eurelectric
powering people

ECHA's consultation for the restriction on the manufacture, placing on the market and use of per-and polyfluoroalkyl substances (PFAS)

A Eurelectric response

July 2023

Eurelectric represents the interests of the electricity industry in Europe. Our work covers all major issues affecting our sector. Our members represent the electricity industry in over 30 European countries.

We cover the entire industry from electricity generation and markets to distribution networks and customer issues. We also have affiliates active on several other continents and business associates from a wide variety of sectors with a direct interest in the electricity industry.

We stand for

The vision of the European power sector is to enable and sustain:
- A vibrant competitive European economy, reliably powered by clean, carbon-neutral energy
- A smart, energy efficient and truly sustainable society for all citizens of Europe

We are committed to lead a cost-effective energy transition by:

investing in clean power generation and transition-enabling solutions, to reduce emissions and actively pursue efforts to become carbon-neutral well before mid-century, taking into account different starting points and commercial availability of key transition technologies;

transforming the energy system to make it more responsive, resilient and efficient. This includes increased use of renewable energy, digitalisation, demand side response and reinforcement of grids so they can function as platforms and enablers for customers, cities and communities;

accelerating the energy transition in other economic sectors by offering competitive electricity as a transformation tool for transport, heating and industry;

embedding sustainability in all parts of our value chain and take measures to support the transformation of existing assets towards a zero carbon society;

innovating to discover the cutting-edge business models and develop the breakthrough technologies that are indispensable to allow our industry to lead this transition.

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Distribution & Market Facilitation Committee
Generation & Environment Committee
Electrification & Sustainability Committee
WG Technology
WG Thermal & Nuclear
WG RES & Storage
WG Hydro

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Eurelectric answer to ECHA's public consultation

A Eurelectric response paper July 2023

MAIN MESSAGES

Eurelectric welcomes the fundamental efforts to use perfluorinated and polyfluorinated alkyl compounds (PFAS) in an environmentally conscious manner to protect people and the environment. A holistic approach must be adopted along the power value chains **in consideration of the positive effects of the energy transition for the climate and our environment**. An overly restrictive ban must not lead to a *de facto* blockade of environmental technologies that we need for a renewable, low carbon and secure energy supply.

Differentiate between each compound, their function and effects

In the energy sector, PFAS substance groups are used in **essential, professional and long-life industrial products**, without which large parts of the infrastructure, such as energy supply and transport as well as hydrogen technologies are unimaginable. The currently proposed PFAS restriction approach needs to ensure that the societal costs arising from a general ban on PFAS do not outweigh the benefits from a ban on certain PFAS. The currently proposed PFAS restriction also needs to be adapted and must **differentiate between dispensable PFAS use** with large emissions (non-essential and short-lived products and applications), **versus essential professional / industrial use of long-life products** and solutions with low emissions. The restriction should also differentiate between PFAS applications for which alternatives already exist (e.g. some coatings, cooling) and PFAS applications for which there is no alternative available at the moment (e.g. nanoscience applications, membranes, semiconductors...) and for which specific derogations are needed (see below). This is in line with the REACH regulation itself, which states that any new restriction "must take into account the socio-economic impact, including the availability of alternative solutions" (Article 68).

Measure the impact of the regulation in relation to the greater objective of the EU's decarbonisation

In a decarbonized energy economy, ensuring a secure supply heavily relies on renewable and low carbon electricity, energy storage systems, and hydrogen technologies. These play crucial roles in safeguarding the energy transition. Key components such as new wind turbines, PV installations, thermal and nuclear power plants, electrolysers, hydrogen compressors, transformers, batteries, cables, and switchgears, among other facilities, are vital for this transformation but could be impacted by the proposed restrictions.

Assess derogation needs and apply circular economy principles

To ensure the safe operation of these essential pieces of equipment and technologies, certain materials containing PFAS are currently used, and there are no feasible alternatives at a significant scale and technological readiness level. **Consequently,** derogations **for the use of PFAS, as well as**

the ability to repair and maintain existing installations, become indispensable in achieving climate targets and serve as a crucial pillar for a successful energy transition.

Assess the capacity of the industry to provide alternatives and the associated delays

An unrestricted ban on PFAS would mean that the energy transition in Europe would come to a standstill for some years, at a time when acceleration is necessary. The entire electricity sector is aware of its responsibility in dealing with PFAS and is already looking for alternative substances to substitute PFAS. In the short term, however, there is no guarantee that products with the necessary technical and **safety requirements** will be available **at large scale.** To avoid adverse effects on the energy system, **a proportionate and responsible legislation is needed**.

It is important to highlight that utilities face challenges in identifying all cases of PFAS usage because manufacturers are not required to disclose the presence of PFAS in their products due to the lack of regulations. Despite this obstacle, the industry is committed to addressing the issue and actively contributing to climate and environmental protection through their products. In collaboration with politicians and scientists, the industry is willing to engage in constructive discussions to establish and commit to effective processes for recycling and implementing industry-specific circular economy practices at reasonable expenses.

According to the definition of the European Chemicals Agency (ECHA), there are over 10,000 PFAS types with different properties. Fluoropolymers which are also used in the electricity industry are, in contrast to other PFAS types, non-toxic, non-bioavailable, non-water-soluble and non-mobile molecules according to the GHS classification. They meet the OECD criteria as "Polymers of Low Concern" (PLC) and are therefore considered unproblematic for the environment and human health. Despite this classification, the industry considers further research into the possible risks of fluoropolymers to be important in terms of its own responsibility and intends to make its contribution to this, among other things by collecting data together with the manufacturers.

Evaluate the socio-economic impacts and the availability of alternatives through a proportionate restriction

Besides, it is important to consider and expand upon the concept of “essential uses” for society, as proposed in the European Commission’s communication of October 14, 2020, “Chemicals Strategy for Sustainability Towards a Toxic-Free Environment” which provides for a phase-out of PFAS in the EU, “**unless their use is essential”**. This approach acknowledges that the utilisation of PFAS in industrial processes can be highly intricate, requiring a comprehensive **evaluation of the technical functionality of each PFAS compound and the suitability of alternative substances.**

In conclusion, considering the essential role the electric sector plays for society, in particular with regards to fulfilling decarbonisation objectives, the PFAS restriction should provide a special regime for articles or mixtures containing PFAS that contribute to facility safety, electrical supply security, as well as renewable and low-carbon electric means of production.

Implement a timely reassessment policy in light of technology and market situation

Furthermore, for all uses benefiting from derogations, a mechanism should be established to reassess the derogation period if no substitution meeting equivalent safety or production efficiency properties is available within the specified timeframe.

MAIN PRINCIPLES THAT SHOULD BE SET

- **Existing installations and / or projects that are approved for installation before the regulation** comes into **force must remain unaffected**.

The repair and maintenance of operational equipment should be possible in accordance with circular economy and life cycle assessment principles. This choice would allow the reduction of waste and environmental impacts until the completion of the entire lifespan of the equipment. The ban should only take effect after substantial repair or renewal of the existing installations, and if alternatives with equivalent technical properties (especially safety properties) are available at acceptable economic conditions.

Indeed, regarding distribution and transmission networks, and installations of the users of such networks (industry, power plants), a significant part of the electrical equipment in networks is designed with a lifespan over 40 years, given that proper maintenance and repairs are carried out regularly. Very often, spare parts needed must be of the same properties as originally designed, otherwise the technical performance of the whole installation might change. For the security of supply and the continuous expansion of electricity networks, essential for the integration of renewable energy sources, the possibility to repair existing and future installations is of utmost importance.

- Appropriate and adequate **transition period** must be defined for PFAS-containing installations.

Where equivalent alternatives to PFAS exist (e.g. for domestic heat pumps, as opposed to industrial heat pumps for which the options are limited to certain applications) and are available on the market at a relevant scale, they should be used after a transition period of 6.5 years in accordance with the ECHA regulations. If no equivalent alternative substances are known or if they are not technically proven and/or not available on the market at a relevant scale, a transition period of 13.5 years must be set in accordance with the ECHA regulations.
Considering the operation of the electricity networks and the use of PFAS alternatives, it must be stressed that DSOs, TSOs and other users (industry, power stations, etc.) need long testing periods before the introduction of new products into the network operation. These testing and piloting periods, that are part of the certification process of new products, are necessary to ensure a **reliable and secure system** and in some cases are expected to exceed the transition period proposed by the regulation. This parameter should be taken into account.

- Reassessment mechanisms should be implemented.

Furthermore, for all uses benefiting from derogations, a mechanism should be established to reassess the derogation period if no substitution meeting equivalent safety or production efficiency properties is available within the specified timeframe.

LIST OF RELEVANT TECHNOLOGIES IMPACTED BY THE PFAS RESTRICTION

Like many other industries, the electric sector uses PFAS mainly because of their ability to withstand harsh corrosive atmosphere, as well as for sealing and refrigerant applications. Although it is not feasible within the limited consultation period to identify all equipment containing or potentially containing PFAS, given the multitude of substances involved (several thousands), this section provides information on some specific uses that we consider crucial and representative for the safe operation of our installations and for the production of electricity in Europe, and for which specific derogations or exclusions should be considered.

A. Focus on specific uses:

1. SF_6 ALTERNATIVES IN SWITCHGEARS, GAS INSULATED LINES AND BUSBARS

Fluorinated gases serve as insulating and switching agents in switchgear. While some PFAS-free alternatives (such as vacuum and dry air technologies - **useable under technical compatibility and market availability only**) exist for gas-insulated electrical switchgear under 145 kV, the situation changes for switchgear above 145 kV (HV). Currently, there are no ready-to-market PFAS-free products available for equipment above 145 kV, particularly for circuit breakers, and development in this voltage range seems limited with physical constraints making market maturity in the next 10-15 years unlikely.
At present, only one manufacturer can supply F-gas-free products to meet European switchgear requirements for the next decade or more regarding HV. Competitors have not shown any development strategy for non-PFAS, gas-insulated high-voltage switchgear in the European market. With the ongoing energy transition and the necessity for substantial grid expansion to accommodate renewable energy feed-in capacity, it would be an economic and political concern to have just one manufacturer dominate the switchgear market across Europe for such a long time.
A comprehensive derogation for areas where only one manufacturer offers PFAS-free products, such as certain voltage levels, becomes essential. Otherwise, there is a risk that this single manufacturer may not be able to meet the demand from all switchgear users in Europe, potentially leading to monopolistic conditions.

Moreover, it is crucial to adopt a consistent approach with the EU F-GAS Regulation. Banning both SF6 and PFAS would require using solutions that demand physical space often unavailable in electricity distribution substations, especially in urban areas, offshore substations, and offshore converter stations. This may necessitate complete refurbishments or increased gas operating pressure, leading to thicker and heavier equipment with greater environmental impact. In cases with strict space limitations, like underground switchgears in caverns of pump storage power plants, or regular power plants, using larger and heavier equipment is not feasible, as the existing infrastructure is designed specifically for certain sizes and weights. Consequently, derogations are necessary to allow the use of alternative F-gases to replace SF6 in these scenarios.

2. ENERGY STORAGE SYSTEMS (FOCUS ON LITHIUM-ION & REDOX-FLOW BATTERY TECHNOLOGIES) AND COOLANTS

At present, no alternative is foreseen to substitute these elements. Therefore, a transitional period of at least 13.5 years should be set in accordance with the deadlines proposed by the ECHA. This will allow battery technology to be adapted by around 2040.

The current PFAS proposal might severely impact the batteries' availability, which are necessary for the ecological transition and the decarbonisation processes of electricity production. For this reason, a transitional period of at least **13.5 years** should be set in accordance with the deadlines proposed by the authors of the proposal in order to allow research and industry to find efficient and secure alternatives to PFAS for the **Lithium-ion and Redox-flow battery technologies.**

These specific derogations are necessary to achieve the ambitious objectives set up by the EU in order to deploy storage systems especially for the production of electricity from renewable sources. In October 2017, the European Commission set up the "European Battery Alliance" to support the scaling up of innovative solutions and manufacturing capacity in Europe. In May 2018, as part of the third "Europe on the move" mobility package, it adopted a dedicated strategic action plan on batteries, with a range of measures covering raw materials extraction, sourcing and processing, battery materials, cell production, battery systems, reuse and recycling. Moreover, the European Commission funded in the framework of Horizon 2020 and Horizon Europe the "Bridge" initiative, that unites smart grids, energy storage, islands and digitalization projects.

The next paragraphs illustrate the applications of PFAS on two aforementioned storage technologies: Lithium-ion batteries and Redox-Flow batteries. Furthermore, the possible alternatives present on the market or in the R&D phase are analysed, which provides justifications for derogations regarding the time necessary to replace PFAS, based on the maturity of the alternative materials.

Nowadays, two of the technologies which can meet the energy storage needs of renewable energy sources (aside from pumped hydroelectric energy storage and production of hydrogen) are as follows:

i. **Lithium-ion battery**, characterised by high performance and flexibility in the application. Lithium-ion batteries are at the center of enormous efforts by the scientific and industrial community to achieve continuous improvement in terms of performance and costs, but also to increase the production rate in order to support the energy transition at a global scale. To date, lithium-ion battery application is limited to up to 4 hours energy storage.
ii. **Redox-Flow battery** is currently the only technology able to store electricity between 4-12 hours (daily storage).

Both lithium-ion and Redox batteries use components with PFAS for their operation.

- **Lithium-ion Battery technology** (main PFAS used: Lithium hexafluorophosphate ($LiPF_6$), Lithium bis(trifluoromethylsulfonyl)amide (LiTFSI), Lithium bis(fluorosulfonyl)imide (LiFSI), Polyvinylidene Fluoride (PVDF)):

Lithium-ion batteries have revolutionised the world of electrical energy storage in recent years: thanks to their high energy density and long cycling life, lithium-ion batteries are able to provide energy efficiently and reliably, making them particularly useful for stationary energy storage. Indeed, lithium batteries can store energy produced from renewable sources, such as solar or wind energy, and they can be used to balance energy demand and supply in real-time, helping to prevent blackouts and service interruptions.

Classic lithium-ion batteries are composed of two electrodes (a cathode and an anode) immersed in a liquid electrolyte and separated by a polymeric separator, which allows the passage of ions, but not electrons (electronic insulator). Both electrodes are composed of three main components: the electroactive material, the conductive carbon and the binder.

The first application of PFAS is as electrolyte salts or electrolyte additives, as in the case of **Lithium hexafluorophosphate ($LiPF_6$), Lithium bis(trifluoromethylsulfonyl)amide (LiTFSI), Lithium bis(fluorosulfonyl)imide (LiFSI).** The electrolyte salts allow the electrochemical communication between the two electrodes, through the exchange of lithium ions between them. Therefore, it is a fundamental component for an electrochemical cell. Despite the enormous efforts of the academic and industrial community to find potential replacements for these fluorinated lithium salts, to date there are no commercial alternatives and no possible roadmap has been proposed by the battery suppliers.

The second application of PFASs is as electrode binder, as in the case of **Polyvinylidene Fluoride (PVDF)**. PVDF is the homopolymer of Vinylidene Fluoride powder and is characterized by excellent chemical-mechanical properties. In the traditional Li-ion cell manufacturing process, PVDF (Polyvinylidene Fluoride) is mostly adopted in the cathode and anode slurry making processes. For processing requirements, cost and environmental issues, battery manufacturers are gradually moving from using PVDF to hydrophilic binder materials such as SBR (Styrene Butadiene rubber) copolymers, that can be used for practically all Li-ion cell chemistries – for both the anode and cathode electrodes, without change of electrochemical properties. Although the replacement of PVDF for aqueous binders is desirable and at the core of the efforts of several cell manufacturers, to date this goal has not been achieved and it is not possible to find suppliers of batteries without PVDF. Also, no detailed roadmap has been provided by cell supplier about the availability of PVDF-free batteries.

Furthermore, some battery manufacturers use separators coated with **fluorinated polymers** in order to improve the chemical-mechanical properties of the separators. In terms of physico-chemical properties, PVDF-based separators (monolayer/multilayer) evidence strong polarity, high dielectric constant, excellent tensile properties and mechanical strength, favorable thermal stability and wettability. However, it is much more difficult to map this product category, as some suppliers only provide the commercial name of the material used for the separator and there is no disclosure PFAS polymers employed.

For aforementioned reasons and given the crucial role of electrolyte salts in the batteries commercially available, a full exemption should be set for the $LiPF_6$, LiTFSI and LITFI compounds.

Regarding the PVDF, a transitional period of at least 13.5 years should be set in accordance with the deadlines proposed by ECHA.

These two proposals are formulated in order to leave enough time to the R&D and industrial actors to replace PFAS component in the Lithium-ion battery technology, without impacting the need for batteries for the energy transition.

- **Redox-Flow Battery technology** (main PFAS used: Nafion (PFSA), Polyvinylidene Fluoride (PVDF))

Redox flow batteries (RFBs) are a type of rechargeable battery, in which the electroactive molecules are dissolved in the electrolytes and they are flowed through an electrochemical cell that converts chemical energy directly into electrical energy. RFBs are a promising energy storage technology for stationary applications, thanks to their high efficiency, low cost per unit energy, long duration energy storage and extended lifetimes, providing the ability to enhance the stability of the grid. In a typical set-up, the redox flow battery consists of 2 electrolyte reservoirs from which the electrolytes are circulated by pumps through an electrochemical cell stack comprising cells connected in series or parallel to enable reaction taking place at inert electrodes. Each cell is composed of anode, cathode and an ion exchange membrane separator to allow diffusion of ions across the membrane while preventing the cross-mixing of the electrolyte solutions from these 2 reservoirs.

Nowadays, the manufacturing of membranes for redox-flow batteries is still dominated by Nafion®, which is used as a reference. Nafion is the brand name of a sulfonated tetrafluoroethylene copolymer fluoropolymer supplied by DuPont, and these perfluorosulfonic acid (PFSA) membranes are made from a PFSA/polytetrafluoroethylene (PTFE) copolymer. The IUPAC (International Union of Pure and Applied Chemistry) name is tetrafluoroethylene-perfluoro-3,6-dioxa-4-methyl-7-octenesulfonic acid copolymer. Besides its characteristics as a cation conductor, Nafion stands out due to its good mechanic properties, its excellent proton conductivity and its outstanding chemical stability, especially notorious for strong acidic media as those used for VRFBs (Vanadium redox flow batteries). In the market, several Nafion-based membranes are proposed, different in terms of thickness, chemistry or manufacturing process used by different suppliers. Nevertheless, these membranes suffer from their high crossover of vanadium ions, leading to energy efficiency decrease and capacity loss in VRB. Due to the high cost of Nafion membranes, several RFBs producers propose in-house membranes based on PVDF (Polyvinylidene fluoride), another PFAS. In addition, Nafion/PVDF blends are also studied in VRB. The addition of PVDF allows a reduced swelling and improve the ion selectivity (in comparison with pure Nafion membranes). Recently, research has also focused on the development of membranes based on fluorine-free materials, as for example the Poly(ether ether ketone) (PEEK), which has been considered as a low-cost fluorine-free alternative to Nafion. It can be easily functionalized in sulphuric acid to obtain sulfonated-PEEK (SPEEK), which displays excellent chemical resistance, a high ion selectivity, interesting cation exchange properties with a good proton conductivity and permeability. However, this new membrane material is still under development and is not commercially available. A well-defined technological roadmap on the development and production of redox flow batteries based on fluorine free membranes is not currently available.

Redox flow batteries are a promising technology for long term storage applications. The current technology under development is based on PFAS and has no alternative materials. Given the need to develop this technology, a transition period of 13,5 years should be set to allow research and industry to find alternative materials to replace PFAS.

- **Battery Recycling:**

The recycling of battery systems is mandatory in Europe since the Battery Directive 2006/66/EC. A new regulation was adopted by the European Parliament on 14 June 2023 concerning batteries and waste batteries, and repealing Directive 2006/66/EC, to improve the recycling and the circularity of the battery systems, in order to make them more sustainable.

There are multiple methods for battery recycling. The two most mature and promising methods are pyrometallurgical process and hydrometallurgical process. However, economically, eliminating the emission of fluorinated organics -which are due to the decomposition of PFAS in the batteries during the recycling process- poses big challenges for the battery recycling industry. For the moment, some battery recycling companies are working to tackle this issue. But a concrete technological roadmap on this topic is not yet available.

3. PHOTOVOLTAIC PANELS

Certain PV modules currently incorporate polyvinylidene fluoride (PVDF) in their polymer back sheets for safety purposes. Additionally, PFAS are found in the front sheet coating, necessitating further examination. The plastic material on the front of glassless modules can also contain PFAS. However, it is important to note that the majority of photovoltaic modules are already produced without PFAS.

To ensure a smooth transition, a reasonable period of 6.5 years is deemed appropriate. This duration allows sufficient time for these systems to be readily available in the market and for stakeholders to adapt to the changes effectively. During this transitional period, efforts can be made to gradually phase out PVDF and PFAS-containing components from PV module production, thus promoting the use of PFAS-free alternatives.

<u>Glass / Backsheet panels (rooftop PV):</u>

Glass/backsheet modules account for around 60% of the market share in the world and are mainly used for rooftop applications. Most backsheets are composed of fluorinated compounds such as PVF (polyvinyl fluoride), PVFD polyvinylidene fluoride). If the OECD definition of a PFAS is applied, then:

- PVF is not a PFAS
- PVDF is a PFAS because of the (-CF2-)

> PFASs are defined as fluorinated substances that contain at least one **fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it)**, i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group ($-CF_3$) or a perfluorinated methylene group ($-CF_2-$) is a PFAS.

<u>Glass / glass panels (Ground PV)</u>

Most Ground PV projects are based on Glass/Glass panels, as their reliability and lifespan are far superior. As these panels have no backsheet, they are not expected to contain PFAS in the laminate.

<u>Both Glass / glass and Glass / back-sheet panels:</u>

PFAS are probably present in:

- <u>Junction Box and cable</u>: PFAS can be used as additives in electrical cables and junction boxes for their fire-resistant and flame-retardant properties. PFAS are known for their ability to withstand fire and reduce flame spread, making them potential candidates for fire protection applications.
- <u>ARC (Anti-reflective Coating) or ASC (Anti Soiling Coating)</u>

PFAS are generally not used in the ARC or ASC of new solar panels. Commonly used materials for anti-reflective coatings on solar panels include thin layers of metal oxides such as silicon dioxide (SiO2) or titanium dioxide (TiO2). However, during the operating phase of the solar power plant, a coating can be applied to the front glass surface of the module to enhance its performance or to give the module self-cleaning properties. This type of coating is likely to contain PFAS.

4. THERMAL INDUSTRY

As in many other industrial sectors, **PFAS in thermal installations confer high-performance qualities such as durability, high temperature resistance, chemical resistance and high mechanical strength** on the equipment in which it is used (e.g. seals and gaskets, lubricants, etc.) and contribute more broadly to the production of electricity of thermal origin in complete safety (e.g. sealing, operation of pumps, parameter measurement, maintenance of turbines, etc.).

Consequently, the entire thermal sector, including the roll-out of new low-carbon production means, carbon offsetting, as well as energy storage, will be affected by the proposed restriction **which will have an immediate effect on**:

- maintenance of electrical grids (presence of PFAS in the cables),
- maintenance of thermal power plants (particularly due to the potential lack of seals),
- their safety and,
- electricity production, particularly during peak periods. Indeed, these are means of production which can produce and inject electricity very quickly into the electricity grid when required (e.g. during periods of peak consumption, unavailability of other means of production) and which thus ensure the security electricity supply within the European Union.

It should also be noted that this could lead to production of materials requiring the use of PFAS in their manufacturing process - <u>but devoid of PFAS in the finished product</u> - **being relocated outside of the European Union** (e.g. the process of electrolysis of water to produce green or blue hydrogen or other synthetic fuels).

Finally, concerning more specifically the substitution, where it is technically possible:

- May present risks, such as affecting the performance guarantee of the equipment (as was the case for example with the first substitutes for asbestos seals, which led to numerous problems with leaks and maintenance)
- Must consider the necessary compatibility with supplier qualification requirements (feasibility, duration, cost, etc.), especially to meet requirements for performance or safety. For example, the substitution proposed for "PEEK" (thermoplastic) seals and backup rings in the Appendix XV file of the authors of the restriction proposal is not functional in acid chemistry and is therefore not compatible with our uses
- May lead to replacements with products having a shorter lifespan, such as seals, which would in fact lead to a significant increase in maintenance operations and the quantities of waste produced (hazardous or not).

Examples of uses of articles containing PFAS that are decisive for the safe operation of present and future thermal installations:

- Greases, lubricants, membranes, seals, linings and valves used in turbines and their related installations necessary for thermal production
- Cables (insulating material)
- Elements making up the flue gas treatment installations (e.g : desulphurisation units, etc.)
- Internal linings protecting against corrosive chemical products (acid or alkaline) for tanks and storage retentions of chemical products (particularly fuel such as heating oil for example)

- Certain sensors and measuring devices required to comply with regulatory emission limits
- Energy storage in batteries (Lithium ion, etc.). Indeed, the thermal industry is installing them on its electricity production sites to set up EMS (Energy Management Systems) which manage the mix of thermal production, renewable energies and batteries, in particular in the island territories for which this type of system is essential for meeting the challenges of energy transition and increasing the share of renewables in their local energy mixes (see section on Batteries)
- Electrolysers used in the recovery of CO_2 (Carbon Capture and Usage – CCU). Indeed, there is PFAS in the membrane, electrodes, gas diffusion layer (GDL) and sealing material of electrolysers - mostly fluropolymers - and no alternative is expected to be able to substitute these highly specialized materials in the near future. This technology is necessary for the recovery of the CO_2 used in the thermal industry (CCU), thus making it possible to decarbonize the thermal energy of tomorrow downstream. For more information about the use of PFAS in hydrogen production, please refer to the response made by Hydrogen Europe.

The above urges the experts and legislators to investigate extensively the cited compounds and equipment before deciding about the regulatory regime and transitory delays to apply.

5. NUCLEAR INDUSTRY

In the nuclear sector, as in many other industrial sectors, the presence of PFAS-containing equipment in installations (e.g., seals, lubricants) serves important functions, particularly in heat and corrosion resistance, and contributes more broadly to the safe production of low-carbon electricity (e.g., sealing, operation of backup pumps, safe transport of radioactive materials).

In addition, some PFAS are essential to the enrichment process of uranium (application for which there is no alternative).

The implementation of the proposed restriction, without specific derogations or exclusions, would immediately impact the maintenance of nuclear power plants, their safety, and the production of low-carbon electricity in Europe.

For more information about the use of PFAS in the Nuclear energy sector, please refer to the response made by Nuclear Europe.

The above urges the experts and legislators to investigate extensively the cited compounds and equipment before deciding about the regulatory regime and transitory delays to apply.

6. INDUSTRIAL HEAT PUMPS

Decarbonising the industry is a major challenge if we are to meet our targets for reducing CO_2 emissions, in particular Fit for 55 ones. Most of the energy consumed by industry is in the form of heat. As a result, the deployment of Heat Pumps (HPs) to decarbonise industrial heat and make the industry more energy efficient has been identified by a majority of players as one of the main solutions. In its NZE2050 report, the IEA set an ambitious target of 500 MW/month for the installation of HPs in light industry over the next 30 years, in order to achieve carbon neutrality.

The impact of the PFAS ban on Refrigeration, Air Conditioning and Heat Pumps would be twofold:

1) All fluoropolymers fall under the proposed definition in the proposal. These substances such as PTFE, FPM etc are critical to most of the components which makes these systems run efficiently and at best performance.

2) Most F-gases, which are a core part of the full portfolio of refrigerants used on RACHP applications are covered by the proposal. Refrigerants are an essential element for the good functioning of their RACHP components, equipment and systems to heat and cool.

In the case of **large industrial high-temperature heat pumps**, crucial for the decarbonisation of industry and district heating, special refrigerants called Hydro Fluoro Olefines (HFO, e.g. R1234ze) have been developed in order to replace refrigerants according to the F-Gas Regulation (e.g. R134a). These HFOs allow high temperature ranges combined with a high efficiency. They are not ozone-depleting, have a very low GWP and are in case of accidents not so dangerous compared to alternatives like NH_3 (toxicity) or propane (flammability and explosion protection). There are already technical solutions to minimise emissions into the atmosphere. A large number of these HFO-based heat pumps with a lifetime of more than 20 years have been recently installed or are in installation. Because the heat pumps are constructed according to the refrigerants' physical properties, the revamping of the heat pump in order to use natural refrigerants is not possible. It needs to be possible to operate them until the end of their lifetime.

The industrial HP market can be divided into 3 categories depending on heat supply temperature (up to the actual limit of 150°C):

- Standard HPs providing heat up to 85°C
- High-temperature (HT) heat pumps providing heat from 85°C to 100°C
- Very high temperature HPs (VHTs) providing heat between 100 to 150°C.

The F-Gas Regulation, under ongoing review, mandates the progressive phase out of fluorinated gases, including HFCs used in refrigeration systems. In order to meet these requirements, European industrials developed a few years ago HFC-free solutions, today mature or very close to maturity (in the process of being demonstrated) for these three markets.

As shown on the table below, most of these solutions for the HT and VHT markets (supply temperature > 90°C) are designed to use an HFO-type refrigerant (r1234ze(Z); r1234ze(E); r1233zd(E); r1336mzz(Z)), which belongs to the PFAS family. Manufacturers of industrial HPs have chosen this solution for a number of reasons: Zero ODP, extremely low GWP, limited or zero flammability, non-toxic, optimum performance at target temperatures.

Refrigerant type	Code	ODP	GWP	Flamability	Tcritic (°C)	Working temperature range															
						STD								HT		VHT					
						0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
HFO	R1234yf	0	4	A2L	94,7																
HFO	R1234ze(E)	0	7	A2L	109,4																
HFO	R1234ze(Z)	0	1	A2L	150,1																
HCFO	R1233ze(E)	0	6	A2L	165,6																
HFO	R1336mzz(Z)	0	2	A1	171,3																
hydrocarbon	R600	0	3	A3	151,8																
hydrocarbon	R601	0	4	A3	196,55																
Natural	R717 (Ammonia)	0	0	B2	132,4																
Natural	R744 (CO2)	0	1	A1	31																
Natural	R718 (water)	0	0	A1	374											close loop					

TRL	
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Source data: New developments and products for supply temperature above 100°C – 02/2023 – Cordin Arpagaus

For heat pumps providing heat at high or very high level (> 90°C), alternative refrigerants to HFO are still non-existent from a commercial point of view (TRL < TRL 9): the first laboratory demonstrators are under way and the first field demonstrations will see the light of day from 2024/2025 (often using hydrocarbon-type fluids: butane or n-pentane). The use of hydrocarbons will also require time for industries to adapt in order to incorporate these highly flammable refrigerants. The use of water is also an alternative but at laboratory demonstration stage for closed cycles.

To sum up, the vast majority of HT and VHT heat pumps use HFO refrigerants, with no alternative solution available in the short term. However, more than 60% of industrial heating requirements that can be met by a HP (i.e. < 150°C) are actually at temperatures covered by these HT and VHT heat pumps (i.e. >90°C). **It is therefore very important to ensure that mature products are available over time in this temperature range.** This is essential if we are to meet the challenge of decarbonising the industry by accelerating the pace of HP development. As most manufacturers chose HFOs relatively recently, **a transition period to develop new products and adapt or even strengthen their industrial facilities is also crucial** from an economic point of view.

In conclusion, **it is essential to introduce a derogation extending the use of HFOs in high and very high temperature HPs for a minimum of 5 years** (6.5 years including the 18 months legal application period). This derogation would allow players to develop or industrialise their natural refrigerant-based solutions and adapt their production facilities or build new ones.

7. ELECTRICAL SYSTEMS, HIGH VOLTAGE (HV) EQUIPMENT AND OTHER CONCERNED EQUIPMENTS OR EQUIPMENTS

1. Insulation materials, gaskets and coating

Insulation materials: In the electricity industry, PFAS-containing insulation materials are employed in electrical transformers, switchgear, and other equipment that require thermal insulation and fire resistance. These materials can help protect critical components from overheating and potential fire hazards.

Gaskets play a vital role in maintaining a secure seal in electrical equipment, preventing the leakage of potentially hazardous substances or protecting sensitive internal components. PFAS-containing gaskets have been used in situations where chemical resistance, temperature resilience, and a reliable seal are paramount for electrical safety and performance.

Coatings: PFAS-containing coatings have been applied to electrical components to provide water repellency and resistance to oils and other contaminants. This may include coating surfaces of power lines and electrical connectors to prevent damage from moisture or environmental exposure.

The above urges the experts and legislators to investigate extensively the cited compounds and equipment before deciding the regulatory regime and transitory delays to apply.

2. Case of circuit breakers and PTFE

Circuit breakers (voltage modulation) rely on nozzles (which help resist the electrical arch and disconnect power flows) in which a PTFE (PFAS substance which is very resistant to extremely high temperatures) is used. The nozzles have a very specific, crucial technical function; there is no alternative material that can substitute PTFE in this application. In the case of a necessary maintenance, the original, PTFE-containing material needs to be used. Should this not be the case, the whole circuit breaker cannot be repaired, taking it out of service and limiting the performance of the substation.

The above urges the experts and legislators to investigate extensively the cited compounds and equipment before deciding about the regulatory regime and transitory delays to apply.

3. Wind Turbine Generators (WTGs):

PFAS can be used in wind turbines, especially in electrical switchgear, in cable insulation, in semiconductors (the latter are used in power convertors, control and protection systems associated to WTGs - see paragraph 6. below), in coated semiconductor plates, as surface coatings and as additives in lubricants. When filling, operating and recycling, manufacturers are bound by high standards to prevent the gas from escaping into the atmosphere.

One must also note that the manufacturing of rotor blades implies the use of PFAS. If this parameter is ignored in the PFAS regulation's drafting process whereas the UE follows a decarbonisation path through the massive deployment of renewable energy assets, with a strong Net zero industrial (NZIA) policy, the production of WTGs will most probably be relocalised outside the EU.

Alternative technologies are being developed in isolated cases but currently are not reliably available on the market. Therefore, a transition period of 13.5 years is appropriate, but an investigation must be conducted regarding semiconductors.

4. Fuel cells:

There are many application areas for PFAS in fuel cells. They occur in particular in the gas diffusion layers, sealing materials for gas, water and air paths, and the cooling circuits. Since no alternatives are currently available in the areas of application, **a transition period of 13.5 years seems appropriate for this. Alternative solutions exist for proton exchange membranes; a transition period of 6.5 years as set in the proposed restriction should be enough**.

5. Electrolysers and P2X apps

For electrolysers, and more generally for **applications at a product development stage** for which the use of substances containing PFAS is necessary, an assessment and classification by ECHA in the sense of essential uses should occur. This is associated with unlimited use in the corresponding usual production and life cycles. The further use of substances containing PFAS is subject to the condition that no other equivalent technological alternatives are available.

Chemical and thermal stability are particularly important for electrolysers. In gas diffusion layers, fluorinated polymers are needed as electrochemically stable binders and surface functionalization (hydrophobic/hydrophilic) to withstand acidic conditions near catalysts or fuels or electrolytic cell membranes. The excellent chemical and electrochemical stability of fluorinated polymers under various conditions in fuel cells or electrolytic cells is of particular importance here and, according to current technical standards, cannot yet be replaced.

To be more specific, a ban of PFAS would mostly affect Proton Exchange Membrane (PEM) electrolysers. Indeed, the proton exchange membranes used in the electrolysers are made of SPE (solid polymer electrolyte), which contain PFAS. Thus, banning these PFAS could lead to an increased use of alkaline electrolysers instead of PEM electrolysers, even though the latter are more compact and flexible in operation (which entails a better integration of intermittent RES).

6. **Semiconductors manufacturing and production**

PFAS are essential in semiconductors manufacturing. In the energy sector, including power transmission and power generation, semiconductors are used for several applications such as power convertors to transmit power in WTGs, Photovoltaic and HVDC systems, in intelligent devices which are used to control and protect the electrical systems, and so on.

An investigation should be made with semiconductor manufacturers to define the regulatory regime and transitory delays to apply.

B. Additional requests from the electricity industry

Since the electric sector plays an essential role for society regarding decarbonisation, the PFAS restriction should provide a special regime for equipment, components or mixtures containing PFAS standing for facility **safety**, electrical supply **security**, as well as renewable and low-carbon electric means of production.

In particular, **and in addition to the specific requests for derogations mentioned above**, the PFAS restriction should expand:

- **The proposed derogation "*Fluoropolymer applications in petroleum and mining industry until 13.5 years after entry into force*" to the energy sector;**
- **The proposed derogation "*Additives to hydraulic fluids for anti-erosion/anti-corrosion in hydraulic systems (including control valves) in aircraft and aerospace industries (until 13.5 years after entry into force)*" to the energy sector;**
- **The proposed derogation "*Lubricants where the use takes place under harsh conditions or is necessary for safe functioning and equipment safety (until 13.5 years after entry into force)*" to all articles (e.g., seals) and mixtures of the energy sector.**

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