mainly created by:

- Sulphur compounds, including hydrogen sulphide (H_2S), mercaptans, sulphides, and disulphides
- Nitrogen compounds, including ammonia (NH_3) and amines
- Hydrocarbons, including VOCs, ketones, aldehydes, organic acids, phenols, and aromatics

The main sources of odour at refineries include:

- Storage
- Bitumen production
- Water desalters
- Sewers, oil/water separators, uncovered DAF units and biotreatment units
- Flaring of gas
- Loading operations

In September 2017 a Diffused VOC Emissions inspection of 41 of the floating tanks of the refinery was conducted using OGI, optical gas imaging, by a Dutch company, following the Dutch regulation NTA 8399 *(Guidelines for detection of diffuse VOC emissions with OpticalGas Imaging, Oct 2013).* A first discussion about monitoring odours in real time was done.

In 2018 the first university study's results were announced and corrective actions for the refinery were suggested (relocation of the sludge treatment unit, improvement of existing odour abatement units, improvement of fence line monitoring).

In 2019 Hellenic Petroleum assigned a French company to perform odour measurements in Wastewater Treatment Plant (WWTP) and suggest technology for odour abatement, which proved to be quite difficult due to the lack of expertise and mature odour abatement technology for refineries in the market. Moreover, Greece should overcome difficulties such as no guidelines or regulations for odour issues, or limited infrastructure for waste treatment.

In 2020 a network of electronic noses was installed at Thessaloniki Industrial Complex which proved to be an important tool for day to day, real time odour monitoring and management. Furthermore, an extended survey for mapping the odours sources was assigned, based on olfactometry method. All sources were identified and quantified. The survey is repeated every year, and the improvements are monitored.

In 2022 a new refinery permit was issued. An odour management plan was developed and implemented. Also, several new odour abatement projects were initiated within the refinery.

More recently, the odour management program was announced by local authorities in cooperation with the University, with the financial support of the Hellenic Petroleum refinery. According to it, 10 noses will be installed in the Kordelio residential area, samples of ambient air will be collected and analysed for odorous compounds by the University lab and Olfactometry will be applied for analysing ambient air samples.

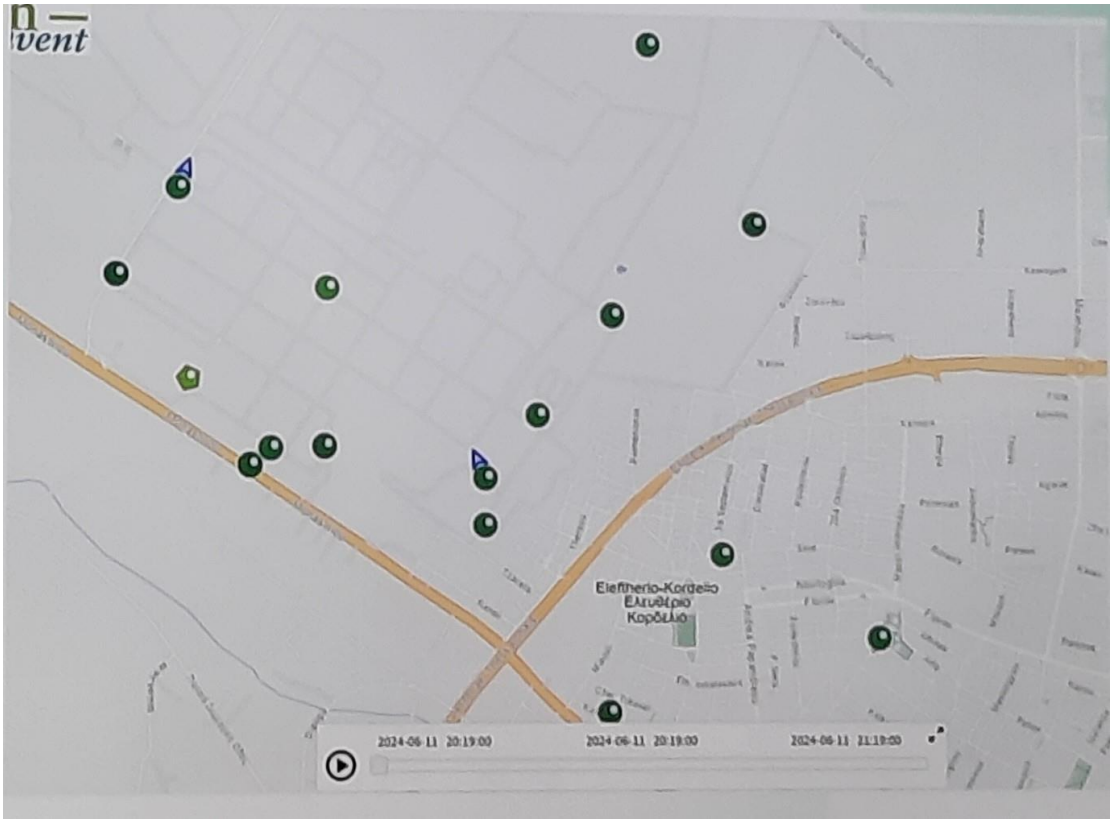

Figure 1 A network of e-noses was established in 2020.

Annex V. Handling of odour complaints in Germany

Handling of odour complaints – A case in Germany (NRW)

In one acute case, the authorities in several cities in Germany (NRW) received over a thousand odour complaints within a short period of time (about 3 month). Some of the cases involved disgusting odours. Due to the large number of potentially odour-causing installations, identifying the polluter was problematic. Several activities were undertaken in this context, including:

1. listing of potentially odour-causing installations and on-site inspections in cooperation with the responsible authorities.

2. systematic recording of citizen complaints via an online tool and evaluation with the help of wind direction during odour impression.

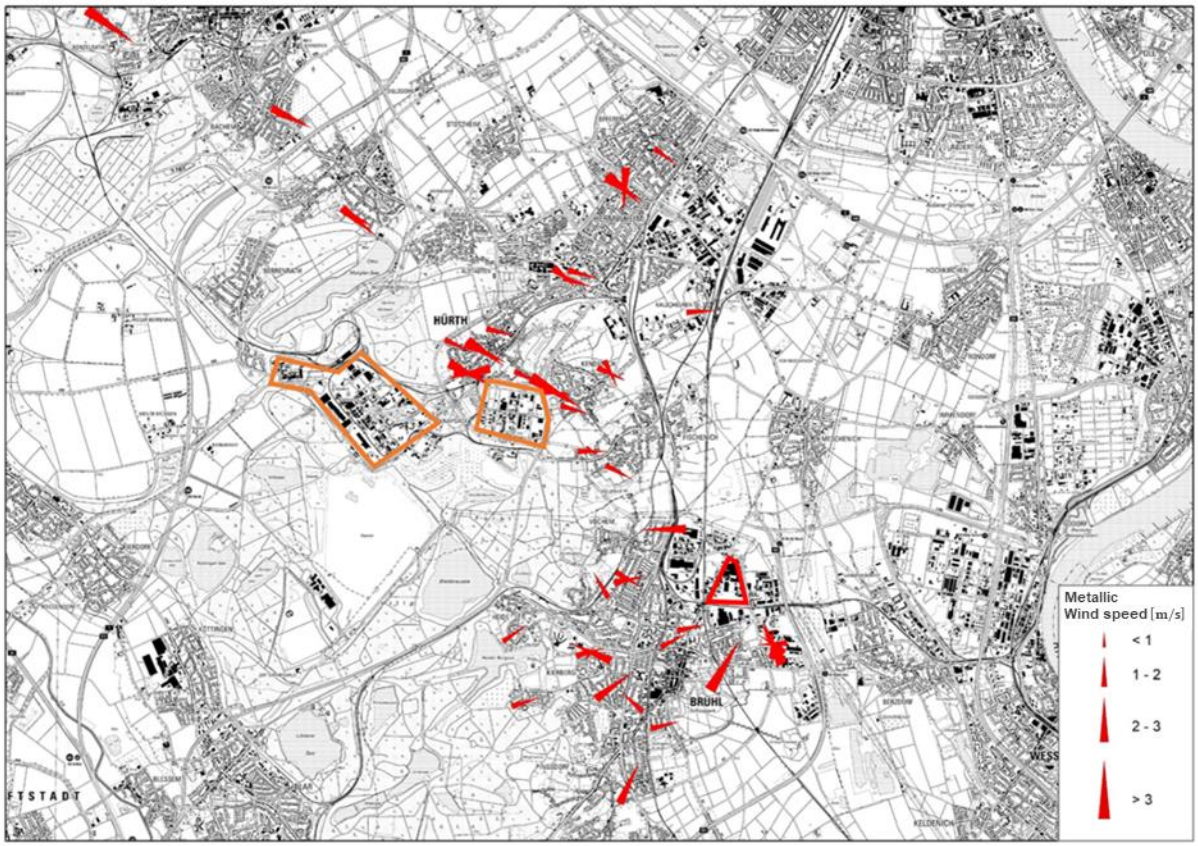

Figure 1 Exemplary representation of the odour complaints that indicated the odour quality 'metallic / iron (welding work / brake pads)'; chemical park framed in orange, metal processing company framed in red (recording period: 20.05. - 07.09.2022).

3. use of an odour reporting tool (Ortelium app) to back calculate the possible origin of the reported odour impressions.

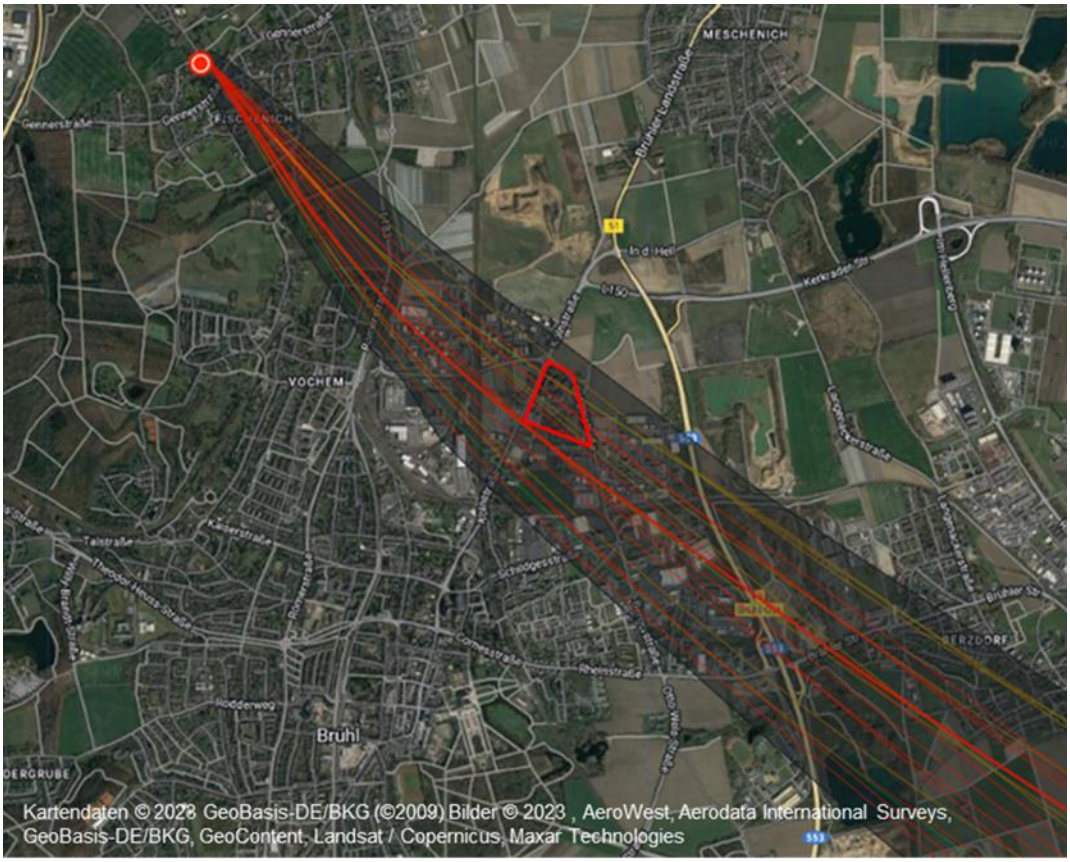

Figure 2 Example of an odour report in Ortelium from 02.09.2022, 9:32 a.m., odour quality 'metallic', framed metal processing company

4. a large number of on-site investigations.

As a result, several sources, including an iron foundry and a recycling centre, responsible for the odour complaints were identified. Furthermore, the investigated odour immission situation was assessed in accordance with Annex 7 Technical Instructions on Air Quality Control 2021 (TA Luft), the assessment system for odour immissions in Germany. Despite the results of a grid measurement in accordance with DIN EN 16841-1:2016, which showed that everything was ok, the odour pollution was assessed as a significant nuisance within the meaning of the Federal Immission Control Act *FPCA* (German *BImSchG*) in accordance with No. 5 Annex 7 TA Luft 2021. Based on this result, a large number of measures were implemented to reduce the odour pollution of the facilities and lead to a visible reduction in complaints.

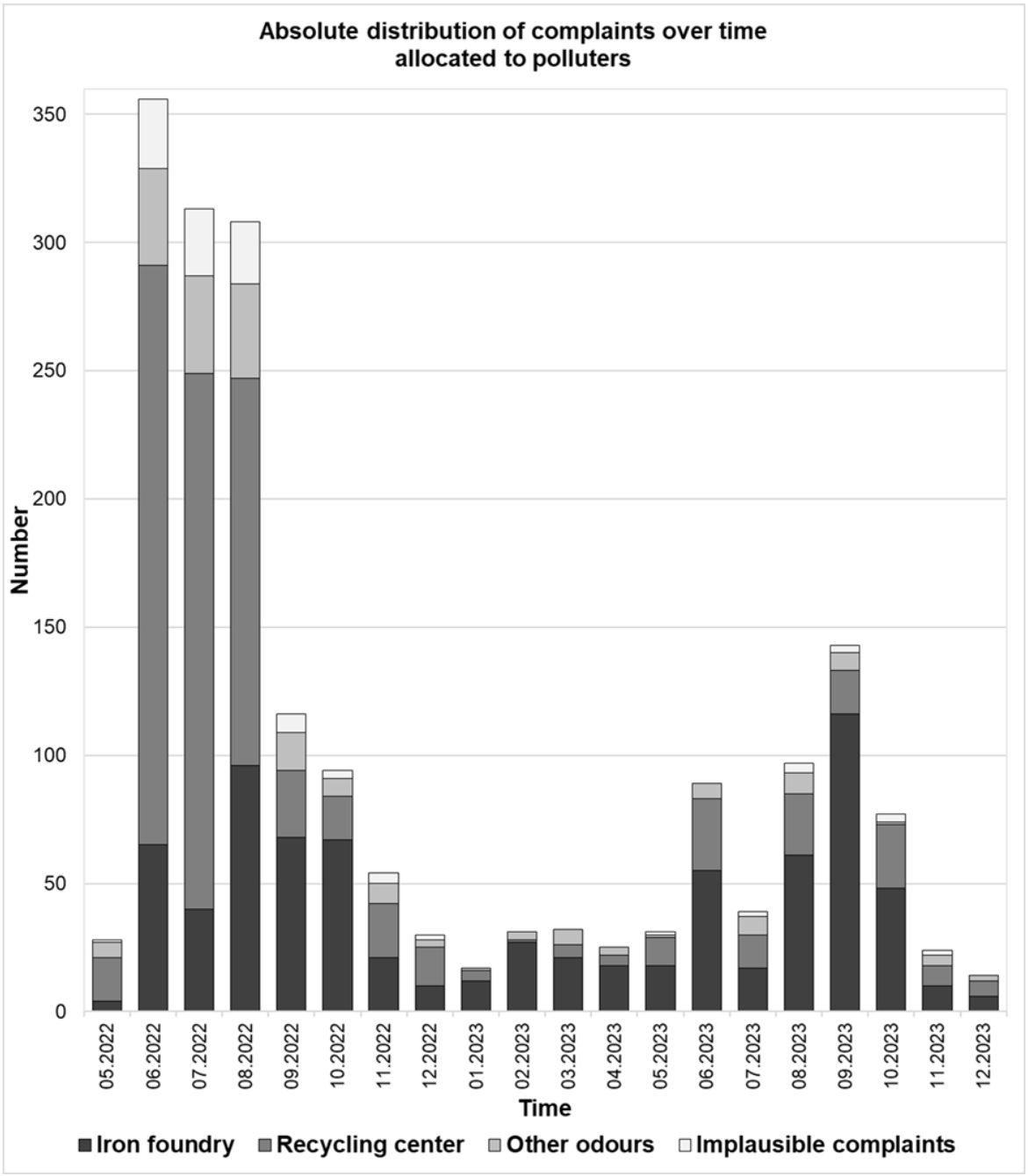

Figure 3 Absolute distribution of complaints over time; assigned to possible polluters (iron foundry and recycling centre), as well as other odours and implausible complaints (period 20/05/2022 - 31/12/2023)