FEDENE
Déchets-énergie

SVDU

fnade

Nitrous oxide canisters in WtE plants

October 2024

Table of Contents

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Executive summary

Over the last five years, the French Union for the Treatment and Recovery of Urban and Assimilated Waste (Syndicat National du Traitement et de la Valorisation des Déchets Urbains et Assimilés, SVDU) has noted an upsurge in incidents in French waste-to-energy plants, due to the explosion of nitrous oxide (N_2O) canisters, the misuse of which for recreational purposes has increased among young people. This phenomenon poses a major health challenge: the widespread use of N_2O inhalation for its euphoric effects, coupled with its easy affordability, exposes young people to immediate risks (loss of coordination, hypoxia) and long-term consequences such as neurological disorders. On a technical level, these canisters, initially used in cooking, medicine or the car industry, cause dangerous explosions when exposed to the heat of incineration furnaces, causing the residual gas to expand. These incidents cause material damage, costly shutdowns and compromise the safety of operators.

Explosions affect around half of France's facilities, with significant impacts:

- Material damage: Explosions damage furnaces, boilers and other equipment, causing shutdowns of between 20 and 40 hours and repair costs of up to €200,000 per incident.
- Economic impact: Losses to the industry are estimated at between €15 and €20 million a year.
- Operator safety: Explosions can cause serious injuries to personnel, including burns, contusions and internal injuries due to blast effects.

Measures have been put in place:

- Internal: Reinforcement of safety equipment, secure access to furnaces and bottom ash extractors, awareness-raising among teams and local authorities.
- External: Following a warning from operators, a decree was published in July 2023 limiting the sale of nitrous oxide canisters to private individuals to 8.6 g per cartridge. However, this measure has proven insufficient, with larger-capacity canisters continuing to arrive at waste incinerators.

The situation in other European countries is just as worrying as in France, with similar impacts, both on facilities and regarding young people’s consumption issue.

Three possible solutions can be considered:

- European regulations: Impose a safety valve on N_2O canisters to reduce the risk of explosion.
- Targeted collection: Introduce specific collection of canisters via waste services to limit their presence in incinerators.
- Canister deposit: Introduce a deposit return system to encourage the recovery and recycling of used canisters.

Explosions of nitrous oxide canisters in incinerators are a threat to the safety of installations, operators and the continuity of public service. Coordinated action at national and European level is essential to put in place effective prevention measures, ensure the safety of waste-to-energy operations and protect public health.

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

1. Introduction

Background and issues

Over the last five years, the French Union for the Treatment and Recovery of Urban and Assimilated Waste (SVDU) has observed a worrying increase in incidents in French waste-to-energy plants, caused by the explosion of nitrous oxide canisters. These explosions cause significant damage to infrastructure, leading to prolonged shutdowns and necessitating costly repairs. In addition, these incidents endanger the physical integrity of operating personnel, with potential harmful consequences.

It should be noted that the increase in the presence of these canisters is linked to the rise in the recreational use of this gas, mainly by non-professional users. Overall, it has general damaging health consequences, in particular among young people who happen, to be the primary recreational users, and has significant impacts on the waste management industry.

Incidents require treatment facilities to be shut down, resulting in an inability to treat waste thus breaching the continuity of public service and causing a hygienic issue. From an economic point of view, interruptions and repairs to incinerators result in significant costs for diverting untreated waste, but it also leads to a loss of recovered energy and a reduction in operational efficiency. In terms of safety, the increased frequency of incidents poses a serious threat to the health and safety of operators and facilities. It is therefore imperative to find effective solutions to prevent these explosions and ensure that waste-to-energy plants operate safely and optimally.

Objective

The purpose of this report is to provide the French Directorate-General for Risk Prevention (DGPR) with an in-depth analysis of the problem of nitrous oxide canisters explosions in household and similar waste incinerators. Based on feedback from French operators and information gathered from European operators, this report:

1. Describes the current situation: detailed description of the incidents that have occurred, their causes and their consequences in France.
2. Analysis and presentation of the situation at the European level: Description of incidents that have occurred in other European countries.
3. Puts forward concrete solutions: Technical and regulatory recommendations to reduce the risk of explosions and improve the safety of installations.

The report is also intended to provide the DGPR with the information it needs to submit an exceptional request to the European Commission. The aim is to obtain support for the introduction of new standards and practices aimed at resolving this problem at the European scale, thereby guaranteeing the safety and sustainability of waste-to-energy operations in France and Europe.

2. Background and current situation in France

Presentation of the SVDU and its missions

The French Union for the Treatment and Recovery of Urban and Assimilated Waste **(SVDU)** is a professional organization which brings together the main French stakeholders involved in the management, treatment, and recovery of municipal and assimilated waste. Through its members,

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

the SVDU represents **108 energy recovery facilities from waste out of the 116 operating in France**. SVDU's mission consists in representing the interests of its members before **national and European authorities**, promoting best practices in waste management, and contributing to the development of legislation and regulations. In collaboration with its partners, the SVDU strives to meet the **environmental, economic, and social challenges** associated with energy recovery from waste.

Explosions of nitrous oxide canisters in incinerators

For approximately five years, **French incinerators have experienced an increase in incidents caused by the explosion of nitrous oxide canisters**. These incidents occur when nitrous oxide canisters are inadvertently thrown into household waste, still contain residual gas, and are processed in incinerators.

When the canisters are exposed to the intense heat of the incineration process, the expansion of the residual gas inside the canisters leads to an increase in pressure, causing them to explode. These violent explosions result in **significant damage to facilities** and pose a serious danger to operators.

Nitrous oxide canisters – general information

Nitrous oxide (N_2O) is a widely used gas and marketed in the form of cartridges in cooking, medicine and the automotive industry. Also known as 'laughing gas', it is frequently diverted from its original use, and its consumption has been rising sharply since 2019. Nitrous oxide is stored in gaseous or liquefied form under pressure.

Figure 2 : Nitrous oxide canisters

Figure 1 : N20 canister before and after explosion

Process in the combustion chamber

As a general rule, **compressed gases and liquefied gases under pressure are stored in containers specifically designed to withstand pressure**, in compliance with applicable standards for pressurized equipment. However, in the event of fire exposure, an increase in temperature leads to a rise in the container's internal pressure while simultaneously weakening its mechanical properties. This often results in the rupture of the container, causing the rapid expansion of the pressurized gas and the sudden vaporization of the liquid in the case of liquefied

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

gases. This reaction generates a **shock wave in the environment** and the projection of fragments from the container.

When nitrous oxide canisters explode in a **household waste incinerator**, fragments may be ejected inside the incinerator, causing damage to the walls. External repercussions are also possible if openings are present or if more fragile parts of the structure give way under the force of the explosion.

Furthermore, the **oxidizing nature of N_2O** can introduce additional risks, such as the occurrence of a flame explosion inside the furnace, often referred to as a "fireball." This phenomenon is closely linked to the explosion of nitrous oxide canisters.

The explosions of nitrous oxide canisters in incinerators threaten not only the facilities but also the safety of individuals. **External effects**, such as fireballs and the projection of metal plates, can have dramatic consequences for operators and operational staff. These incidents highlight the **urgent need to strengthen safety and preventive measures** to protect workers and ensure a safe working environment.

Frequency of incidents

Data collected by the SVDU reveals a **significant increase in nitrous oxide canister explosions** over the past five years. These incidents vary in severity, ranging from minor explosions causing minimal damage to more severe explosions resulting in prolonged production stoppages and costly repairs.

The frequency of explosions differs from one facility to another and across regions: some facilities report explosions **a few times per week**, while others experience **several per day** on a regular basis. In 2021, data indicated that nearly a third of French facilities were affected. By 2023, this figure rose to nearly half of all waste-to-energy facilities, accounting for several million canisters recovered annually and between **12,000 and 15,000 cumulative hours of processing line downtime**. Some WtE facilities, particularly hard-hit, recorded **over a month of cumulative downtime** across all processing lines.

The frequency of these incidents is further highlighted in the media. Articles on the subject have been published in **French media outlets since 2020**[1].

Upward trend of explosion power

With neither a **deposit return system nor a specific treatment pathway**, nitrous oxide canisters end up in the household waste stream, destined for WtE or landfills. However, these products are not authorized for disposal in this manner.

Before 2019, the gas was stored in **small containers (< 10 g)** for domestic use and in larger canisters for professional uses. After this date, producers began using **larger containers**, which became accessible to non-professional users. This change led to a **major increase in both the frequency and the intensity of explosions** in incineration furnaces.

[1] Appendix

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Impact on waste-to-energy plants and operating personnel

Explosions of nitrous oxide canisters have many consequences for household and similar waste incinerators.

- **Material damage and shutdowns**

The explosions of nitrous oxide canisters can cause significant damage to equipment, requiring costly repairs and prolonged production stoppages. The most affected areas are typically the furnaces, boilers, and slag extractors, with severe consequences such as broken or lost grate bars, lateral cracks in furnaces, refractory damage, and boiler tube deterioration. These incidents frequently disrupt operations, compromising sanitation services, reducing the efficiency of waste management operations, and increasing costs.

On average, production stoppages caused by these incidents last between **20 and 40 hours**, with costs ranging from **€20,000 to €200,000 per stoppage**, depending on the extent of material damage and the capacity of the site affected. These costs include not only repairs (labor and parts) but also losses related to the interruption of waste treatment, reduced revenues from electricity and heat production, and increased fuel consumption (oil/gas) during shutdown and restart procedures.

The **economic impact on the entire sector is estimated at between €15 and €20 million annually.** This financial loss weighs heavily on operating companies, particularly since no local authorities currently cover these costs. This situation raises significant concerns about the financial health of the affected companies, which, in principle, should not receive household waste containing nitrous oxide canisters. Nevertheless, they bear the full brunt of the consequences of these unwanted canisters in their treatment processes.

- **Environmental impact**

Plant operators also report peaks in CO emissions during explosions, creating a risk to exceed the emission limit values authorised by their permit.

- **Workers safety**

The **explosions of nitrous oxide canisters** pose an immediate and severe danger to operator safety, with potential risks of serious or even fatal injuries. An explosion can trigger multiple mechanisms that cause various harmful effects:

- **Blast Effect:** This can result in significant injuries to operators, such as:
    - Contusions or ruptured eardrums,
    - Laryngeal injuries,
    - Pulmonary contusions,
    - Injuries to hollow abdominal organs.

The blast effect can also cause the **projection of materials**, endangering operators. High-velocity fragments, such as pieces of metal sheets, bolts, fragments of nitrous oxide canisters, or incinerated materials, can strike operators, particularly on the face, uncovered areas, or other parts of the body.

- **Burns:** Burns can occur in two main ways:

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

1. Through contact with a **flame front** during the explosion, particularly via a vent.

2. Through contact with hot materials being incinerated, scalding water from a ruptured pipe in the network, or cooling water from the slag extractor. Burns can be external or internal (affecting the respiratory tract through smoke inhalation). External burns primarily affect the **face**, as flames escape through inspection hatches at head height.

For example, in **2023**, a deflagration in a furnace at one facility caused the projection of hot ashes through the hopper hatch beneath the boiler, injuring an operator. This incident resulted in burns, pain, and contusions, illustrating the risks faced by operators.

The **unpredictable and uncontrollable nature of explosions** leads to growing anxiety among operators, particularly during operations near the facilities (inspections, checks, maintenance activities). This concern is exacerbated by the increasing frequency of explosions, making operator safety a critical issue.

Attached is a list of photos illustrating other examples of damage caused by nitrous oxide canister explosions:

Figure 3 : Broken grate bars

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Figure 4 : Access door broken in half due to the explosion

Figure 6 : Exploded nitrous oxide canister found near the fine particle extraction screw

Figure 5 : Lateral crack in the furnace

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Figure 8 : Different types of nitrous oxide canisters found in the bottom ash

Figure 7 : Broken sight glass after an explosion

Figure 10 : Hatch blown off by the blast of the explosion

Figure 9 :Multiple month of N2O canisters yield from bottom ash

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Figure 11 : Damaged grates

Figure 13 : The projection of a fragment of a nitrous oxide canister into the furnace

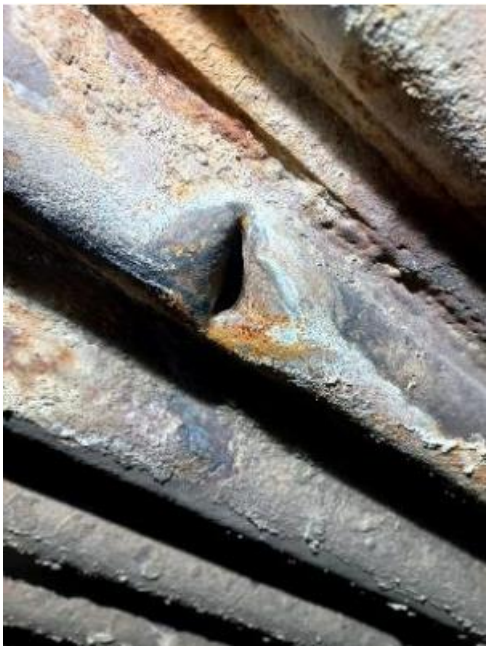

Figure 12 : Boiler tube breakage.

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Main initiatives undertaken to date by the industry

Internal initiatives

The main actions taken to date focus on **staff safety and prevention/response measures**:

- Strengthening of safety equipment
- Reinforcement of equipment (slag extractors)
- Enhanced inspections of municipal solid waste (MSW) deliveries and regular removal of pressurized gas canisters (N_2O) when identified before unloading into the pit (when possible)
- Awareness campaigns and communication about risks, both internally and externally
- Strengthening of safety measures
- Occasional inspections of waste deliveries through ground emptying (occasionally), even though canisters remain difficult to identify within the waste
- Active visual monitoring by crane operators and platform agents (though it is challenging to spot canisters and impossible to retrieve them with the grabber)
- Implementation of indicators to monitor overpressure/explosions
- Study of new grate bar systems
- Securing access to furnaces and slag extractors
- Awareness efforts targeted at contributors, particularly local authorities

External initiatives

In recent years, the French **Directorate General for Risk Prevention (DGPR)** has been alerted by numerous operators who have observed a significant increase in incidents at their facilities, linked to the growing presence of large-capacity nitrous oxide canisters. In response to these concerns and following in-depth discussions between industry representatives and the DGPR, a decree was issued on **July 19, 2023**. This decree sets the maximum allowable quantity of nitrous oxide products that can be sold to individuals, in accordance with Article L. 3611-1 of the **Public Health Code**.

The decree aims to regulate not only the total quantity of nitrous oxide that can be sold to individuals but also the maximum weight of individual canisters.

The main measures adopted are as follows:

- Limiting cartridges to an individual weight of **8.6 grams or less**.
- Imposing a limit of **ten canisters per package (box)**.

However, despite the decree coming into force on **January 1, 2024**, the consequences for household and similar waste incinerators, as well as for personnel, remain concerning. No notable decrease in explosions has been observed, and a new worrying trend is emerging: the **introduction of larger nitrous oxide canisters**. This development suggests that consumers are turning to higher-capacity canisters, leading to **more intense explosions** with even graver consequences for operators, equipment, and the availability of tools critical for maintaining public sanitation.

Despite efforts by the industry, both internally within the plants and through the enforcement of the decree, these measures have proven insufficient. The increase in explosions of nitrous oxide canisters in French incinerators constitutes a serious issue with wide-ranging implications. This

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

situation impacts not only the **safety of infrastructure and operators**, **operational efficiency**, and **waste management costs**, but also **public health**, particularly affecting young people.

Impact on young people's health

Nitrous oxide is primarily consumed through **inhalation from nitrous oxide canisters**, with an alarming increase in its use among young people in France and Europe in recent years.

This consumption is particularly widespread among **young people aged 15 to 25**, due to several factors:

- **Ease of access:** The gas is available in cartridges or canisters for food or industrial use, and its purchase is not strictly regulated.
- **Low cost:** A cartridge or bottle is inexpensive, making it easy for young people to acquire.
- **Normalization of use:** Social media plays a major role in promoting nitrous oxide, highlighting its euphoric effects while minimizing its dangers.

According to the press release by the **Interministerial Mission for Combating Drugs and Addictive Behaviors (MILDECA)**, in 2022, about **one in three young people aged 18 to 25** had tried nitrous oxide. This practice is particularly common at parties but is increasingly being used repeatedly and in isolation by young people.

The effects of nitrous oxide manifest a few seconds after inhalation and generally last for **1 to 2 minutes**. However, its immediate risks are far from trivial:

- **Balance and coordination disorders:** Dizziness, falls, or loss of consciousness can occur.
- **Risk of hypoxia:** Direct inhalation of the gas carries a high risk of oxygen deprivation, potentially leading to suffocation or cardiovascular issues.
- **Serious accidents:** Several cases of head trauma and injuries from falls have been reported due to disorientation and loss of motor coordination.

Regular and prolonged consumption of nitrous oxide leads to serious health risks, particularly for young people whose brains and nervous systems are still developing. Long-term effects include:

- **Neurological disorders:** Frequent use can damage the peripheral nervous system, leading to tingling in the limbs, loss of sensitivity, muscle pain, and motor difficulties.
- **Vitamin B12 deficiencies:** Nitrous oxide inactivates vitamin B12, essential for proper neurological function. This can cause neuropsychiatric disorders (memory loss, depression), mood disorders, and risks of paralysis.
- **Psychological dependence:** While nitrous oxide does not cause physical dependence, repeated use for euphoria can lead to psychological dependence, especially among young people seeking thrills or escape.

Accidents related to nitrous oxide consumption are rising sharply. In 2020, **more than 500 reports of intoxications and accidents** linked to the use of nitrous oxide were recorded by poison control centers in France. This represents a more than **500% increase compared to 2018**, highlighting the scale of the phenomenon. Hospitals also report cases of hospitalization for neurological complications, cardiac incidents, or physical injuries caused by falls or suffocation.

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

In response to the scale of the problem and the health risks, several measures have been implemented to raise awareness among young people and reduce the dangers:

- **Prohibition of sales to minors:** The law now prohibits the sale of nitrous oxide cartridges to minors and limits their promotion in public places.
- **Awareness campaigns:** Prevention programs in schools and on social media aim to inform young people about the dangers of nitrous oxide.
- **Restrictions on online sales for individuals:** Cartridges are subject to weight and quantity restrictions for individual buyers.

However, for this last measure, it remains possible to freely purchase large quantities online, including substantial canisters, with options to select flavors and rapid delivery—for example, delivery in Paris within an hour of ordering. Attached is a list of websites where nitrous oxide canisters can be purchased easily:

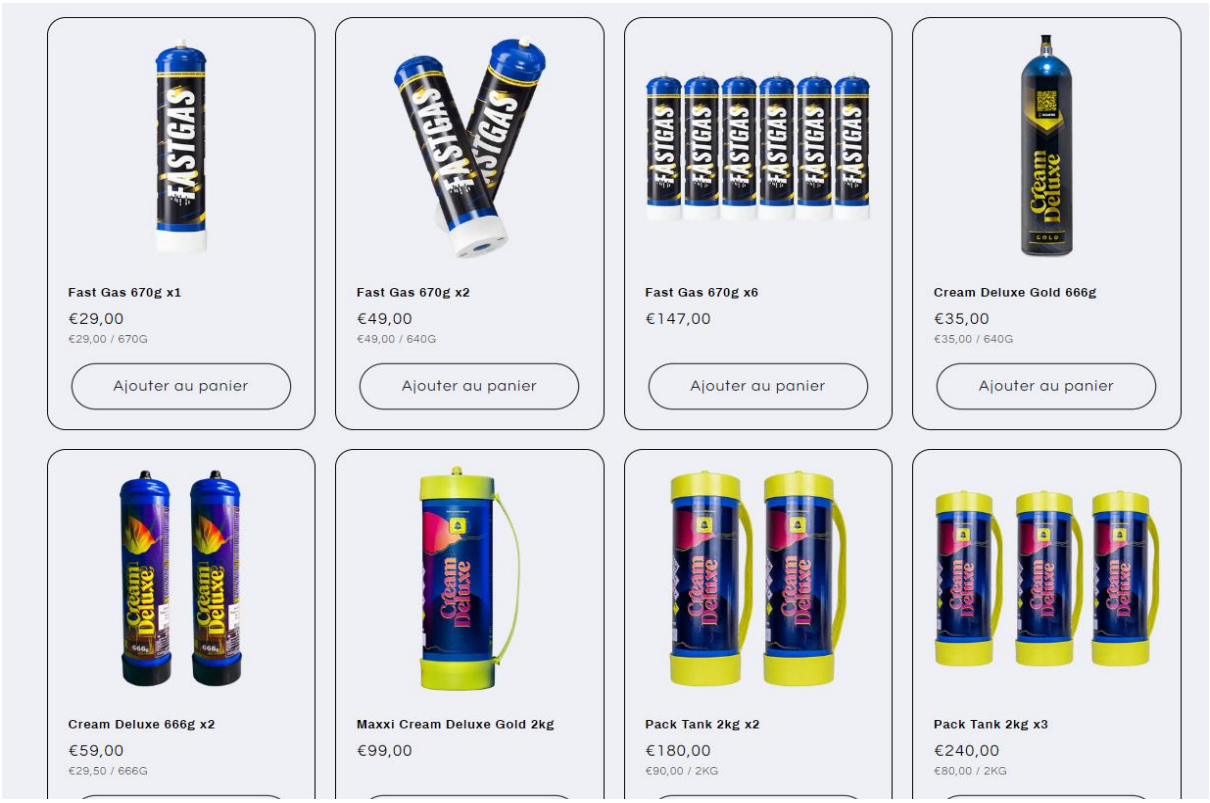

Figure 14 : Site: https://h24paris.com/collections/ballons

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

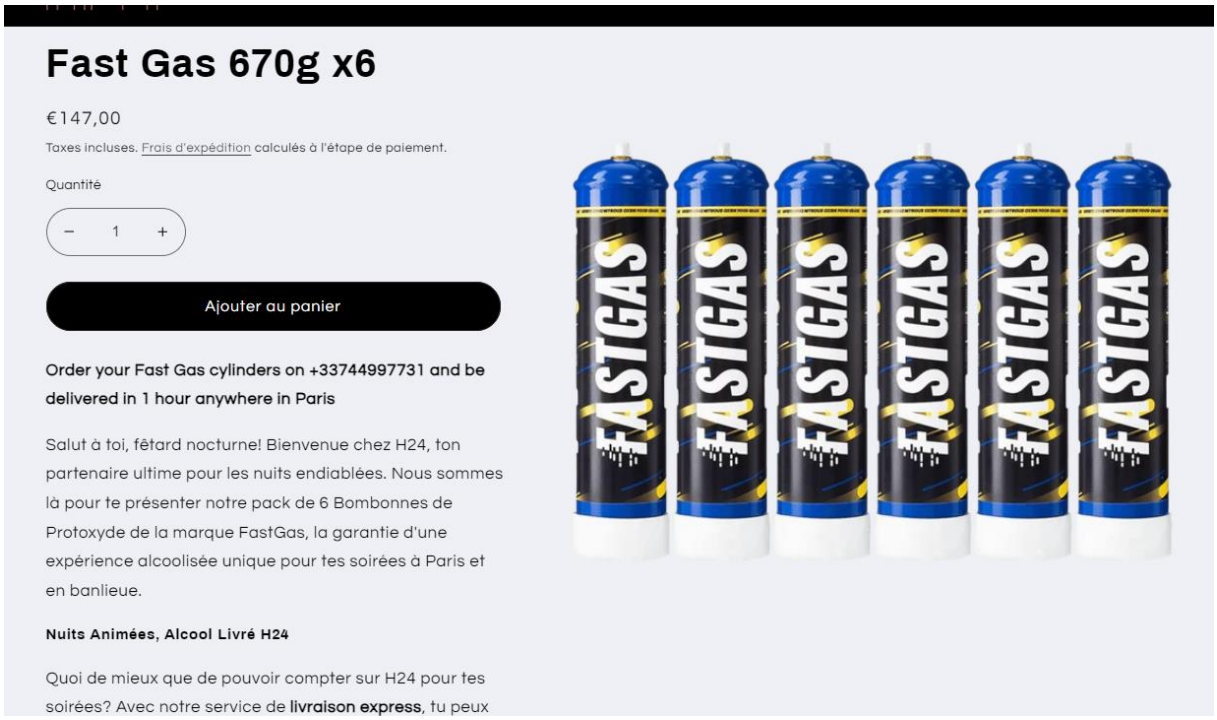

Figure 15 : Site: https://h24paris.com/collections/ballons

Figure 16 : Site: https://h24paris.com/collections/ballons

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain – gvolcovschi@fedene.fr

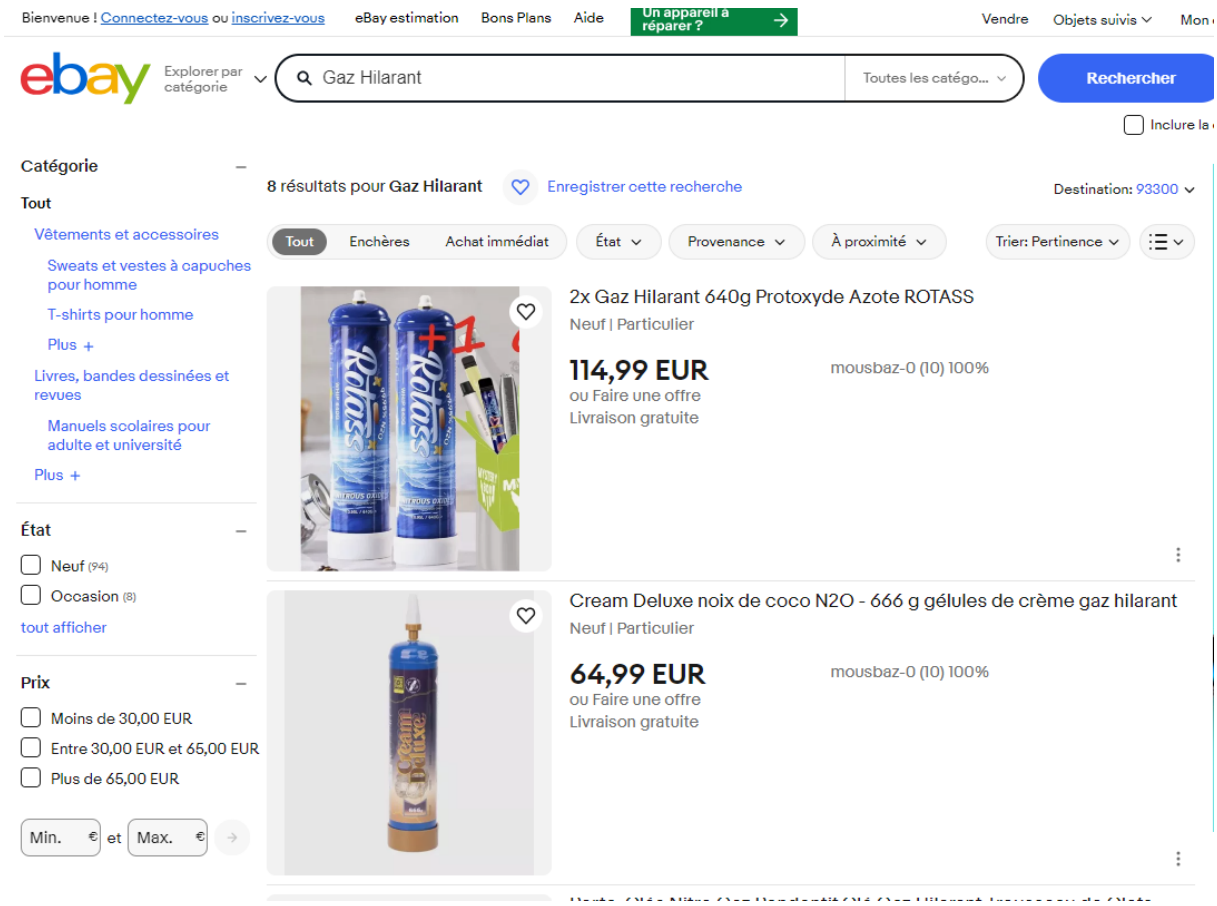

Figure 17: Site ebay.com

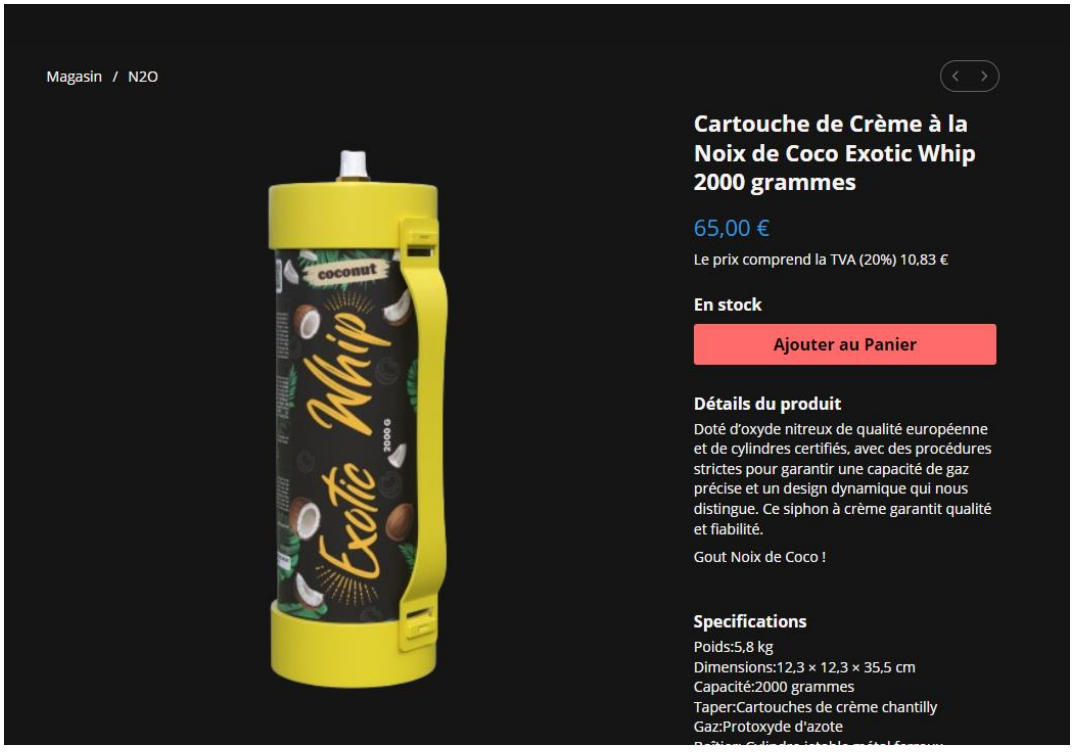

Figure 18 : Site: gofastgas.com

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

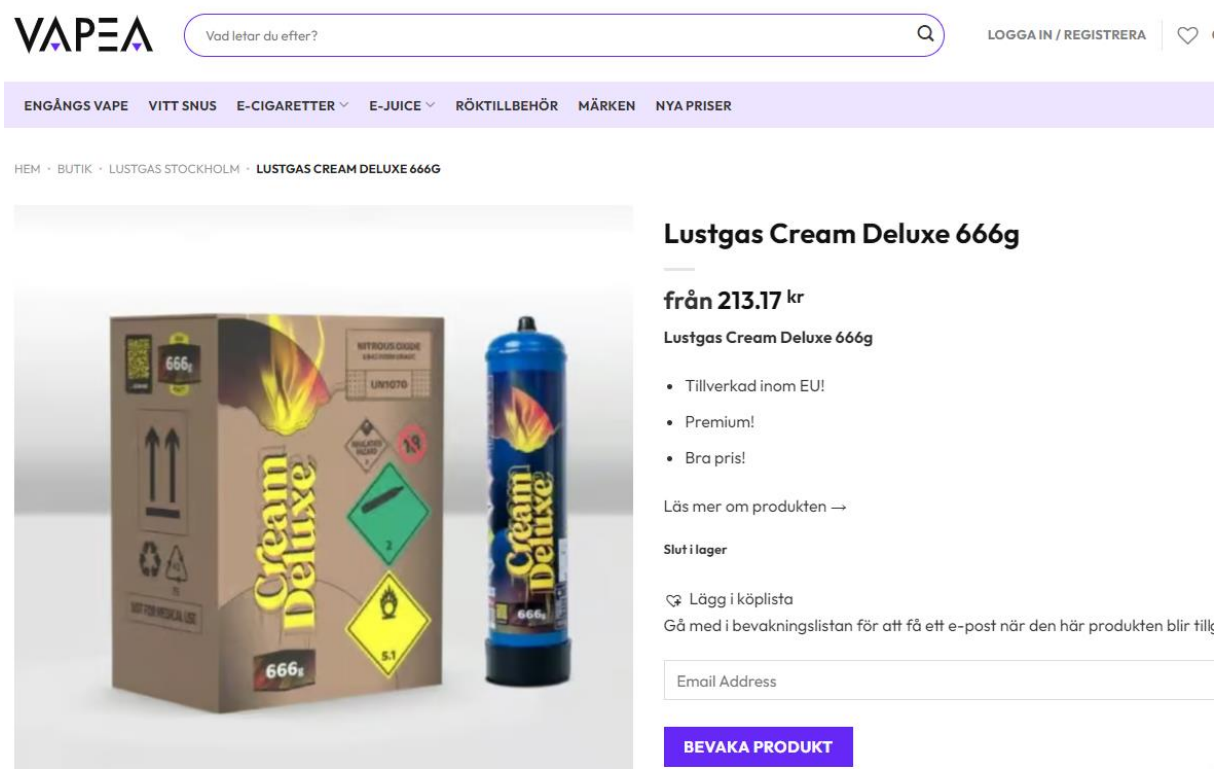

Figure 19 : Site: https://vapea.se/butik/lustgas-cream-deluxe-666g/

Figure 20 : Site: https://pureaura.se/product/kartong-greatwhip-platinum-640g-aluminium/

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain – gvolcovschi@fedene.fr

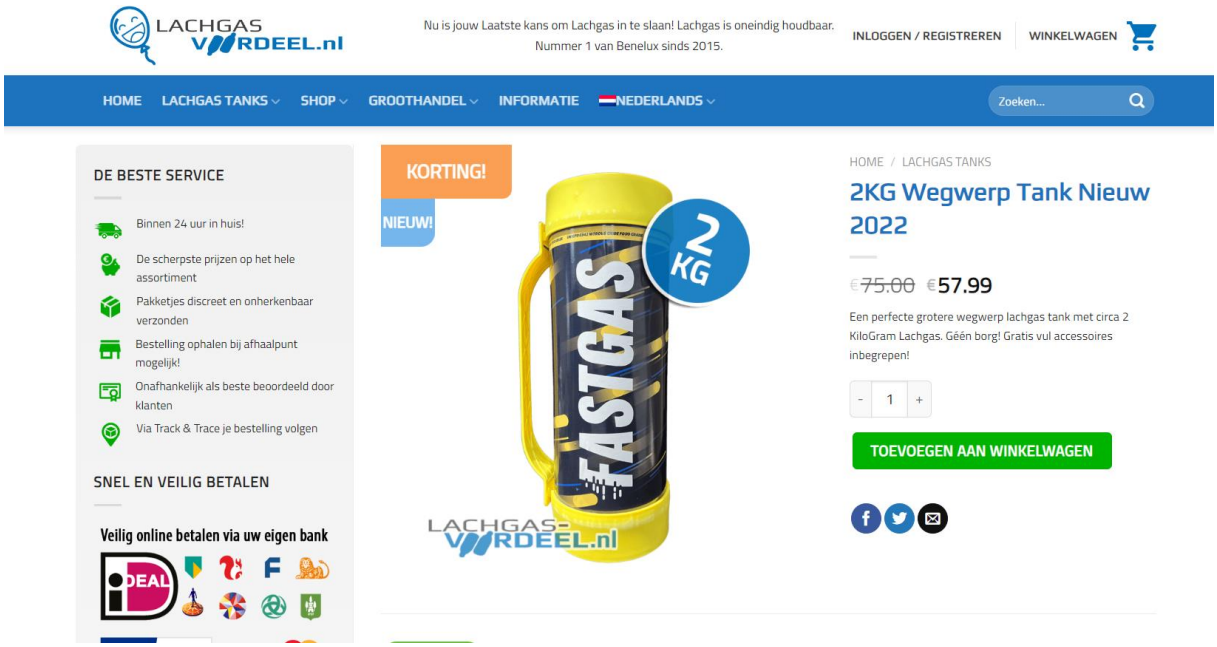

Figure 21 : Site: https://lachgas-voordeel.nl/2kg-wegwerp-tank-nieuw/

Allowing individuals to freely purchase large canisters of nitrous oxide presents significant dangers and constitutes a major public health risk for young people, both due to its **immediate effects** and its **long-term consequences**. Raising awareness about the dangers of this substance, combined with strict regulation of its accessibility, is essential to limit its recreational use and protect the health of young people. Strengthening prevention and control measures is critical to curbing this phenomenon and reducing accidents related to nitrous oxide use.

Additionally, the **poor management of waste** associated with the consumption of this gas causes **dangerous explosions in incineration facilities**, raising environmental and industrial concerns. Given this alarming situation, it is imperative to reinforce corrective and preventive measures to minimize risks and ensure the safety of both facilities and workers.

3. Situation in other European countries

CEWEP, the Confederation of European Waste-to-Energy Plants, is an association of waste-to-energy plant operators, representing around 410 plants in 23 countries. It represents more than 80% of Europe's waste-to-energy capacity.

Please find attached some feedback from CEWEP on nitrous oxide cylinder explosions in waste-to-energy plants.

Belgium

The Belgian Waste-to-Energy association BW2E has observed an alarming increase in the number of explosions occurring on a weekly basis, or even several times a day, at certain waste-to-energy plants among its members.

Here is an overview of the frequency of explosions at three plants:

- Plant A: Over a period of 70 days, 89 explosions were recorded on two lines, giving an average of 4.45 explosions per week and per line.

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

- Plant B: Over 305 days, 530 explosions were recorded on three lines, with an average of 4 explosions per week per line.
- Plant C: In 305 days, 67 explosions took place on two lines, i.e. 0.7 explosions per week and per line.

Belgian Waste-to-Energy cost estimates:

- Variable costs: The cost per shutdown depends on the extent of the damage, ranging from €20,000 to €150,000 per incident, taking into account repairs, loss of income and other indirect costs.
- Financial impact: A single plant has reported losses of up to €10 million in 2023 due to nitrous oxide cylinder explosions.

Direct and indirect costs cover:

Direct costs	Indirect costs
- Repair of damage caused by explosions. - Maintenance costs arising from unplanned shutdowns.	- Implementation of additional precautions for upstream sorting. - Specific management of the delivery and processing of waste containing nitrous oxide canisters. - Losses in energy production due to shutdowns. - Losses due to the temporary impossibility of recovering waste.

Since the end of 2022, there have been 60 additional shutdowns at five waste-to-energy (WtE) plants caused solely by nitrous oxide. These unplanned shutdowns lasted from a few hours to several days, depending on the intensity and location of each explosion.

One serious incident occurred when an employee was thrown by the high pressure of a nitrous oxide cylinder explosion while working to clear a blockage. Fortunately, he was not injured. However, any work carried out, whether for inspection or maintenance purposes, entails increased risks, particularly when opening hatches or doors:

- Daily checks: Inspection of the bottom ash conveyors located under the grates.
- On-line cleaning of electrostatic precipitators (ESP): Need to open the manhole located between the boiler and the ESP.

Netherlands

The Dutch Waste Management Association (DWMA) observes between 250 and 300 explosions per week in Dutch incineration plants.

Total estimated costs for the Dutch waste-to-energy industry: €65 million per year, including additional shutdowns and excluding costs for plant customers (municipalities, collectors) to remove nitrous oxide canisters from waste as much as possible. Despite efforts to remove canisters upstream, the number of explosions is not decreasing.

Risks to operational employees are a major concern for operators on a daily basis. Many costly measures have been taken to limit the risks as much as possible.

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

In 2023, a staggering 500,000 nitrous oxide canisters were found/intercepted in public spaces, in the waste processing chain or by Customs/Police

Sweden

In recent operating years, a significant increase in explosions has been observed at the Linkoping plant's household and similar waste incineration facility. This applies to all five incineration lines at the plant and reflects a trend seen at many other waste-to-energy plants in Sweden and Europe. In 2023, 122 explosions were recorded, while between January and March 2024, a further 74 explosions were registered. This high rate of occurrence, with several explosions a week and sometimes several on the same day, is causing considerable concern.

The explosions vary in intensity: some cause minor disruption to plant operation, while others cause more serious damage, leading to service interruptions. The most severe explosions can cause significant overpressure in the furnace, compromising not only the operation of the plant, but also compliance with the CO emission limits imposed by the regulations in force. In some cases, the damage is such that the plant has to be shut down completely to carry out repairs.

A particularly striking example illustrates this situation: shortly after the boiler was brought back into service following the annual maintenance shutdown, a major explosion occurred, causing several bars to detach from the grate and a large hole to form in its centre. This incident led to the immediate shutdown of the line concerned, necessitating a prolonged intervention to restore the equipment.

Figure 22 : Example of an explosion which led to shotdown

In response to these recurring incidents, **preventive measures have been implemented**. During an emergency shutdown while fuel remains on the grate, the operator has integrated into their procedures the obligation to **raise awareness among staff about the risks associated with gas canisters**. This awareness is now included in the risk analysis conducted prior to any intervention in the boiler-furnace.

Similar incidents have been observed in other European countries, such as **Norway, Luxembourg, Germany, the Czech Republic, and Ireland**, where explosions in incineration furnaces have also been reported. These incidents highlight a common European issue: the **recreational use of nitrous oxide** is not confined to France but is a widespread problem affecting many European countries.

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Whether in France or at the European level, the situation is both concerning and consistent. The issue of nitrous oxide use for recreational purposes **transcends borders** and requires a **collective approach** to be effectively addressed.

4. Solutions

There are several ways of solving the problem of nitrous oxide canisters.

First option: European regulation

Regulating nitrous oxide canisters at the European level by mandating the addition of a safety valve could significantly enhance safety. This measure would reduce the risk of explosion in the event of exposure to a high heat source by providing an escape route for the gas before the internal pressure reaches the container's rupture point. Such a regulation would improve the safe use of these canisters and **minimize incidents related to their handling and their arrival at household waste incineration plants**.

Second option: Collection and separation of flows at source by street cleaning services

This involves working closely with local authorities, in particular the waste collection services, to raise awareness of the importance of specifically sorting these canisters. It also involves identifying the areas where these canisters are most frequently deposited and targeting the collection rounds most affected. This approach could prove effective in certain towns and cities, thereby limiting the amount of waste going to incinerators. However, this method remains partial and cannot capture all canister flows.

On a local scale, canisters are found in public spaces: litter bins, illegal dumps and deposits on the road.

Figure 24 : Nitrous oxide canisters in Montpelier ©JMA / Métropolitain

Figure 23 : N2O canisters in Paris

It is important to work more closely with waste management and collection services to improve this system. In addition, local authorities, faced with budgetary constraints, need financial support to ensure that these canisters are taken back and processed. Such support is essential to guarantee the sustainability of the efforts made to manage this specific type of waste.

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Third option: deposit return system

The creation of a deposit return system could make a significant contribution to reducing the number of nitrous oxide canisters. By encouraging users to return used canisters, this system would incorporate the principles of the circular economy, enabling them to be recycled under appropriate conditions. Once the canisters have been inspected and certified as safe, they could be reused, thereby limiting their environmental impact.

5. Conclusion

Professionals in the waste-to-energy sector are facing a massive and almost continuous influx of nitrous oxide canisters into their facilities. These canisters, classified as hazardous waste, require specific collection and treatment. However, when they arrive at non-hazardous waste treatment sites, they cause considerable damage to facilities, jeopardizing both infrastructure and operator safety.

Despite the entry into force of the decree regulating the sale of nitrous oxide canisters to individuals, the situation has unfortunately not improved **for household and similar waste incineration plants.** Operators continue to face significant daily risks, without effective solutions in place to mitigate these dangers.

We sincerely hope that this report will prompt the **Directorate General for Risk Prevention (DGPR)** to engage the French government in decisive action with the **European Commission**, as this is a major issue that transcends France's borders and affects many other European countries. National and European support is crucial to addressing this problem comprehensively and effectively, and we firmly believe that a coordinated European-level intervention could provide sustainable solutions.

For this reason, we urge the DGPR to take the initiative in issuing an appeal to the European Commission. A coordinated response among member states is essential for implementing appropriate prevention and safety measures to protect both people and property.

It is important to emphasize that this problem does not solely concern household waste incineration plants but also **sorting centers**, which face similar risks. Explosions of nitrous oxide canisters can occur at any stage of the waste treatment process, making it essential to implement strict measures throughout the entire waste management chain.

Actions must be taken without delay to address this growing threat. The measures proposed in this report must be adopted and implemented swiftly to ensure the safety of workers, facilities, and the entire waste management chain in France and across Europe.

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Appendix

Articles published on the subject in the French media:

2020 :

Déchets-infos : https://dechets-infos.com/protoxyde-les-cartouches-de-gaz-qui-ne-font-par-rire-les-collectivites-4924503.html

2021:

BFMTV : https://www.bfmtv.com/economie/entreprises/industries/quand-le-gaz-hilarant-explose-dans-les-usines-d-incineration-de-dechets_AV-202108050132.html

Lefigaro : https://www.lefigaro.fr/societes/les-bonbonnes-de-gaz-hilarant-cauchemar-des-usines-de-traitement-des-dechets-20210804

Le Parisien : https://www.leparisien.fr/val-de-marne-94/toute-la-france-est-concernee-les-bonbonnes-de-gaz-hilarant-font-derailler-les-usines-dincineration-des-dechets-03-08-2021-OUSQQSTEBNA2PHGFX7DIY5D2NQ.php

2022:

Echo du Mardi : https://www.echodumardi.com/politiqueetterritoire/comment-le-protoxyde-dazote-met-la-pression-sur-lincinerateur-de-dechets-de-vedene/

Actu Vaucluse : https://actu.fr/provence-alpes-cote-d-azur/vedene_84141/vaucluse-les-fours-de-vedene-a-l-arret-a-cause-du-gaz-hilarant_50404959.html

2023:

France 3 : https://france3-regions.francetvinfo.fr/bourgogne-franche-comte/doubs/protoxyde-d-azote-ce-dechet-orphelin-provoque-regulierement-des-explosions-dans-l-usine-d-incineration-de-besancon-2885015.html

Est Républicain : https://c.estrepublicain.fr/economie/2023/12/05/explosion-de-bouteilles-de-gaz-au-centre-de-tri-des-dechets-l-alerte-du-sybert?utm_medium=social&utm_source=Facebook&fbclid=IwAR2WzFdOOF4nd6KecbfRYbS7uZ7F0VwyYbuNIx6gbgHCsmm0KP-xwxwQh00Echobox=1701795196

MaCommune.info : https://www.macommune.info/des-explosions-a-repetition-a-lusine-dincineration-des-ordures-menageres-de-besancon/

La Dépêche : https://www.ladepeche.fr/2023/01/05/toulouse-le-fleau-des-bonbonnes-de-gaz-hilarant-qui-explosent-dans-les-fours-de-lincinerateur-de-dechets-10904678.php

Le Parisien : https://www.leparisien.fr/essonne-91/le-protoxyde-dazote-nouvel-ennemi-des-dechetteries-en-essonne-cest-comme-jeter-des-bombes-a-la-poubelle-29-07-2023-B6BTWGNQKBE5VMHRDA5B3VWRGE.php

2024:

Ouest-France : https://www.ouest-france.fr/environnement/dechets/enquete-cest-catastrophique-des-bouteilles-de-gaz-hilarant-explosent-dans-des-incinerateurs-59cd466a-f32b-11ee-9bee-6b4d91ded6b2

ActuEssone : https://actu.fr/ile-de-france/villejust_91666/explosion-des-bouteilles-de-protoxyde-d-azote-un-nouvel-incident-dans-une-dechetterie-de-l-essonne_61301384.html

Nice matin : https://www.nicematin.com/faits-de-societe/protoxyde-d-azote-comme-des-bombes-a-univalom-896544

Republicain Lorrain : https://www.republicain-lorrain.fr/societe/2024/02/21/protoxyde-d-azote-ces-bombes-retrouvees-dans-vos-poubelles

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr

Articles published on the subject in European media:

Belgium :

2023:

RTL Belgique : https://www.rtl.be/page-videos/belgique/faits-divers/des-cartouches-de-protoxyde-dazote-explosent-dans-les-incinerateurs-de-dechets/2023-12-28/video/621717

Brussels Times : https://www.brusselstimes.com/362201/laughing-gas-capsules-cause-explosions-in-waste-incinerators

Netherlands :

2023:

Euwid-recycling : https://www.euwid-recycling.com/news/business/dutch-waste-industry-seeks-state-help-in-dealing-with-ni-trous-oxide-canisters-240723/

Nl times : https://nltimes.nl/2023/12/22/exploding-nitrous-oxide-canisters-caused-eu65-million-damage-waste-processors-claim

2024:

Dutch News : https://www.dutchnews.nl/2024/06/nitrous-oxide-no-laughing-matter-for-waste-incineration-firms/

28 Rue de la Pépinière, 75008 Paris - Syndicat national du traitement et de la Valorisation des Déchets Urbain –
gvolcovschi@fedene.fr