European Fireworks Association EuFiAs

Sector Roadmap

For

"Sustainable Fireworks"

November 2024

c/o An der Pönt 48 – 40885 Ratingen – Germany

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Foreword

From Fireworks over Sustainable Development Goals (SDGs) and the European Green Deal to the three-step approach in the SDG Sector Roadmap Guidelines described by the World Business Council for Sustainable Development (WBCSD) – There are important aspects to define a common direction via exchange of data, building know-how and the creation of a clear vision in line with prioritized SDGs for our sector.

Careful evaluation of key factors, development chances, critical challenges, market implementation and barriers maximize the impact of this work. We aim to protect the freedom of usage, cultural traditions and to prevent prohibitions. Products, markets, companies, and their processes will be affected.

We must accept the challenges of the presence and lead by example, even though our main problems are illegal sales and illegal use of fireworks. This cannot be cured by more stringent regulations.

HEINZ SWART, PRESIDENT OF THE EUROPEAN FIREWORKS ASSOCIATION EUFIAS

"Maximizing the profits of the day is not enough, one must also figure out what we shall do in the day after tomorrow and ask ourselves, what products do we really want or need at the end of this decade."

UFFE CEDERQVIST, INITIATOR OF THE GREEN DEAL INITIATIVE OF EUFIAS

Supporting companies and associations

Austria: FIREevent GmbH (former supporter: Verband der Österreichischen Pyrotechnik, VÖP)

Czech Republic: Association of Czech Professional Fireworkers z.s. (ACPF)

Denmark: Fyrværkeribrancheforeningen

Finland: Finnish Association of Pyro and Fireworks Arts

France: Syndicat des Fabricants d´Explosifs, de Pyrotechnie et d´Artifices (SFEPA)

Germany: Verband der pyrotechnischen Industrie (VPI)

Italy: Associazione Nazionale Imprese Spettacoli Pirotecnici (ANISP)

Netherlands: Belangenvereniging Pyrotechniek Nederland (BPN)

Norway: Norsk Fyrverkeriforening (NFF)

Poland: Stowarzyszenie Importerów i Dystrybutorów Pirotechniki (SIIDP)

Slovenia: Piro Planet d.o.o.

Spain: Asociación Española de la Pirotecnia (AEPIRO)

Sweden: Sveriges Pyroteknikbranschförbund (SPB)

UK: British Fireworks Association (BFA)

UK: British Pyrotechnists Association (BPA)

EuFiAs President: Heinz Swart

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CHAPTER 01. Roadmap and Sustainability Strategy Development

It is important to evaluate our sector, our products, their legislative framework, and the consequence of performing display shows in terms of sustainability. Subsequently, relations to the European Green Deal are assessed. Since sustainability is a global challenge and a common goal, our way towards effective sustainable developments is of course associated with the Sustainable Development Goals (SDGs) of the United Nations (UN).

a. The European Green Deal and Sustainable Development Goals

The European Green Deal is the European Union's (EU) current plan to make the Union's economy sustainable [1]. The idea is to turn "climate and environmental challenges into opportunities" [2]. The systematic approach of the European Green Deal initially followed nine Policy Areas. In line with the 'fit for 55' package, nine policy areas are transformed into eight actions [3]:


Agriculture


Climate


Energy


Environment and oceans


Finance and regional development


Industry


Research and innovation


Transport

Icons for all policy areas are © European Union and licensed as CC BY 4.0

Every former policy area and every current action is a key to achieve the Green Deal goals; hence, we founded our Green Deal Initiative (GDI) to assess every element of the European Green Deal. We found our most important potentials.

The European Commission (EC) describes in the EU holistic approach to sustainable development the relationship between the European Green Deal and the United Nation's (UN) Sustainable Development Goals (SDGs) [4]. Figure 1 illustrates an overview on SDGs under the Green Deal. In addition to the systematic and contents of the European Green Deal, our GDI and our roadmap will be in line with the UN SDGs as well.

Figure 1: Excerpt of the Commission's holistic approach for sustainability and the SDGs [4]

The SDGs and associated targets are the global analogy to the European Green Deal. The SDGs are part of the UN 2030 Agenda and lead the way how to achieve a better and more sustainable world by 2030.

Figure 2: Summary of the seventeen global SDGs as defined by the UN [5]

The SDGs are not only focusing on environmental aspects; hence they go beyond the goals of the European Green Deal. The SDGs describe diverse topics, ranging from social targets, over economic and environmental targets to health-related targets (see Figure 2). The UN summarized 169 targets that way in 2015 [6]. Fireworks provide not only an environmental potential. Therefore, it is useful to match our sustainable potentials to both, the European Green Deal and the 17 SDGs.

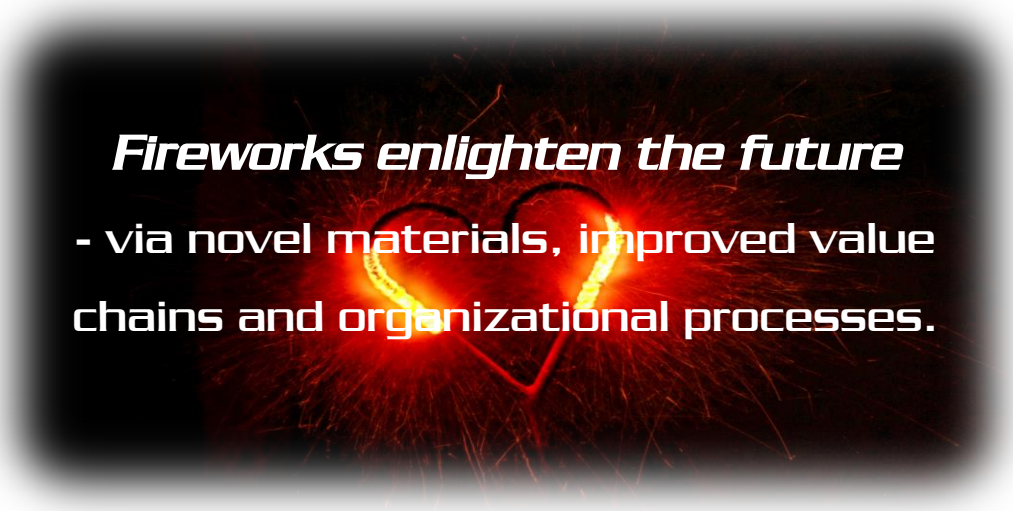
Achieving SDGs is only possible if different stakeholders work together. This applies to governments as well as to industries, communities and even to individuals. The European Fireworks Association (EuFiAs) strongly supports this approach and therefore includes SDGs in the sustainability strategy.

b. Motivation for this roadmap and our sustainability strategy

EuFiAs and its members treat sustainability as the major driving factor for upcoming developments. A better growth will result from such developments. Therefore, our vision is to ensure:

- Fireworks do not contribute to climate change (life-cycle assessments)
- Fireworks do not contain hazardous substances (intensive substitution strategy)
- Emissions from fireworks are reduced to a necessary minimum (intensive R&D).
- Fireworks undergo eco-design approaches during their development (new approach)
- Fireworks do not affect biodiversity (proven).

All parts of our vision will not introduce any competitive distortion. Discussions around prohibitions of fireworks will become obsolete. Sustainable developments will be the state of the art. Benefits for the entire industry will increase.



c. Method and Approach

EuFiAs sees the European Green Deal as a technological and social opportunity. Our products will advance. Our industry's reputation and the image of our products, especially fireworks, will receive help from the Green Deal. EuFiAs made the decision to start the GDI early. All national industry organizations (NIOs) were asked to actively participate in the GDI. The aim of the GDI is that all members and their operating companies (OCs) openly take part. This does not restrict individual solutions. The GDI brings together industry leaders from different European countries with different perspectives and diverse cultures. All participants work together on the perspective of the pyrotechnic industry and its products. The efficiency of research and development will increase. Developments are accelerated. Novel technologies can be introduced. The reputation of our industry benefits from such efforts.

The key elements of the EuFiAs GDI are:

(1) Setting up a framework for sharing “Best Practices”
(2) Organization of open and forward-looking communications, including information sharing
(3) Initiation of PR work on a European and national level
(4) Regular inclusion of activities into the EuFiAs Advisory board agenda
(5) Technical collaboration work
(6) Strategy development and roadmapping

This roadmap is created by the EuFiAs GDI, accepted by EuFiAs, and edited by NIOs. Action will take place on the level of the members’ OCs. The creation was done in accordance with guidelines of the WBCSD for SDG Sector Roadmaps to effectively “drive transformation in line with the SDGs” [7].

We follow a three-step approach in the creation process. First, EuFiAs members have been addressed to introduce sensitivity and to explain associated challenges. An internal analysis has been performed. A common position became achievable. A second step was and will be to freeze certain working points. A target-oriented communication and exchange with external stakeholders becomes more efficient and is included in our approach. Impact opportunities with an external perspective become obvious. A third step is to define our way forward. This will be accompanied by public relations (PR) activities.

d. What truly matters on our way to 2030?

Three fundamental areas of importance exist within the GDI:

- Sustainable industry & circular economy
- Analysis and reduction of the environmental impact.
- Climate actions, especially due to CO_2 emission

Those fundamental areas are aligned with the prioritized policy areas and actions of the European Green Deal. In this way, we can focus our sustainable developments and maximize both our contribution to the SDGs and our impact on sustainability. The Green Deal actions that may have the greatest impact are:

Climate

Environment and oceans

Like finding priorities within the European Green Deal, we set up priorities for the SDGs to ensure an effective contribution. Our major impact to minimize negative impacts and to maximize positive impacts is currently seen within the SDGs of figure 3.

Figure 3: Prioritized SDGs to provide most effective action by our industry.

Priorities can be illustrated by the materials used in typical fireworks. Bangers, rockets, shells and batteries are essential types that stand as examples for certain types of fireworks. The weight distribution allows us to name aspects for improvement.

The NEC of a banger is about 8%-12%, Cardboard materials are about 35%-45% and plugs (often clay) are about 50%-60%. In contrast, a shell has 35%-50% NEC and the rest is typically cardboard (40%-60%). The amount of pyrotechnic composition in rockets is about 15%-20% and the pyrotechnic composition in batteries typically 10% to 20%. That comparison illustrates that there can be diverse needs for improvement for distinct types of fireworks.

Deviations from the examples exist and values can significantly differ. However, for illustration this kind of assessment is useful to think about the strategies presented in the following chapters.

e. Materiality matrix for modern and sustainable fireworks

Fireworks are controversially discussed from different perspectives. We collected all discussion points. We aligned SDGs and Green Deal policy areas with those challenges.

This roadmap is not limited to environmental challenges. Topics beyond the European Green Deal are related to public security and human rights. The latter one rises from high import tonnages of fireworks from Asia.

Furthermore, this roadmap reflects our ambitions and vision. Our ambitious effort can be described best with the words of the Business & Sustainable Development Commission's (BSDC) flagship report: "It opens up new opportunities and big efficiency gains; it drives innovation; and it enhances reputations" [8]. Especially the last benefit can increase our credibility with authorities and the European citizens, showing that we always act in a responsible way. We assessed each challenge to sustainable fireworks accordingly via a "materiality matrix". The outcome of this assessment is reflected in Figure 4.

This way, we found the most influential fields of sustainable developments and R&D to realize the vision mentioned above. Certain elements allow a very efficient progress and a responsible management of resources. Doing more with less is the target. Innovation is crucial since technological solutions are not available in all fields. In some cases, they must be defined, in other cases solutions

are immature. Scaling issues concerning innovative technologies are a high challenge for achieving some of the goals. Approaches based on scientific insights become necessary in a way that has never seen before in our very traditional industry. An academization in certain fields will be achieved to incorporate scientific results. A science-based approach becomes available; a science-based roadmap is described here.

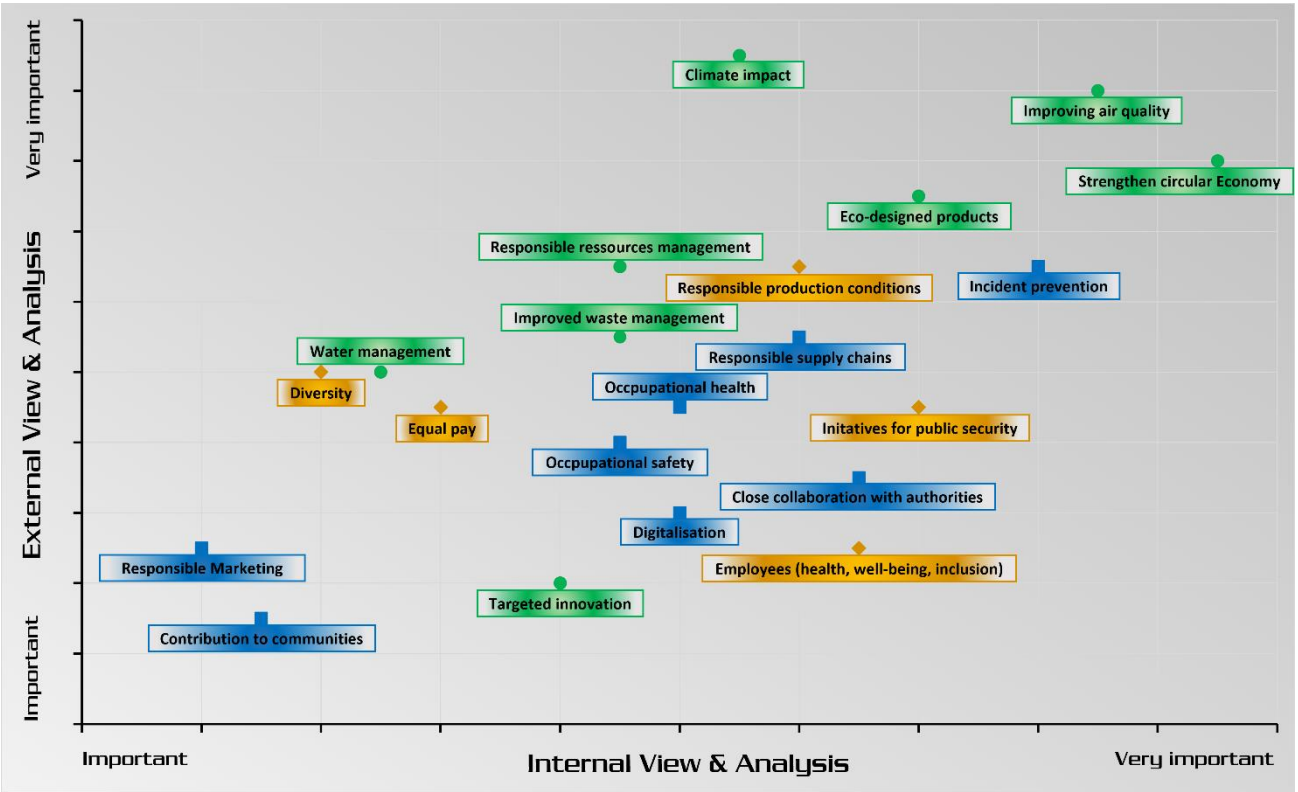


Figure 4: Materiality matrix for sustainable fireworks, based on 2020 and 2021 analyses.

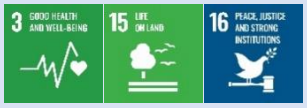
The most dominant aspects included in the materiality matrix, as described in Figure 4, are regarded as top priorities. These fields have been shared within the GDI to define common goals and involve different members from different member nations with different perspectives, traditions, and cultural behaviours. The priorities are associated with specific fields under the European Green Deal as illustrated in Table 1.

Table 1: Important actions under the European Green Deal

Climate	Environment and oceans	Circular econ-omy action plan	Zero pollution action plan	8th Environ-ment Action Programme	Biodiversity Strategy for 2030

Table 2 summarizes the fields and challenges with the potentially highest impact on sustainable development.

Table 2: Identified top priorities for sustainable fireworks.

Identifier	Challenge	Green Deal relation	SDGs	Complexity
A1	Circular economy: Plastics			Extremely high
A2	Circular economy: Paper and cardboard			
A3	The alternative cycle: Bioeconomy			Remarkably high
B1	Pollution: Microplastics			Moderate
B2	Pollution: Particulate matter			Remarkably high
B3	Pollution: Noise			Moderate
C1	Climate impact			Moderate
D1	Misuse of fireworks	-		High
D2	Injuries due to fire-works	-		High

CHAPTER 02. Characteristics of the fireworks sector

a. Overview on Fireworks in Europe

The pyrotechnic industry consists of various sub-sectors and branches. They all have in common that related products are pyrotechnic articles. The branches are dealing with the products themselves, their equipment or services related to such products.

Experts from the pyrotechnic industry work closely together with authorities both on an international and national level. This allows to ensure the above-mentioned high safety and ensures proper regulation. Our voice on a European level is EuFiAs. As such, we actively take part in various organizations:

- Technical committee (TC) 264 of the International Organization for Standardization (ISO)
- TC 212 of the European Committee for Standardization (CEN)
- European Commission's Group of Experts (GoE) on Pyrotechnic Articles (E01323)
- Forum of notified bodies for pyrotechnic articles (PNB)
- Partner Expert Groups (PEG) of the European Chemicals Agency (ECHA),
- Standing Committee on Precursors (SCP, E03245)
- Consultancy in law-making processes, for the Directive 2013/29/EU
- National Expert Groups like the working group on class 1 of the standing committee on the transport of dangerous goods at the German Federal Ministry for Digital and Transport (BMDV)

EuFiAs is acknowledged by the EC, Parliament, and Council as the representative for the fireworks industry in Europe. As such, EuFiAs is an instrument to gain influence within the European community on behalf of all people who professionally work with fireworks and especially its members. EuFiAs concerns itself mainly with European and international laws and regulations on fireworks and theatrical pyrotechnics. EuFiAs stands for NIOs from European countries. EuFiAs meetings are the major communication platform of the European professional fireworks industry. International efforts by national fireworks associations are also coordinated.

EuFiAs and NIOs manage, and drive efforts related to PR and define strategies, especially from the technical point of view. In addition, EuFiAs supports parties interested in developments related to fireworks and associated regulations which are found outside Europe.

b. The current EU framework

Pyrotechnic articles are regulated in the EU by different legislative fields. These fields range from related ones to chemicals' legislation, safety of production sites and product conformities. In addition to legislative requirements, judgements of the European Courts and European standards complete the regulatory framework.

The major EU legislation is realized by the Directive 2013/29/EU. Its purpose is the free movement of pyrotechnic articles in the internal market while ensuring a high level of protection of human health and public security. Furthermore, protection and safety of consumers as well as aspects related to environmental protection are included in the subject matter of the directive [9].

The use of pyrotechnic articles is subject to significant divergent cultural customs and traditions over the EU's Member States. Therefore, the directive allows national measures to restrict the use or sale of certain categories of pyrotechnic articles to the public.

EU regulations and especially the directive define that economic operators manage their products and services. This means that producers, importers, and distributors placed within the EU handle pyrotechnic articles and their conformity with the EU regulatory framework. The role of government agencies is to watch that economic operators follow the rules laid down. Traditionally most EU Member States have strong government agencies which, for example, function as market surveillance authorities or maintain opinions e.g., on matters related to quality, user safety, user behaviour and can influence political decisions in the Member States through their position. This creates a complex situation. On each side of the border between two Member States a specific product can be regarded as "safe to use" on one side of the border, while being banned from use on the other. Nevertheless, the EU is an open market. The free cross-border movement of goods should not be restricted, apart from linguistic aspects such as labelling or marking. Product specifications (e.g., classification limits or NEC limits) are maintained by economic operators. Economic operators are potentially able to use differences in local regulation to their own economic benefit.

However, the directive sets up essential safety requirements to protect consumers and to prevent accidents. The following harmonized standards are pointed out for detailed description of products, their function, and functional requirements:

- EN 15947:2015 - Pyrotechnic articles - Fireworks, Categories F1, F2 and F3
- EN 16256:2012 - Pyrotechnic articles - Theatrical pyrotechnic articles
- EN 16261:2012 - Pyrotechnic articles - Fireworks, Category 4

Standards around pyrotechnic articles follow the Directive's logic as told in its article 6. Categories of pyrotechnic articles are defined "according to their type of use, or their purpose and level of hazard, including their noise level" [9]. The dominant category are fireworks which are defined by categories F1 (very low hazard) to F4 (articles intended for use only by persons with specialist knowledge). Theatrical pyrotechnic articles can be categorized as T1 (low hazard) or T2 (intended for use only by persons with specialist knowledge). All other pyrotechnic articles must meet the criteria for categories P1 (low hazard) or P2 (intended for use only by persons with specialist knowledge).

The importance of harmonized standards was set by the judgement of the court in case C-613/14. "Legal force" was assigned that way [10]. The judgement in case T-474/15 confirmed the high significance of harmonized standards, stating that "it is the publication by the Commission of the reference

of a harmonized standard in the Official Journal which confers on it legal force" [11]. Therefore, harmonized standards for pyrotechnic articles provide a legally binding effect.

The directive 2013/29/EU also covers quality issues. Product quality is an important topic that is discussed. It is assumed that processes related to production of pyrotechnic articles are sufficient from a quality control point of view when a CE marking is achieved. This especially important matter is included in this roadmap since sustainable fireworks must provide a sufficient level of quality.

c. Value chain assessment

The value chains are characterized by different purposes of pyrotechnic articles and distinct locations of the sector members. Different traditions influence how to deal with fireworks. The value chains of our sector range from production of substances as raw materials to services like performing fireworks display.

Life cycles can be influenced differently. Some life cycles are completely under the control of our members. Other life cycles provide less impact opportunities. Therefore, we are cooperating closely with authorities, customers, and partners to realize our businesses. Extensive cooperation with the chemical industry, process manufacturing, pulp and paper industry, packaging and polymer industry and logistics is necessary. Professional customers can be found in the automotive sector, aerospace, defence sector, entertainment industry and in public authorities such as police or agencies for technical relief. The customer range is completed by private end-users, especially for fireworks, which is the reason for strict regulations and an enhanced safety.

A very general approach related to our value chains and how each phase in the life cycle is associated with every field of action is described in the latter chapters. Therefore, the following tables will conclude every field of action in the way of Table 3:

Table 3: Exemplary template to relate the value chain and life-cycle phases with measures in different field of action related to sustainable fireworks.

Life Cycle / Value Chain	**Measures**
Management	
Design / Product components	
Raw Materials	
Production	
Transport	
Packaging	
Storage	
Disposal	

d. Supply Chain characteristics

The supply chains are closely related to the value chains. However, the supply chains are primarily distinguished between fireworks that are subject to import and fireworks that are subject to production inside the EU. If fireworks are imported, there are often suppliers, i.e., exporters, that do not produce the fireworks themselves. Therefore, there can be up to three actors within the supply chain between the producer of the fireworks outside the EU and the official “manufacturer” according to Directive 2013/29/EU inside the EU (acting as an “importer”).

e. Methodology for product assessment

The internal analysis has proven that a structured approach is necessary to maximize the impact of modern fireworks on sustainability. Implementing a new vision for our industry is an elaborated matter. A general rule that can be applied here, is to divide complex problems into smaller issues. Therefore, we introduce a simple model of structuring as illustrated in Figure 5:

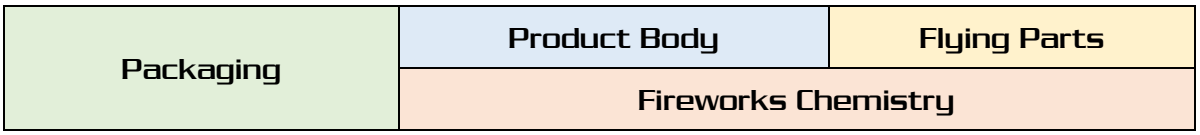


Figure 5: Schematic representation of the relevant product components

“Packaging” refers to the parts used in transport or distribution. It might consist of a transport packaging, a primary and/or secondary packaging, depending on product type and producer. Besides the type of packaging, sales presentation and safety must be considered. “Product body” and “Flying parts” refer to actual components of fireworks. The product body remains after the use of the fireworks item. The user can clean up and dispose of correctly. Flying parts must be distinguished. There are “flying” parts, like the propelled content of a table bomb, which can be easily collected. In general, there is a negligible probability that parts of indoor fireworks or parts of hand-held fireworks contaminate the environment. On the other hand, components of fireworks exist, like the tip of a rocket, which are not accessible after functioning of the pyrotechnic article. Therefore, measures on disposal become obsolete. Since the ambition of EuFiAs and its NIOs is to avoid microplastic pollution, such components must undergo innovative research and development to account for environmental responsibility and are the core of our assessment.

The distinction between a professional star shell and a consumer rocket is an instructive example. A star-shell is shot up in the air using a reusable launch tube (e.g., 100 mm diameter). The star-shell is a closed unit containing a lift charge and a shell. When shot, the shell mass is burned and disintegrated into small pieces of e.g., cardboard. Therefore, such a shell holds only flying parts. Its environmental footprint depends on fireworks chemistry and material used in constructing the shell.

A consumer rocket consists of a rocket engine with a stick attached to it to keep its flight steady. An effect cartridge is on top of the rocket, which is lighted when the rocket has reached its optimum height. The effect cartridge will disintegrate in the air, but engine and stick will float to the ground. The cartridge is in practice “lost”. The other parts of the rocket can be collected. The environmental footprint depends on fireworks chemistry, but the design of the rocket components is also important. “Fireworks chemistry” refers to the integral substances and mixtures, i.e., the pyrotechnic composition. What kinds of chemicals are used? What kinds of residues exist (combustion gases, microparticles or solid waste (e.g., soot)? All activities are closely related to the EU’s chemicals strategy for sustainability (CSS). However, this topic is a lower priority for the moment and will be part of a revision of this roadmap.

CHAPTER 03. Field of actions

a. Circular Economy

It is necessary to assess the whole life cycle, the supply chain, and the value chain of fireworks to evaluate the current state of our economy and show circular potentials. It is especially useful to apply the introduced model of structuring: flying parts, product body and packaging. We must perform life cycle assessments (LCAs) for exemplary types of fireworks and figure out their product carbon footprint (PCF). This allows us to find the technological solution with the greatest impact on sustainability. Since LCA results require certain knowledge [12], this is no short-term objective.

Packaging is usually not contaminated at all. Product related components are often broken down or hold combustion products as residues. Therefore, different challenges apply to materials for the product body and for the packaging. Flying parts are out of the circular economy scope because parts that are distributed in nature are hard to bring in a circular economy system. This assessment is also done by Science Advice for Policy by European Academies (SAPEA), who officially consults EC [13]. SAPEA named fireworks as one application where it is challenging to remove or collect a particular plastic product or its fragments from the environment after use. Biodegradable materials are recommended. Consequently, the Group of Chief Scientific Advisors adopted the SAPEA opinion and published an official report on behalf of the EC [14]. EuFiAs appreciates the opinions of SAPEA and the Group of Chief Advisors since this is in line with our internal efforts. Solutions are under development and this area is closely related to the microplastics chapter (see pollution related to Fireworks).

Our overall approach is based on the circular economy mindset that “waste result in raw materials”. Figure 6 summarizes our goals for substituting plastics or avoid it completely.

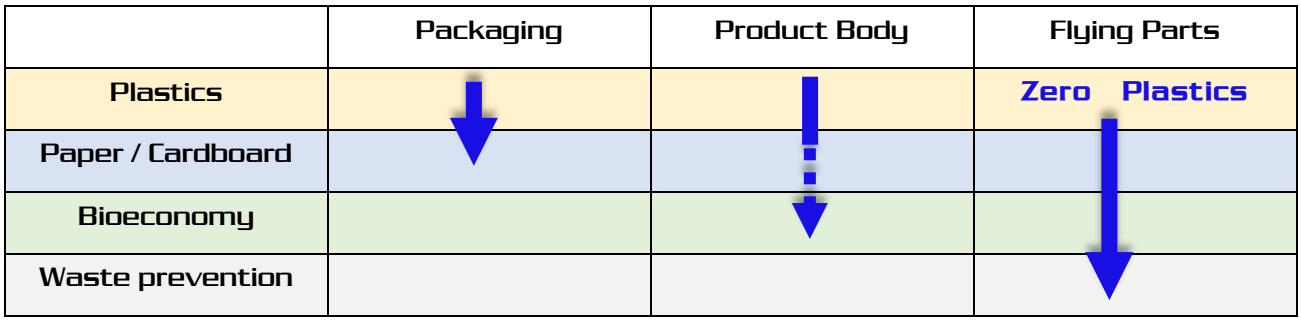


Figure 6: Strategy for circular economy aspects under the Green Deal Initiative

Packaging materials are polymers/plastics or paper/cardboard. The strategy clearly defines a first goal by transforming plastic packaging materials into paper-based ones. Renewable resources must be the basis to rely on. This is in line with the EU’s plastics strategy to support the protection of our environment, to reduce littering, greenhouse gas emissions and the dependence on fossil materials. The goals of the single-use-plastics directive is adopted [15].

One barrier is the knowledge gap on recycling efficiency. This efficiency is an individual aspect for each member state because recycling is not harmonized. The most important legal basis is the Directive 2008/98/EC (so-called waste framework Directive, WFD). The WFD is only a directive. Therefore, EuFiAs members work closely with disposal associations to close the knowledge gap.

- Is the resourcing efficiency of plastic packaging or paper packaging the more effective one?
- Is the recycling rate of plastics or paper the better one?

The long-term goal is to switch to renewable packaging materials. On a short-term basis, plastics can potentially stay in use in certain cases as packaging materials due to better recycling efficiency.

Product bodies can be contaminated with smoke residues. Not all Member States are able to dispose of such bodies, especially for recycling purposes under a circular economy. A further argument rises to cooperate with disposal associations. If plastics are easier to clean and therefore available for recycling, plastic product bodies can stay available on a short-term basis.

Additionally, safety aspects must be considered. Applications exist that rely on the resistance of plastics. Usual paper products are not appropriate as a substitution. The motor of a rocket is the prime example when it comes to safety based on plastics application. Special developments become necessary.

There is a particular challenge for display shows. Resistance to rain must be always given. This is often done with foils made from aluminium or plastic. Modern alternatives are planned to be subject for R&D next to product-related aspects.

Since users of fireworks sometimes celebrate in public and do not dispose of used articles, plastics are left over. This is not intended by EuFiAs members. Therefore, developments for innovative product body parts can go beyond cardboards and consider biodegradable or compostable materials. Simultaneously, the high ratio of recycled paper used for fireworks can be maximized. Raising awareness in public and education about how to deal with fireworks waste complements our strategy.

LCAs for all materials are necessary to define a harmonized long-term strategy. Since “the Commission will propose measures to ensure that all packaging in the EU is reusable or recyclable by 2030” [16], this is our contribution to sustainability efforts.

During all future phases, EuFiAs and its members will consider the waste hierarchy as introduced by the WFD (see Figure 7) [17]. Disposal is not an option at all. Prevention is always the method of choice. Forcing no plastics in flying parts is the first step to prevent waste generation and to prevent the exposure of the environment. Packaging materials can be well-prepared for re-use. Product bodies, especially when contaminated, could be recycled. If contaminants by combustion products hinder recycling in some Member States, recovery is the absolute minimum for the moment.

Figure 7: Waste hierarchy according to the Waste Framework Directive [18]

Special applications will be identified that may not be suitable for “classical circular aspects”. It is widely accepted, that there are two cycles today: “Classical circular economy” is more for “technical nutrients”. However, the term can be used more broadly, and biological nutrients could be covered. This part is often related to “bioeconomy”. Cases, technical nutrients are less important. Biological nutrients are the focus. Numerous biological materials exist that can be used in fireworks. There are either cascades planned to achieve high efficiency on the bioeconomy side or biochemical feedstocks are used. Circular economy and bioeconomy can be regarded as complementary and separate cycles as illustrated for the respective nutrients by the butterfly diagram in Figure 8.

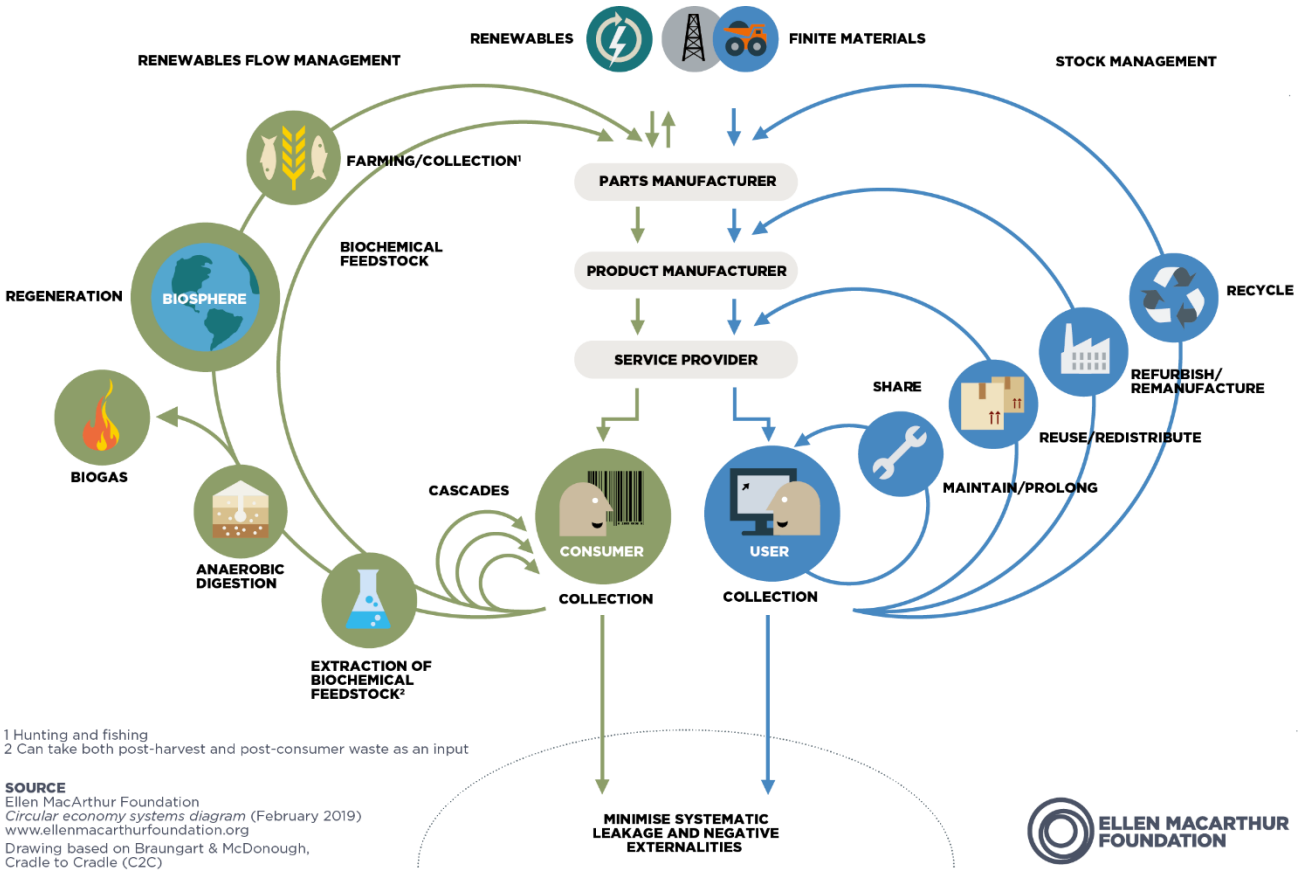


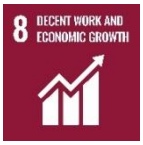
Figure 8: The butterfly diagram that visualizes nutrients for circular economies [19]

Circular Economy is the most sophisticated field of the GDI. Introducing the circular economy mindset is a first step in all Member States. Waste must be considered as raw materials. This method helps to ensure more sustainable, more environmentally respectful production processes and life cycles. One of the most important tools will be the LCA. There are important combinations to assess, in analogy to Figure 6.

a) Polymers as product components or bodies (see right cycle in Figure 8)
b) Polymers as packaging material (see right cycle in Figure 8)
c) Paper as product components or bodies (see right cycle in Figure 8)
d) Paper as packaging material (see right cycle in Figure 8)
e) Bio-based or renewable materials for body parts (see left cycle in Figure 8)
f) Composite materials as packaging material (see right cycle in Figure 8)

The option with the highest possible recycling rate while using a minimum energy demand will define the long-term solution. Bio-based materials and composites are special cases. Bio-based materials because they are part of the bioeconomy cycle and composites because they are a challenging aspect during recycling. On one hand, the potential that composites end up for recovery or even disposal (see Figure 7) is high which is a drawback. On the other hand, reinforced packaging materials provide higher mechanical stability, and less packaging material must be used, i.e. CO_2 emissions during transport are significantly reduced. The PCF will be minimized. Introduction of natural resources in the fireworks cycle are alternative assessments to extend the scope of our sustainability roadmap. Our aim is to decouple the economic growth from waste generation due to the use of fireworks. (Compare recent news on this strategy [20]). EuFiAs members and related operating companies will contribute to the SDGs in the following way:

Less microplastic, less environmental impact, better well-being (e.g., drinking water) (However, the highest impact is achieved by prevention related to flying parts, see microplastics chapter).



Responsible use of natural resources for packaging and body parts.

Forcing a sustainable growth and secure jobs in the pyrotechnic industry.

Waste from fireworks is intended to be raw material for new goods.

Sustainable fireworks must become the norm in the EU.

By preventing waste, a significant contribution is made to SDG11, especially via the SDG target 11.6. Since consumers and professionals celebrate with fireworks and cities officially order fireworks displays, the adverse per capita environmental impact of cities has improved. Waste management is the central tool. The corresponding indicator is 11.6.1; hence, the proportion of municipal solid waste that is collected

and managed in controlled facilities compared to the total municipal waste generated will receive help from circular economy.

The operating companies of EuFiAs members can change the design of products based on this roadmap. A sustainable consumption is a consequence. The SDG target 12.5 will receive help from novel developments. Waste is reduced tremendously through prevention, reduction, recycling, and reuse.

Less components and less fossil-based materials (plastics) result in decreased CO_2 emissions during the life cycle of fireworks. Therefore, there is a contribution to climate neutrality.

Less waste leads to less littering, less plastics in the environment lead to less microplastic. Biodiversity is a sensitive field related to microplastics.

Less waste leads to less littering, less plastics in the environment lead to less microplastic and less environmental impact.

Table 4: Statement of Intent (SoI) concerning circular economy.

Life Cycle / Value Chain	**Strategy and actions**
Design / Product components	Use and produce product parts with and from recycled materials. Zero-plastics approach for flying parts. Stop using non-recyclable materials for product components. Avoid processes that block recycling; Ban the use of (current, i.e. non-biodegradable) moulded cakes.
Research & Development	Performing LCAs for each material selected during development. R&D projects related to new raw materials.
Raw Materials	Waste = Raw materials Use more bio-based raw materials.
Production	Auxiliary materials during production are collected and re-used (e.g., distillation of solvents).
Transport	No one-way plastics for fixation during transportation.
Packaging	Use 100% recyclable materials for packaging. Stop using non-recyclable materials for packaging. Stop using plastics for packaging.
Disposal	Waste = Raw materials. Act according to the waste hierarchy. Disposal is not an option. When recycling is not possible, recover the residuals.
Use	By definitions, flying parts are lost, and are not returned to circulation. Inform the user on recycling and compostable components. Intensive PR that we care. Feasibility study on a kind of deposit system (open R&D).

b. Pollution related to Fireworks

B1: Microplastics

The effort for minimizing and preventing microplastics complements our circular economy actions. The biggest challenge is to apply biodegradable or compostable materials. This is due to recent developments. The framework related to such materials has just been set up [21]. Terms like “biodegradability” are often misused and must be understood and applied correctly [22].

For this purpose, it is particularly useful to evaluate the origins of fireworks. There is a huge tradition and a long history. Plastics were not known during the beginning. Natural resources were important. If we can rely on such resources again and prove traditional ways to be important, microplastic production from materials ending up in the environment will be mitigated. This also applies for auxiliary materials like foils made from aluminium or plastic to protect professional fireworks during display shows. Modern alternatives are planned to be subject for R&D next to product-related aspects.

The distinction that has been made for circular economy (packaging/product components/flying parts) directly applies to microplastics as well. We will address “flying parts” since the impact on sustainability is higher in the other two categories when solved by circular economy solutions.

This way, we will contribute to the policy area of “eliminating pollution - Measures to cut pollution rapidly and efficiently” under the European Green Deal and the action “environment and oceans” will benefit directly from our efforts. Applying a wider perspective, the relevant SDGs are:

SDG 3	**SDG 6**	**SDG 14**	**SDG 15**
Good health and well-being	Clean water and sanitation	Life below water	Life on land
			

Microplastics can be produced by fireworks in two ways. There is a direct emission, when polymers in certain particle sizes are emitted by using fireworks to the environment (minor way). In addition, there is an indirect pollution (major way). This is due to debris of fireworks components that are made from plastics, such as the tips of a rocket. Microplastic pollution is commonly regarded to impact at least twelve SDGs - directly or indirectly [23].

Fireworks are used as an exemplary potential application for biodegradable plastics according to SAPEA [13]. The group of chief scientific advisors to the EC adopted this opinion. However, the biggest challenge will be the wide variety of the environments for fireworks debris. This is a contrast to other potential applications like mulch films, where the range of relevant environments for end-of-life biodegradation can be well estimated [13].

Our solution to avoid microplastics is to prevent flying components in accordance with the waste hierarchy of the WFD [18]. If this is not possible, we will apply validated standards for biodegradable

and compostable materials. Due to the variation in the environment and the lack of official standards, novel developments are not yet on the market. Materials could be certified per EN 13432:2000-12. However, the basis is an industrial composting. Such a certification is not valid for composting in the open environment. Official standards are necessary; hence, EuFiAs, its members and their operating companies appreciate the new framework in the EU which can be seen as a first important step [21].

By avoiding microplastics, we avoid a negative impact on human health (e.g., via contamination of food from local farms). Therefore, we contribute substantially to reduce the number of deaths and illnesses from water and soil pollution and contamination (SDG target 3.9).

Like our contribution to SDG target 3.9, avoiding microplastics means less contamination of drinking water. Since microplastics do not only affect the human health that way, but have an impact on biodiversity, SDG target 6.3 is supported. Water quality will be improved by reducing pollution. The indicator 6.3.2 can be used to evaluate the impact via a proportion of water with good ambient water quality.

No microplastics result in a protection of the life below water. The SDG target 14.1 is important because a significant reduction for marine pollution of all kinds is the goal. The corresponding indicator 14.1.1 highlights plastic debris density.

Multiple negative impacts on terrestrial ecosystems due to microplastics are known. Avoiding such emissions leads to a direct improvement and more sustainable fireworks.

Legal issues, like a German court case [24], based on European standards, demonstrate that premature solutions are no solution. The GDI raise awareness within OCs, knowledge was increased, and actions were discussed. As one example in April 2021, a new process has been introduced that is claimed to “make ‘biodegradable’ plastics truly compostable” [25]. Such work is followed closely and R&D activities in each member state are evaluating promising alternatives to conventional plastics from fossil fuels.

In conclusion, Table 5 summarizes what is important to avoid microplastics.

Table 5: Statement of Intent (SoI) concerning microplastics.

Life Cycle / Value Chain	
Design / Product components	Consider materials that do not create microplastics.
Raw Materials	Choose suppliers that use modern production processes and materials to minimize pollution by microplastics. Circularity (see 2 a.) helps to decrease pollution (e.g., using recycled polymers). Bio-economical approaches can be applied.
Production	Define production processes that lead to less pollution.
Transport	Choose transport ways that minimizes pollution.
Packaging	Consider materials that can be easily recycled or that have no risk of creating microplastics.
Use	Ban use of all plastics that generate micro-plastics. Minimize particulate matter emissions.

B2: Influence of fireworks on air quality

Combustion processes produce particulate matter (PM). Clean air is one field within the Green Deal policy area “Eliminating pollution.” A review of air quality standards in line with the World Health Organization (WHO) guidelines is already fixed and the WHO limits are lower than the EU ones [26]. Most important is so-called ‘fine particulate matter’ ($PM_{2.5}$). $PM_{2.5}$ means particles with an aerodynamic diameter equal to or less than 2,5 micrometres (µm) [27]. In addition, several statistics and authorities refer to particles with an aerodynamic diameter equal to or less than 10 µm.

EuFiAs supports this field with academic approaches. The German member of EuFiAs introduced, in agreement with the German Environment Agency (Umweltbundesamt – UBA), a novel methodology for emission reporting: 42,5 kg PM_{10} instead of 99,92 kg PM_{10} per t gross weight is a tremendous correction [28]. This approach was the first of three subsequent phases: First, quantification of emissions. Second, careful evaluation of raw materials and their combustion behaviour. Start of research projects. Third, development of novel approaches to minimize PM emissions and introduction to the market of fireworks.

Relation to the European Green Deal

The topic of air quality and particulate matter emissions is related to the action “environment and oceans”. Especially the Zero Pollution Action Plan (ZPAP) is important since particulate matter is a strictly regulated air pollutant [29]. Emissions from fireworks can be influenced via applied substances and mixtures, the so-called pyrotechnic compositions. Therefore, the chemicals strategy for sustainability (CSS) is of relevance. In addition, the 8th Environment Action Programme (8th EAP) will guide European environmental policy until 2030 [30]. Air and air quality are related topics.

It is particularly important to understand the interplay with the EU’s ZPAP. As an example, key targets for 2030’s air quality are established [31]. One key target is the reduction of the number of deaths caused by air pollution by 55%. In an overall assessment, fireworks are no major source of emissions due to several beneficial factors, like time-limited use. By improving fireworks, we actively contribute to this key target. Our sector quantifies particulate matter emissions and supports national environ-

mental agencies in terms of national emissions reduction goals. Since combustion processes naturally produce PM, we have a high interest to clarify often misunderstood facts, support research institutes, identify open R&D challenges, improve our products and correct emission factors.

Relation to the UN Sustainable Development Goals (SDGs):

The topic of air quality and particulate matter emissions is related to four SDGs. Emissions influence air quality. Particulate matter emissions can influence the human health. Air pollution poses a major threat to human health (see SDG 3). It is linked to respiratory infections and cardiovascular diseases. It causes increases in population morbidity and mortality. Fireworks are not a significant origin of those consequences from poor air quality, especially due to their short-term character.

However, Research and Development (R&D) is going on in different fields. The pyrotechnic compositions used in fireworks have changed over the past decades. R&D will continue to change the integral mixtures in fireworks due to the reduction of particulate matter. Such an innovative approach takes time. Funding opportunities are exceedingly rare in the field of air quality. Some fundings are reserved for authorities, cities and communities, e.g., to improve their air quality plans. Such cities and communities celebrate unique occasions using firework displays. By making those displays more sustainable, we actively contribute to sustainable cities and communities. Our sector has continuously worked on standardization. Although the consumption of fireworks has grown from 1990 to 2010, a plateau has been reached during the past years. Our industry appreciates a restrained use of fireworks, making the scattered occasions to use fireworks unique. Responsible consumption is an especially important SDG in this context.

SDG 3	**SDG 9**	**SDG 11**	**SDG 12**
Good health and well-being	Industry, innovation and infrastructure	Sustainable cities and communities	Responsible consumption and production
			

In line with one key target of the ZPAP to reduce the number of deaths caused by air pollution, there is a target (3.9) that aims to substantially reduce the number of deaths and illnesses caused by hazardous chemicals and air pollution by 2030. The mortality rate attributed to household and ambient air pollution is seen as an indicator (3.9.1). Although the overall PM emissions from fireworks throughout the EU are incredibly low and it is a short-term event, we will contribute by reducing PM emissions. Innovative ways are needed. Therefore, making ourselves and our products sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes by 2030 (target 9.4), is a clear focus. However, the indicator on UN SDG level is very much limited to CO_2, although the effect can be measured by other factors, such as PM emissions. Enhancement of research to encourage such innovations is one UN target (9.5). It is measured via indicators 9.5.1 and 9.5.2, researchers in full-time equivalent per million

inhabitants. A similar approach can be used for our sector, following academic employees and research cooperations throughout the EuFiAs members. This way, EuFiAs is not aiming on solutions for individual companies. Most economic actors are depending on fireworks from China. Target 9.b aims to support domestic technology development, research and innovation in developing countries, such as China. Transferring R&D results and knowhow to China will improve the whole EU market. Indicator 9.b.1 can be used for this purpose. The proportion of medium and high-tech industry could be increased in the value chains. After successful R&D the amount of PM reduced fireworks can be measured by the mean levels of $PM_{2.5}$ and PM_{10} induced during occasions of use, such as New Year's Eve or federal holidays. Those levels should decrease over the upcoming years. UN indicator 11.6.2 follows a similar approach by measuring the annual mean levels of particulate matter in cities (population weighted). Concentrations of $PM_{2.5}$ are typically used, often accompanied with PM_{10}. The associated UN target (11.6) aims to reduce the adverse per capita environmental impact of cities, including special attention to air quality.

The current state on air quality and fireworks

Fireworks do influence air quality. Especially at special occasions like New Year's Eve, Guy Fawkes night or other national day's festivities, bigger amounts of fireworks are used. Consequently, air quality can be reduced. The degree of reduction depends on weather conditions and is locally and prompt limited. An overall approach, also applicable for display shows is to reduce the number of explosives used inside fireworks. When the net explosive content (NEC) per show can be reduced, less material burns and influence air quality.

Beyond particulate matter – Toxic emissions

Particulate matter emissions primarily reduce air quality by its particulate character. However, some combustion products may be formed which can be harmful to the environment due to their chemical nature. Therefore, this chapter is part of the pollution chapter within our roadmap.

Our members are often confronted with "metal-organic compounds", "heavy metals" or "metallic poisons". Such compounds and therefore fireworks in general are regarded by detractors as "toxic". It must be pointed out, that various substances are not allowed to be used in fireworks for the EU market. This includes pure substances like hexachlorobenzene, lead compounds, arsenic compounds or picrates and certain mixtures, such as chlorates with metals.

Target 12.4 - By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, following agreed international frameworks, and significantly reduce their release to air, water and soil to minimize their adverse impacts on human health and the environment.

Indicator 12.4.1 - Number of Parties to international multilateral environmental agreements on hazardous, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement.

Beyond particulate matter – Gaseous emissions

The use of fireworks not only produces particulate emissions. Gaseous emissions are formed as well. Major combustion gases are carbon dioxide (CO_2), water (H_2O) and nitrogen (N2). Often reported production of sulphur dioxide (SO_2) and nitrogen oxides (NO_2), as pollutants that cause acid rain, is negligible. This can be derived from air quality measurements throughout the EU.

Our way to move forward

The impact on the reduction of particulate matter can be increased via fireworks that are produced within the EU. Imported goods are more cost-effective but often rely on traditional pyrotechnic compositions. Working on novel pyrotechnic compositions and transferring the new knowledge to China is the right way towards sustainable fireworks. European citizens can be protected from high PM concentrations and the environment will benefit from this approach. A first step is the quantification of emissions. Second, careful evaluation of raw materials and their combustion behaviour is necessary. Third, novel approaches to minimize particulate matter emissions must be investigated.

In relation to display shows, there is no competition foreseen from the pyrotechnic industry between fireworks and other kinds of shows. Each kind of art has its unique strength. Combining different technologies, such as drone shows and fireworks, is a huge benefit for everyone, the operator, the audience, the environment. In addition, focus on the show setting is of increasing importance. Providing an aesthetic show that emphasizes different technologies and describes a clear story will become more important than just firing beautiful shells in the air.

Future contribution to the SDGs

Reduction of particulate matter to improve human health
Consider SDG target 3.9: “By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination” and the corresponding indicator 3.9.1: “Mortality rate attributed to household and ambient air pollution”.

Consider SDG target 9.5: “Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, […]”

Contribution to national emissions reduction programmes
Consider SDG target 11.6: “By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management” and the corresponding indicator 11.6.2: “Annual mean levels of fine particulate matter (e.g., PM2.5 and PM10) in cities (population weighted)”

Consume with care - Responsible production and consumption will reduce emissions

In conclusion, Table 6 summarizes our activities to limit pollution by fireworks.

Table 6: Statement of Intent (SoI) concerning the elimination of pollution

Life Cycle / Value Chain	
Design / Product components	Consider concentration limits of certain substances and even ban substances (e.g., Substitute It Now-List). Design articles that emit less particulate matter but feature more gaseous combustion products.
Raw Materials	Choose suppliers that use modern production processes leading to less pollution. Circularity (see 2 a.) helps to decrease pollution (e.g., using recycled polymers). Bio-economical approaches can be applied.
Production	Define production processes that lead to less pollution.
Transport	Choose transport ways that lead to least pollution (related to air quality, not to CO_2).
Packaging	Consider concentration limits of certain substances and even ban substances (e.g., Substitute It Now-List).

B3: Impact of noise produced by fireworks.

Noise affects the fauna in general, but especially habitats of animals and pets. There are naturally opposing situations: On one hand, the traditional character of fireworks in terms of sound and on the other hand the necessity to avoid disturbing wildlife and pets. Therefore, EC introduced a maximum sound pressure level of 120 dB(AI). We must carefully assess the noise introduced by fireworks with certain measurement techniques. There can be an influence on biodiversity if there is a regular place for celebrations with fireworks. We will take measures to protect our ecosystem.

1. Relevant Green Deal Action: **Environment and oceans**

2. Relevant Sustainable Development Goal(s) (SDGs):

SDG 3	**SDG 15**	**SDG 16**
Good health and well-being	Life on land	Peace, justice and strong institutions

Our most promising measure will be the fight against illegal products and illegal sales. Since many of those products use flash powder, 120 dB(AI) are easily exceeded. There is not only the hard limit of the sound pressure level, furthermore restricting limits on the mass of flash powder exists in legislation and standards, interacting with transport regulations. Therefore, first joint campaigns of institutions for animal protection and actors of the pyrotechnic industry take place (example from Austria). A proper quality assurance performed by operating companies of EuFiAs members strengthen the existing noise limits and protect animals. In addition, pyrotechnicians are also putting in place methods to ensure that animals are warned before shows (daylight firing during set-up) or apply measures to keep animals away from the show area.

Many of the critical products are categorized as P1. This is an issue identified by EC and to be solved by the industry and notified bodies (NBs). Guidelines exist and the new standardization request from the commission refers to this issue as well. EuFiAs members support this process to prevent animals from being affected by P1 items in consumer hands.

Solution: Cooperation with strong partners to evaluate short-term influence of noise. Eventually limit noise or the use of some generic types or compositions under certain conditions.

: Evaluate the impact of noise on the human ear and eventually define measures.

: Protect wildlife, protect habitats, reverse the degradation of ecosystems, recommend measures.

: Limiting noise = to pull the carpet from under persons who misuse fireworks

In conclusion, Table 7 summarizes our activities related to the sound of fireworks.

Table 7: Statement of Intent (SoI) concerning noise

Life Cycle / Value Chain	**Intention**
Design / Product components	Consider the application of flash composition. Design articles that produce less noise.
Use	Ban the use of flash powder or the use of some generic types in certain areas. Limit the maximum quantity of flash powder. Introduce further protection areas. PR how to use fireworks correctly. Importance of safety distances.

c. Climate Change

The burning of fireworks produces CO_2. Therefore, the Green Deal policy area of Climate action for making the EU climate neutral by 2050 is very important. The quantification of greenhouse gases (GHG) is always a first step and can be performed using carbon footprints [32]. Developing emission reduction targets is a common second step [32,33]. Certain actions to implement reductions, such as investing in climate projects or reforestation can be a third and a key step. Compensational measures to reach climate neutrality by 2030 is a potential last step for residual GHG emissions.

For this purpose, it is again useful to evaluate the origins of fireworks. Since plastics were not known during the beginning, natural resources were important. If we can rely on such resources again, fireworks are getting more and more independent from fossil resources.

Relevant Green Deal Action: **Climate**

Relevant Sustainable Development Goal(s) (SDGs):

SDG 8	**SDG 9**	**SDG 12**	**SDG 13**
Decent work and economic growth	Industry, Innovation and Infrastructure	Responsible consumption and production	Climate action
Focus: economic growth	Focus: Industry and Innovation	Focus: Responsible production	Focus: Compensation
			

Corresponding Challenge: Fireworks are responsible for emissions of GHG. The most dominant GHG related to fireworks is carbon dioxide (CO_2). Other GHG, as defined in the Kyoto Protocol [34], like methane (CH_4), hydrofluorocarbons (HFCs) are of little or no importance. CO_2 is emitted during distinct stages of the life cycle of fireworks, from its production over transport to the use. Therefore, it makes sense to calculate a “Product Carbon Footprint” (PCF), at best a so-called “cradle-to-grave PCF” [35].

a. CO_2 due to raw materials: Raw materials are typically produced outside our sector. As part of the fireworks’ value chain, we must account for the CO_2 emitted, but there is no opportunity to influence production processes. The selection of proper and serious partners who care for climate issues is the key.

b. CO_2 due to production: Raw materials are mixed to pyrotechnic compositions. Pyrotechnic compositions are incorporated in fireworks. Improved production processes and close collaboration with international producers support our ambitions for climate action.
c. Transport: A part of the European fireworks will be produced inside the EU. Therefore, less transport is necessary. Imported goods will benefit from improved logistics, leading to short distances and best transport conditions.
d. Distribution: Can be either seen as part of c. or further improved via appropriate storage distances as well as improved route planning and modern trucks.
e. Using fireworks: The burning of fireworks leads to negligible amounts of CO_2. There is a "competition" with particulate matter since the carbon inside the pyrotechnic compositions either is involved in CO_2 formation during combustion or in the formation of potassium carbonate or comparable salts.

Solution: Act according to effective standards, quantification of CO_2, setting reduction targets and compensational measures to be climate neutral by 2030.

Produce regional, less transport, decouple growth from CO_2 emissions.

Consider the SDG target 9.4: "By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities" and the corresponding indicator: "9.4.1 CO_2 emission per unit of value added".

Exchange on production conditions and care for raw material sources, avoid plastic packaging (interaction/reference to explicit sub-chapter of the roadmap)

Calculation of amount of CO_2 during burning, calculation of PCF, Compensation of CO_2. Consider the SDG target: "Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning".

We support the SDGs and follow acknowledged standards. Typically, different so-called scopes are introduced. Scope 1 describes direct GHG emissions, e.g., emitted during quality inspection of fireworks. Scope 2 describes GHG emissions due to purchased electricity, steam, and heating/cooling. Therefore, scope 2 emissions are very much related to the facilities of OCs [36]. The first optional but often considered scope is scope 3. It accounts for all other indirect emissions related to fireworks. Companies are responsible for such emissions, but they stem from sources not owned or controlled

by the company [36]. Using black powder in rocket engines is a prime example for scope 3 because the production of black powder leads to GHG emissions, but they are not directly related to the producer of rockets (not scope 1) and not related to the energy consumed (not scope 2). Scope 3 emissions are often the largest quantity of emissions for companies [37]. Therefore, their biggest reduction opportunities are often related to scope 3 emissions. A visualization of the above-mentioned overview is perfectly made by the GHG protocol team (World Resources Institute, WRI and the WBCSD) and can be seen in Figure 9.

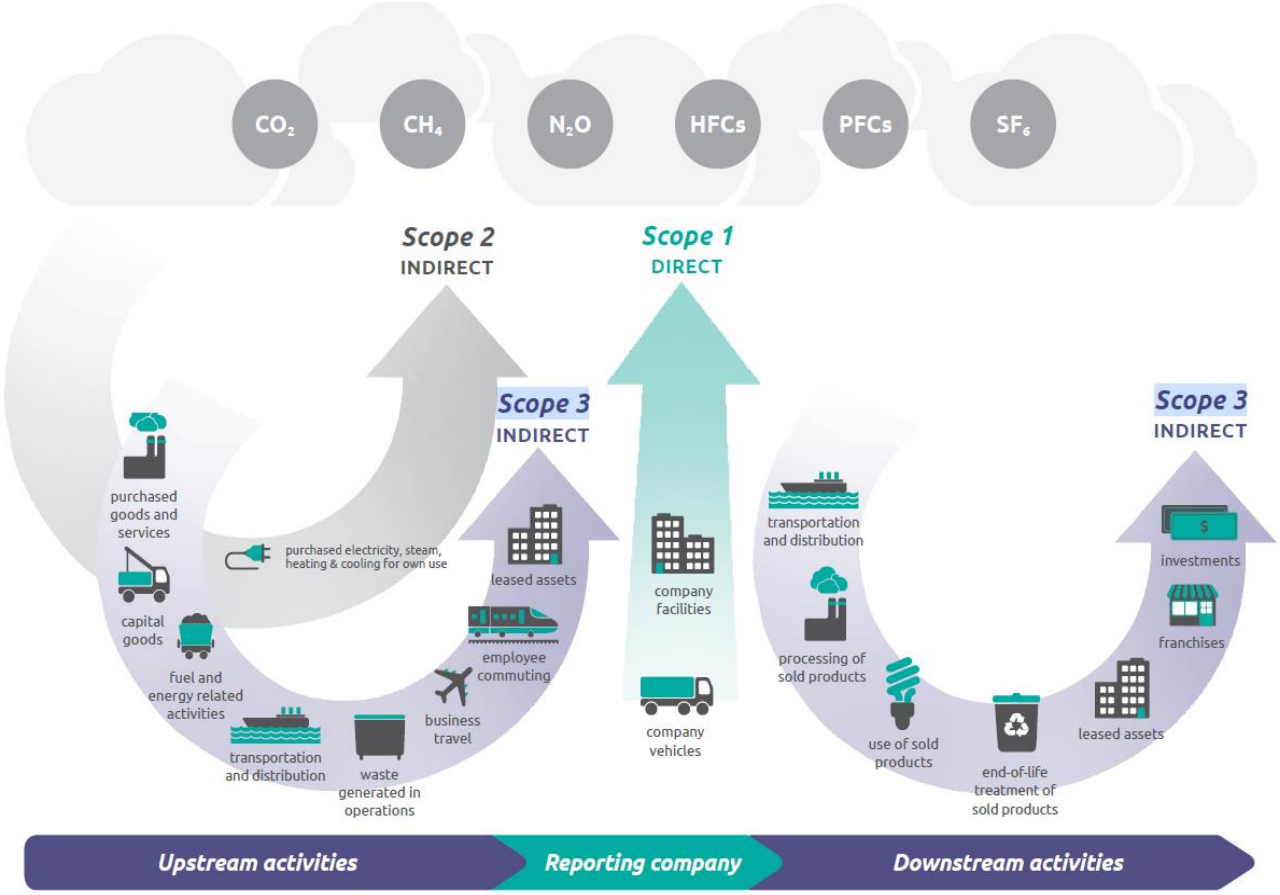


Figure 9: Overview of GHG Protocol scopes and emissions across the value chain [37]

In addition to the three commonly used scopes, scope 4 is a concept that has been introduced by the WRI in 2013 [38]. The WRI defines scope 4 as “emission reductions that occur outside of a product’s life cycle or value chain, but as a result of the use of that product” [39]. Concerning fireworks, a ban on the use of fireworks by consumers is discussed from time to time. Sometimes these discussions are accompanied by the request to perform central displays in cities instead of consumers. If this happens, scope 4 emissions would be increased due to the high traffic volume for people getting to each display.

In conclusion, Table 8 summarizes our activities related to climate change.

Table 8: Statement of Intent (SoI) concerning climate action

Life Cycle / Value Chain	
Management	Use compensational measures for GHG emitted during the life cycle of a pyrotechnic article. Implement organizational processes that emit zero greenhouse gases (electric company cars, photovoltaics, …).
Design / Product components	Design fireworks that use components from renewable carbon sources.
Raw Materials	Choose raw materials that stem from renewable carbon sources.
Production	Strengthen and extend the production of fireworks in the EU. Perform measures to minimize GHG during production.
Transport	Choose transportation methods that emit least greenhouse gases. Improve distribution and storage.
Packaging	Use novel packaging materials that stem from renewable carbon sources.
Storage	Define smart kinds of logistics and palletizing, enforce digitalization.
Disposal	Less waste, less burning, less greenhouse gases.

d. Special Topics beyond the European Green Deal

There are neither European Green Deal policy areas nor Green Deal actions related to the following topics. However, these social fields of action are essential for our businesses. SDGs are associated:

SDG 3	SDG 8	SDG 9	SDG 11	SDG 12
Good health and well-being	Decent work and economic growth	Industry, Innovation and Infrastructure	Sustainable cities and communities	Responsible consumption and production

D1: Enhancing safety – measures against misuse.

Consumer fireworks (Cat. F1 to F3) are enjoyed responsibly by millions of people all over Europe and the UK every year. They can be used to celebrate all kinds of occasions, but they are primarily used to celebrate National Days and New Year's Eve. Specific regulations apply to the trade period, composition and load of consumer firework articles to limit the risks for the public and the environment.

One major issue that negatively affects the reputation of fireworks is misuse. All EuFiAs members intensively work on prevention and closely cooperate with national authorities. In addition, EuFiAs members actively contribute to further legislative developments like the measures on other pyrotechnic articles, classified as P1, but used for "entertainment purposes", e.g., at New Year's Eve.

Unfortunately, a small minority of people use fireworks irresponsibly and cause serious nuisance within their local communities. An even smaller minority sometimes misuse fireworks as a kind of weapons to harass and injure other individuals, especially persons from emergency services, firefighter brigades and the police. This anti-social behaviour involving fireworks ranges from fireworks being set off without allowance with no regard for the noise pollution caused by this, to deliberate physical harm, or threat of harm, caused to people, animals and properties.

Some member states have more problems than others, which could be seen as the anti-social behaviour of a specific group of people and may also be a sign of deeper social issues within the country that make this type of people fight against the social order. Another group of people just function as hooligans without any reasons behind. The most extreme group of people are the criminals which (mis)use illegal products for attacks on ATMs or for other public threats.

Fireworks of the categories F1 to F3 may be the only items where consumers are allowed to handle "explosives". Since consumers can obviously use, store and transport fireworks the wrong way, there is a potential for damages and injuries. Accordingly, the single member-state has set up rules for

permitted generic types and categories, storage at the point of sale, selling, minimum age for purchase, limitations for use and further situations. There is no harmonization on EU-level for those topics by purpose. The single member state is allowed/encouraged to set-up those rules based on history and tradition. Having this in mind, regulations will not change and harmonize. As much of the "fireworks legislation" is based on traditions, good feelings and emotions, there is no common denominator for usage/allowed periods. Even age limits or the allowance for use of category F3 differ from Member State to Member State. However, the basic principle and motivation for misuse are comparable throughout the consumers and money-oriented retailers. A closer look on specific markets and value chains helps to understand the topic of misuse.

Besides the misuse with approved and allowed articles in the specific market the misuse will also be created using illegal articles. This includes the illegal trade (selling/buying) and illegal use (possessing and/or igniting fireworks) under the specific national legislation. Although there are exciting legal articles available in the categories F1 to F3 there is inexplicably specific demand for more "exciting and dangerous firework" among the general population and more specific among adolescents. The most often met illegal firework items that are often being misused by public for entertainment purposes are sound emitters, flash bangers and other professional fireworks, e.g., shells (category F4) which contain immensely powerful flash composition.

The firework sector, like other retail markets, has set up an extensive online retail presence making it possible for EU consumers to buy fireworks and other pyrotechnic articles from online shops based physically in the Member State or across the border in other EU Member States. Former EU studies from 2016 and 2019 show that fireworks, especially F4 fireworks were entering the hands of the public via web/online-sales channels. This phenomenon can also be found for P1 sound emitters which will be sold illegally as fireworks articles instead of CE-approved articles for technical or other specific intended use.

From the latest information the illegal trade of fireworks/pyrotechnics today already starts from low-level local traders to high-level international traders, incl. the ability to launder money and own companies and storage facilities. It was found that the market for fireworks, especially professional fireworks, is partly criminalized by high professional criminals behind it. This also bears a disadvantage for legal traders and heavily damages the reputation of the entire fireworks industry.

Denmark, as a first example, enjoys a very liberal approach as per selling and usage of fireworks in categories F1 to F3. The rules are as follows:

- Deliveries to the points of sale can start 24th November.
- Selling to the public can start 15th December.
- Usage can start 27th December.
- Surplus must be delivered back latest 01st February.

These rules exist because Danish people use a substantial quantity of fireworks – and can avoid a "bottle neck". This applies not only to economic aspects, but safety issues can also be limited that way. Dangerous situations are prevented. Being liberal on the distribution and selling on one hand, lead to stricter allowances of generic types and categories on the other hand in Denmark. Accordingly, Danes travel to Germany to buy bangers or even to Poland to buy flash bangers. At the same time, German people travel to Denmark to buy rockets or batteries, because Germany only allows 20 g NEC and prohibits F3 batteries.

The situation of incidents on authorities and emergency personnel is even worse. Although it is only a ridiculously small minority who abuse fireworks (primarily Roman candles and batteries) that way, such situations are becoming increasingly common and are not restricted to Denmark. New Year's Eve 2022 to 2023 in Berlin was a horrible night for police officers, medical support, emergency vehicles and firefighters. Regardless of the danger they expose other people to, we aim to take measures to prevent such incidents.

Flash bangers are both for own use and resale. Therefore, consumers and retailers are of concern when it comes to misuse. The mark-up is extremely high – the risk to be caught limited. For such criminal activity, the penalty appears not adjusted to the potential damage and injury. Unfortunately, the access to "explosives" is too much of a temptation for some people to act in a reason-based approach and they want to show off jeopardizing the safety of other people. Lately we have experienced a substantial import of fireworks which indeed possess a risk of serious personal injuries i.e., loss of sight, hands and/or arms and so on. Such items are often imported in bigger amounts via online sales and even social media. Further distribution happens in smaller groups, often related to social media groups (such as telegram groups). The police experiences substantial challenges to investigate as the groups are only active for a few days and then re-open under a new name. An estimation for Denmark showed that more than one million F3 flash bangers were distributed on the Danish market in season 2021. They are predominantly (illegally) imported from Poland. Display shells, batteries and Roman candles with large diameters and huge NEC, all of them usually regarded as F4 fireworks, complete the list of illegal imports. Authorities seem to be facing the same challenges across the EU – i.e., intentional misuse of legal/illegal fireworks causing dangerous situations for authorities and emergency personnel. It appears that there is no natural limitation to which articles will be used for such attacks. There seems little or no respect for the energy contained in such items and no knowledge/respect of the damages/injuries they can cause. If F4/some F3 articles are accessible online in poorly enforced shops, the internal market has a problem.

The UK, as a second example, has been trying for many years to combat the misuse of fireworks by irresponsible individuals (initially: hooligans) who year after year seem determined to cause misery and upset to the law-abiding public. Approximately 20 years ago bangers and air bombs were banned in the UK due to their misuse by the hooligans, this ban was instigated by the industry! This action vastly reduced the number of reported injuries to such an extent that in 2005 the Royal Society for

the Prevention of Accidents (RoSPA) stopped recording the number of firework-related injuries and deemed fireworks a safe product. Fireworks are the most heavily legislated product in the UK with some thirteen pieces of legislation.

There have been three Government debates about the safe use and banning of fireworks or stronger legislation for fireworks; these have been brought about by online public petitions. All three debates have ended with the same result, so that the Government has told the firework industry is already heavily legislated with no need for further legislation. The 2019 Westminster enquiry, which heard evidence, in public, from a wide range of stakeholders, including Police, Trading Standards and the Fire Service, concluded that greater restrictions and controls on the sale and use of fireworks would not be appropriate due to the real risk of creating a black market and making matters worse, not better [40]. During this enquiry when questioned about the unintended consequences of greater restrictions on the sale and use of fireworks the National Police Chiefs Council stated [40]: “If a black market became available, it would be even more difficult to police than the situation we currently have, which would be a really unhelpful unintended consequence.”

Also, when asked the National Fire Chiefs Council told that: “I am sure that there would be unintended consequences.” “Whatever threshold and whatever legislation there is, we will always have people trying to evade it and go under the radar. If a total ban was introduced, I am sure it would push the sale of fireworks underground, into a black market.”

Once a supply chain for illegal market fireworks is set up, it will be impossible to close it down. This can be seen from the experience of other countries. The Netherlands and notably the Republic of Ireland, who introduced strict measures over 15 years ago and is now flooded with illegal, untested, dangerous fireworks. Fireworks, some of which were banned in the UK more than 20 years ago!

David Kavanagh, District Officer with Dublin Fire Brigade, says illegal fireworks can have devastating consequences: "We see kids, and adults and young teenagers, with their fingers blown off. Some people their whole arm can be blown off," "Fireworks, because they are illegal in this country, they don't come in with a safety certificate and even though some [people] think they can light them and throw them, sometimes when you light them, they explode straight away. It is terrible to see the devastation that it [a firework] can do to the body.”

In summing up at the end of the third Parliamentary debate, one of the key points raised was education and firework safety campaign. The last safety campaign in the UK was in 2009. As a result, the BFA (British Fireworks Association) decided to be proactive and produced a short video about the safe and considerate use of fireworks: https://vimeo.com/standardfireworks/bfasafetyvideo

The video was deliberately made to target 6 -11-year-olds as it was felt that education of this age bracket was better than trying to educate teenagers who are already playing video / Xbox games often with violent content. The video was shown in several primary schools with a talk by BFA representatives. This approach was well received by the schools and the children, some parents also

attended these sessions. The feedback was incredibly positive; both teachers and parents thought that it was an excellent way to get the safety message across.

Following on from this the video was shown to the government's Office of Product Safety, who went on to use it on their social media sites during the fireworks season, again they received positive feedback. This would suggest that firework safety campaigns should be used instead of further legislation.

Scotland is a third example to have a deeper look at. The Scottish Government has recently introduced new legislation reducing the selling times of fireworks and requiring people to take an online course before they can obtain a licence from the local authority to be able to buy fireworks. We know from the problems in Ireland, where a licence system was introduced for the purchase of fireworks, that this does not work in practice. In 2020, only 500 licenses were applied for out of a population of nearly 2 million. The British Fireworks Association, Police Scotland, the Scottish Fire Service and Trading Standards were strongly represented on the working group before the legislation was put to the Scottish Parliament. All comments from industry, emergency services and enforcement authorities were ignored.

The Chartered Trading Standards Institute told: "If sections of the public who already misuse fireworks are prepared to purchase illegal fireworks, then the safety course will only be of benefit to those safety conscious members of the public who already follow the fireworks' code."

Continuing, the Chartered Trading Standards Institute also said that: "The Northern Ireland experience is that a possession and use licence scheme does not, in itself, prevent the anti-social behaviour of setting fireworks off in public places and using rockets as weapons."

A local enforcing authority told: "We feel this could likely lead to consumers seeking to purchase fireworks online or from 'underground' sources such as unlicensed sellers or 'white vans. This could lead to less traceability of product, unsafe storage, and unsafe product."

The BFA passionately believes that the new legislation in Scotland will encourage 250,000 law-abiding Scots to look elsewhere for fireworks. To look away from legitimate supply channels of safe, tested, and approved fireworks but instead towards the illegal market. A market where products are not subjected to the rigorous safety checks we have in the UK; a market where illegal storage is commonplace and a market where illegal transport puts the safety of the public at risk.

This view is not fiction, it is fact. Recent events in Germany, Austria and the Netherlands have proven the tragic consequences of an illegal market. The illegal market in illegal fireworks created through greater restrictions has been attributed to at least two deaths, something the UK has not suffered from for well over 20 years. However, the UK's low injury rates are no accident, they are a direct result of industry and government working together, and this cooperation is set to continue with Westminster.

Unfortunately, the Scottish government has chosen a different path, despite the numerous warnings.

The unintended consequences of this legislation have been highlighted on many occasions, making them now INTENDED CONSEQUENCES, and therefore will the Scottish Government accept responsibility for the ensuing lawlessness and inevitable injuries?

The British Fireworks Association (BFA) provided ten important recommendations that can be generalized as a 10-Point-Plan to improve firework safety and reduce anti-social behaviour.

1. There should be an annual national safety awareness campaign agreed and funded jointly between industry and government.
2. Enforcement agencies should receive more seasonal funding, to help tackle the growth in illegal fireworks.
3. Enforcement agencies to receive better training in the detection and apprehension of illegal fireworks.
4. The minimum age for buying fireworks in the UK should be raised to 21.
5. Illegal fireworks sold via social media should have their sites taken down immediately.
6. Fines for the sale, possession or use of illegal fireworks should be increased – along with robust minimum sentencing.
7. There should be a central contact point for reporting all firework-related misuse issues.
8. There should be a standardized reporting structure for injuries caused solely by fireworks – to include the cause.
9. Better resources for border control to prevent illegal fireworks entering the country.
10. Tougher sentencing for letting fireworks off in a public place such as streets and shopping arcades. Tougher sentencing for using fireworks as weapons – especially against police officers and other emergency services.

BAN THE HOOLIGAN NOT THE FIREWORKS

Apart from the consumer side, illegal sales are an increasing concern on both authority side and industry side.

For many years there has been much said about the sale of fireworks on social media sites. Many of these have been reported to the authorities, unfortunately in many cases these reports have not been followed up nor have the social media sites been contacted to ask that they block these sales. On the occasions that the social media sites have been contacted they have been somewhat indifferent as to whether they will block the individual or the advert for the sale. The same can be said for various sites on the internet including Amazon although they have now started to remove them if notified.

A quick internet search will soon show where you can buy fireworks delivered by post. It is well known that it is illegal to send fireworks by post or air.

Example 1: One such case was a parcel that was checked by UK Customs at a cargo depot at an airport and contained a large quantity of flash bangers from Poland. These were not packaged or marked as explosives but wrapped in black plastic. When the package was examined, it was found that its intended destination was Eire (Southern Ireland) where they are banned. In Northern Ireland, an import licence is needed for all fireworks, and it is an offence to possess unlicensed fireworks (other than low hazard fireworks, such as party poppers or sparklers), with intent to sell or supply.

Example 2: Whilst checking for sales of illegal fireworks on social media sites (Facebook) by a BFA member it was that a man in Sheffield was advertising flash bangers for sale. He boasted in his post that he had driven a van to Poland to buy the flash bangers and then brought them back to the UK to sell. The picture on his site showed a car boot full of flash bangers and being sold from a petrol station where he worked. The matter was reported to the local Police. After about 30 minutes the local Police contacted the BFA member and asked him what if any offences the man was committing and what was the legislation.

Example 3: A teenage boy was found to be selling illegal fireworks on his Facebook page. The video showed him receiving a parcel from the postal worker. The parcel was wrapped in black plastic and no signs to show that it was containing explosives. The video then showed him opening the parcel revealing the contents with the comment ‘Just arrived, now for sale PM (private message) me for price’. When the teenager was interviewed (16 years old) he admitted that he had ordered the fireworks and tried to sell them. He admitted that he had also used his father’s credit card to make the purchase.

Therefore, EuFiAs promotes a stricter enforcement on online sales. This provides an enormous potential to reduce illegal trading and, consequently, limit misuse.

One of the major challenges we are currently facing is the reluctance of the single Member State to change anything in the national legislation and similarly the non-existing efforts from the EU Commission to secure some harmonization. However, the situation seems to be moving in the right direction. Certain Member States, aware of this, are mobilizing and increasingly discussing ways of improving the application of European rules together to strengthen them. For example, the Netherlands and France cooperate on a joint project and invite the other Member States to take part in the reflection.

Denmark is only one example. Similar gross border trade is seen between other EU-Member States. The way this unfortunate situation will change is only once the politicians will change approach and understand and recognize the need for harmonization.

The black-market seems to be increasing year by year, which is illustrated by the following information: “The police in the Netherlands has seized a record 671 tons of illegal fireworks in the run up

to the New Year celebrations, according to government figures. A year earlier, when fireworks were banned because of the coronavirus restrictions, police confiscated almost 206 tons. This year's record is mainly due to two massive hauls over the German border at Enschede, which totalled 550 tons." [41]

For the time being, our assessment has proven that national authorities try to solve an international problem on national levels. National authorities often try to tighten national laws, hitting responsible market participants and serious companies – while they should corporate more on EU-level to solve what is at least a European problem.

Therefore, EuFiAs supports decision-making for targeted legislation around fireworks. This has an enormous potential to reduce illegal trading and, consequently, limit misuse.

Focus should be on very much expanding online sales. Novel measures for trading F3 or F4 fireworks on the internet must be introduced. They would be most effective in a combination with legislation on how to secure that F4 articles are only bought by a so-called 'person with specialist knowledge' according to Directive 2013/29/EU.

EuFiAs followed the Forum for Exchange of Information on Enforcement (Forum), responsible for REACH and chemicals' legislation. An approach like the eighth major Forum enforcement project (REF-8) that concentrated on online sales of substances, mixtures and articles is very much welcomed. One major reason is, that once there are incidents including illegal fireworks and/or misuse of fireworks, there is no clear distinction between illegal articles and misuse on one hand and legal articles, correct use and failures on the other. In many of these cases only the term *fireworks* is used – i.e., jeopardizing the reputation and image of law obeying and serious companies.

The GDI promotes to highlight the difference between legal and illegal fireworks whenever possible.

: Partnership with local authorities for protection of citizens

: Partnership with local authorities for protection of citizens

D2: Enhancing safety – preventive measures against injuries.

During the season 2021 the Danes ignited more 100 million fuses on New Year's Eve, and we experienced 25 serious injuries. A severe injury is regarded as one that cannot be finished by a visit to the emergency centre but needs a visit to a paediatrician, e.g., to change bandages or, but not necessarily, admission to hospital. The 25 serious injuries consist of:

- Illegal fireworks
- Deliberate misuse of legal fireworks
- Drunken users of fireworks
- Legal fireworks misfunctioning

The distribution between the options is not known, nor are the generic types/categories– so the information is relatively useless. However, the ratio between quantity and serious injuries is adequate and should be highlighted here.

The EU has required the Member States to report injuries and accidents related to pyrotechnic articles and in particular for New Year's Eve including categorization; some Member States have their own methods/categorization.

However - objectively it seems that correct use of legal fireworks causes relatively few damages/injuries – and even better compared to the number of fireworks ignited/used.

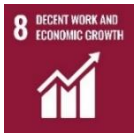
Secondly – the statistics only relate to the generic type. That means that there is no distinction between the categories.

Witness once a discussion about tip over of batteries/combination – and the auto-reaction from authorities was to limit size. Prohibiting smaller batteries/combination and to introduce minimum requirements for e.g., surface would be the correct approach.

Solutions:

The EuFiAs Best Practice for Quality, enhancing safety by certain preventive measures, partnership with authorities, including active cooperation within expert groups, proper PR statements and enlightenment of the public.

: Human health will benefit from certain measures (e.g., PR or authority training)



: Economic growth must not exist at the cost of human health.

: Partnership with local authorities for protection of citizens

: Partnership with local authorities for protection of citizens

: Avoid placing products on the market that can easily be misused, PR work.

In conclusion, Table 9 demonstrates what is necessary to work on sustainable topics beyond the European Green Deal.

Table 9: Conclusion on specific topics beyond the European Green Deal

Life Cycle / Value Chain	
Management	Allows for contribution of OCs on EU level to rise knowledge.
Design / Product components	Clear and harmonized requirements on design parameters, such as NEC or diameters, are necessary.
Sales	Online Sales must be intensively enforced.
Production	A local production and availability of fireworks inside each member state can limit illegal trading and subsequent misuse.
Transport	Illegal trading is often related to individual transports of the consumers themselves.
Packaging	Correct labelling must be enforced. Illegal imports are often not correctly labelled.

CHAPTER 04. Our pathway to 2030

Sustainable development is a continuous process. Therefore, we are not only working on the fields of action described in the roadmap, but we are also identifying further challenges. As an outlook on the next revision, there are various further fields to evaluate. In addition, we will encourage international pyrotechnic stakeholders and increase communication on this topic. A first step was made during the 18th International Symposium on Fireworks in Malta, further steps will follow to share best practices and exchange strategies and ideas for sustainable fireworks.

D4: Working conditions related to imported fireworks.

Avoid exploitation under all circumstances while maintaining import businesses. Is it possible to solve societal problems? Understatement on the side of stakeholders must rise to take any proposed solution into account. Proper certifications like Amfori BSCI or SA8000 can be a key to this action and can be seen as our corporate sustainability. There is no policy area within the green deal concerning working conditions. However, this is one of the key motivations why SDGs have been introduced. Metals are obtained from ores in mines. Our due diligence obligations matters. Sustainable supply chains play a key role over the upcoming decades.

Relevant SDGs:

In conclusion, Table 10 demonstrates what is necessary to work on social sustainability.

Table 10: Proposed actions on social sustainability topics

Life Cycle / Value Chain	
Management	Apply clear procurement rules and select responsible suppliers. Partnership with authorities, active cooperation within expert groups.
Design / Product components	Design correct labels in advance.
Raw Materials	Not only care for fireworks factories, but responsible raw material manufacturers must be selected as well.
Production	Enforcing proper production conditions, visit factories.
Transport	Implement proper and required labels.
Storage	Perform proper stocktakes and excellent documentation.

B4: Modern Oxidizers

"The main target organ for perchlorate toxicity in humans is the thyroid gland. Perchlorate has been shown to partially inhibit the thyroid's uptake of iodine. Iodine is required as a building block for the synthesis of thyroid hormone." [42]

EuFiAs supports the goals of the CSS. Therefore, working on modern oxidizers is one important topic under the CSS. Relevant SDGs are:

B5: Hazardous Substances as Fuels and Additives

Certain heavy metals (Copper, Iron, Antimony, Bismuth, …) are emitted by fireworks. The new Chemicals Strategy for Sustainability is aiming on "zero" pollution [43]. Research on novel compositions will be performed to evaluate the feasibility of even fewer heavy metals than today. There is a kind of "eco-responsibility" related to the chemical composition of used substances and mixtures. The chemical reaction, i.e. burning of pyrotechnic composition, can be optimized using thermodynamic codes. High quality substances allow for high performances. The NEC can be limited that way, reducing all kind of emissions. Complementary activities are under discussion like using charcoal that is certified for not being resourced under deforestation conditions (does FSC help?).

Relevant SDGs:

Minimizing heavy metals and offering substitution opportunities are exemplary actions as described in Table 11.

Table 11: Proposed actions related to pyrotechnic compositions

Life Cycle / Value Chain	
Design / Product components	Design articles novel pyrotechnic compositions and enable research on alternative components. Substitute last uses of heavy metals.
Raw Materials	Choose suppliers that produce modern products without toxic auxiliary agents. Circularity (see 2 a.) helps to decrease pollution (e.g., using recycled polymers). Bio-economical approaches can be applied.
Production	Define production processes that lead to less pollution.
Packaging	Consider concentration limits of certain substances and even ban substances (e.g., Substitute It Now-List).

Annex

Abbreviations and Acronyms

Abbreviation/Acronym	Meaning
BSDC	Business & Sustainable Development Commission
BFA	British Fireworks Association
Cat.	Category
CEN	European Committee for Standardization (French: Comité Européen de Normalisation)
CO_2	Carbon dioxide
CSS	Chemicals Strategy for Sustainability
dB(AI)	Decibel, A- and I- weighted
e.g.	For example
EAP	Environment Action Programme (important: 8th)
EC	European Commission
ECHA	European Chemical Agency
EU	European Union
EuFiAs	European Fireworks Association
F1	Fireworks which present a very low hazard and negligible noise level and which are intended for use in confined areas, including fireworks which are intended for use inside domestic buildings
F2	Fireworks which present a low hazard and low noise level and which are intended for outdoor use in confined areas
F3	Fireworks which present a medium hazard, which are intended for outdoor use in large open areas and whose noise level is not harmful to human health
F4	Fireworks which present a high hazard, which are intended for use only by persons with specialist knowledge and whose noise level is not harmful to human health
Forum	Forum for Exchange of Information on Enforcement
GDI	Green Deal Initiative
GHG	Greenhouse Gas
GoE	Group of Experts
ISO	International Organization for Standardization
LCA	Life cycle assessment (e.g. referred to in ISO 14000 series)
NEC	Net explosive content
NIO	National industry organization
OC	Operating company
PCF	Product carbon footprint (referred to by Greenhouse Gas Protocol)
PM	Particulate matter

$PM_{2.5}$	Particulate matter with an aerodynamic diameter equal to or less than 2.5 micrometres
PM_{10}	Particulate matter with an aerodynamic diameter equal to or less than 10 micrometres
PR	Public Relations
R&D	Research and Development
REF-8	REACH-EN-FORCE project on enforcement of CLP, REACH and BPR duties related to substances, mixtures and articles sold on-line
RoSPA	Royal Society for the Prevention of Accidents
SAPEA	Science Advice for Policy by European Academies
SDG	Sustainable Development Goal
SIN	Substitute-It-Now List
SoI	Statement of Intent
UN	United Nations
T1	Pyrotechnic articles for stage use which present a low hazard
T2	Pyrotechnic articles for stage use which are intended for use only by persons with specialist knowledge
TC	Technical Committee
UBA	German Environment Agency
WBCSD	World Business Council for Sustainable Development
WFD	Waste Framework Directive
WRI	World Resources Institute
WHO	World Health Organization
ZPAP	Zero Pollution Action Plan

References

[1] European Commission, *The European Green Deal: Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions*, Brussels **2019**.

[2] European Commission, A European Green Deal: Striving to be the first climate-neutral continent **2019**, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en#policy-areas, accessed 6 April 2021.

[3] European Commission, A European Green Deal: Striving to be the first climate-neutral continent **2022**, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en, accessed 14 March 2022.

[4] European Commission, EU holistic approach to sustainable development, https://ec.europa.eu/info/strategy/international-strategies/sustainable-development-goals/eu-holistic-approach-sustainable-development_en#:~:text=Communication%20on%20a%20European%20Green,conserves%20and%20enhances%20the%20EU%27s, accessed 07.02.23.

[5] United Nations, Communications materials: SDG POSTER AND INDIVIDUAL GOALS FOR WEB AND PRINT **2022**, https://www.un.org/sustainabledevelopment/news/communications-material/.

[6] United Nations, *Transforming our world: the 2030 Agenda for Sustainable Development (A/RES/70/1)*, United Nations (UN), New York **2015**.

[7] World Business Council for Sustainable Development, *SDG Sector Roadmaps*, Geneva **2018**.

[8] Business and Sustainable Development Commission, *Better Business Better World*, London **2017**.

[9] Directive 2013/29/EU of the European Parliament and of the Council of 12 June 2013 on the harmonisation of the laws of the Member States relating to the making available on the market of pyrotechnic articles (recast): Pyrotechnic Directive (inofficial), in: *OJ L 178*, pp. 27–65.

[10] European Court of Justice, *James Elliott Construction Limited v Irish Asphalt Limited*, *Digital reports (Court Reports - general)*, Vol.2016 **2013**.

[11] European Court of Justice, *Global Garden Products Italy SpA (GGP Italy) v European Commission.*, *Digital reports (Court Reports - general)*, Vol.2017 **2017**.

[12] M. Dieterle, P. Schäfer, T. Viere, Life Cycle Gaps: Interpreting LCA Results with a Circular Economy Mindset, *Procedia CIRP* **2018**, *69*, 764–768, https://doi.org/10.1016/j.procir.2017.11.058.

[13] Science Advice for Policy by European Academies, *Biodegradability of Plastics: in the open environment,* 1st ed., Berlin **2021**.

[14] Group of Chief Scientific Advisors, *Biodegradability of Plastics in the Open Environment*. Scientific Advice Mechanism (SAM), Brussels **2020**.

[15] European Parliament and of the Council, *Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment: Single-Use Plastics Directive* **2019**.

[16] European Commission, Sustainable industry: The European Green Deal **2019**, https://ec.europa.eu/commission/presscorner/api/files/attachment/859442/Sustainable_industry_en.pdf.pdf, accessed 6 April 2021.

[17] European Parliament and of the Council, *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance): Waste Framework Directive (WFD)* **2018**.

[18] Directorate-General for Environment, Waste hierarchy: Preventing waste is the preferred option, and sending waste to landfill should be the last resort. **2022**, https://environment.ec.europa.eu/sites/default/files/styles/oe_theme_medium_no_crop/public/2021-01/SC656%20waste_hierachy%20FINAL.jpg?itok=fTGHo3-Y, accessed 15 December 2022.

[19] Ellen MacArthur Foundation, The butterfly diagram: visualising the circular economy, https://ellenmacarthurfoundation.org/circular-economy-diagram, accessed 15 December 2022.

[20] European Environment Agency, *Clear opportunities to decouple Europe's waste generation from economic growth*, Helsinki **2022**.

[21] European Commission, *Questions and Answers - Communication on a policy framework for biobased, biodegradable and compostable plastics: Questions and answers*, Brussels **2022**.

[22] Greenpeace, *Biodegradable Plastics: Breaking Down the Facts: Production, composition and environmental impact*, Hong Kong **2020**.

[23] T. R. Walker, (Micro)plastics and the UN Sustainable Development Goals, *Current Opinion in Green and Sustainable Chemistry* **2021**, *30*, 100497, https://doi.org/10.1016/j.cogsc.2021.100497.

[24] LG Düsseldorf, *Court Case 34 O 55/19* **2020**, https://openjur.de/u/2200194.ppdf.

[25] Robert Sanders, New process makes 'biodegradable' plastics truly compostable **20211**, https://news.berkeley.edu/2021/04/21/new-process-makes-biodegradable-plastics-truly-compostable/, accessed 23 September 2024.

[26] World Health Organization, WHO European Centre for Environment and Health, *WHO global air quality guidelines: Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide*, WHO European Centre for Environment and Health, Bonn, Germany **2021**.

[27] European Parliament and the Council, *Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (Text with EEA relevance): NEC DIrective* **2016**.

[28] F. Keller, C. Schragen, Determination of Particulate Matter Emission Factors of Common Pyrotechnic Articles, *Prop., Explos., Pyrotech.,* in press, https://doi.org/10.1002/prep.202000292.

[29] European Parliament and the Council, *Directive (EU) 2016/ 2284 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC: NEC-Directive* **2016**.

[30] European Commission, *Proposal for a DECISION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on a General Union Environment Action Programme to 2030: 8th Environment Action Programme (EAP)*, Brussels **2020**.

[31] European Commission, *Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil'*. Zero pollution action plan (ZPAP), Brussels **2021**.

[32] ClimatePartner, Climate action. A new level.: Explore how your company can take climate action now. **2023**, https://www.climatepartner.com/en, accessed 7 November 2023.

[33] Science Based Targets initiative, How it works: Lead the Way to a Low-Carbon Future **2023**, https://sciencebasedtargets.org/how-it-works, accessed 7 November 2023.

[34] United Nations, *Kyoto Protocol to the United Nations Framework Convention on Climate Change*, Kyoto **1997**.

[35] ClimatePartner, Product Carbon Footprint: A life cycle assessment of your product's carbon emissions **2023**, https://www.climatepartner.com/en/take-action/measure-carbon-footprints/product-carbon-footprint-pcf, accessed 7 November 2023.

[36] Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard: REVISED EDITION **2004**, https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf, accessed 7 November 2023.

[37] Greenhouse Gas Protocol, Corporate Value Chain (Scope 3) Accounting and Reporting Standard: Supplement to the GHG Protocol Corporate Accounting and Reporting Standard **2011**, https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf, accessed 7 November 2023.

[38] FactSet, What are Scope 4 Carbon Emission? **2023**, https://insight.factset.com/what-are-scope-4-carbon-emissions, accessed 7 November 2023.

[39] World Resources Institute, Do We Need a Standard to Calculate “Avoided Emissions”? **2013**, https://www.wri.org/insights/do-we-need-standard-calculate-avoided-emissions, accessed 7 November 2023.

[40] House of Commons Petitions Committee, Fireworks: First Report of Session 2019 **d 2019**, https://publications.parliament.uk/pa/cm201919/cmselect/cmpetitions/103/103.pdf, accessed 30 January 2023.

[41] DutchNews, Illegal firework seizures top 670 tonnes as New Year festivities near **2022**, https://www.dutchnews.nl/2022/12/illegal-firework-seizures-top-670-tonnes-as-new-year-festivities-near/, accessed 22 November 2023.

[42] U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Toxicological Profile for Perchlorates **2008**, https://www.atsdr.cdc.gov/toxprofiles/tp162.pdf, accessed 6 April 2021.

[43] European Commission, *Chemicals Strategy for Sustainability Towards a Toxic-Free Environment*, Brussels **2020**.