About the current status of the PFAS restriction proposal

PFAS – the status quo

by

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In cooperation with Fluoropolymergroup of pro-K

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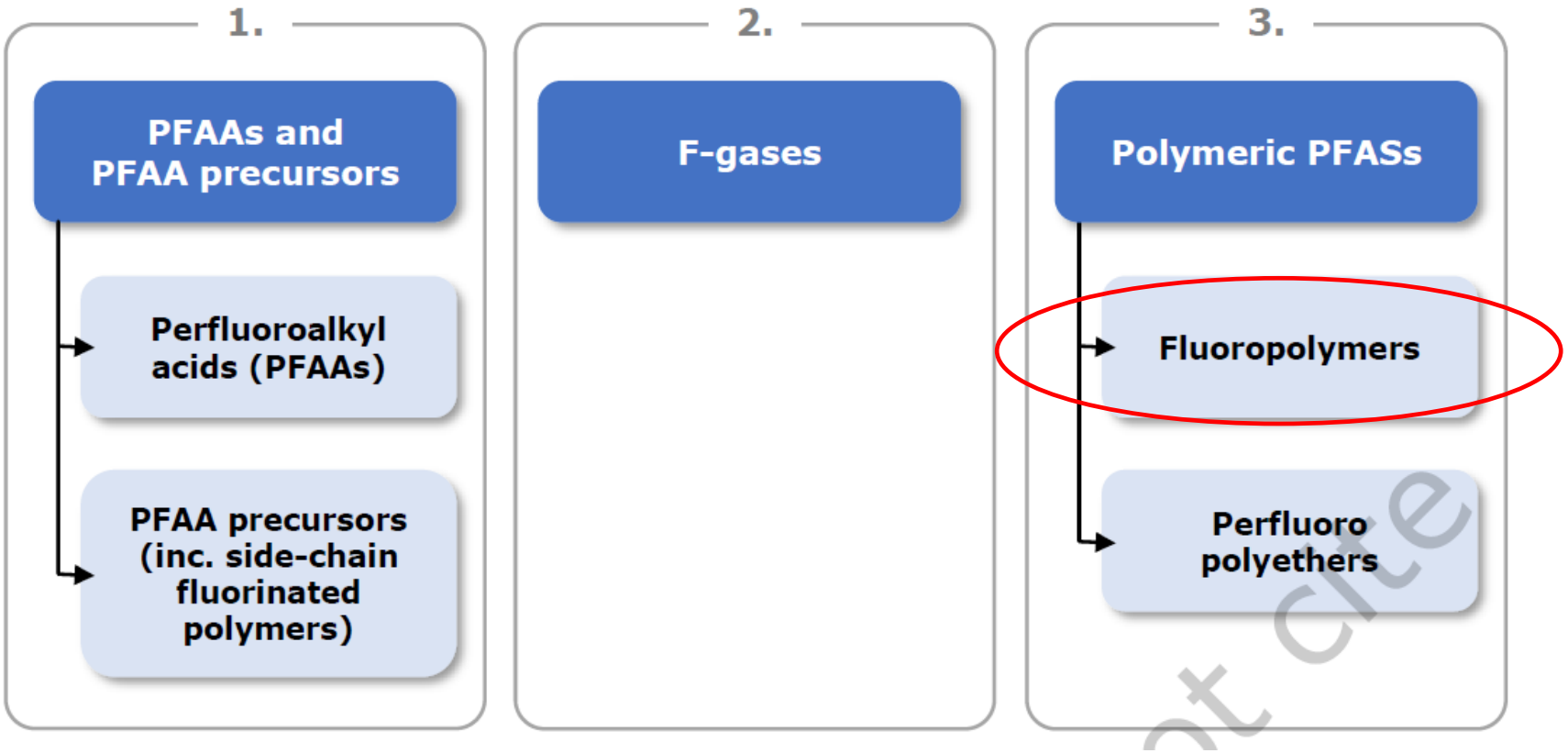
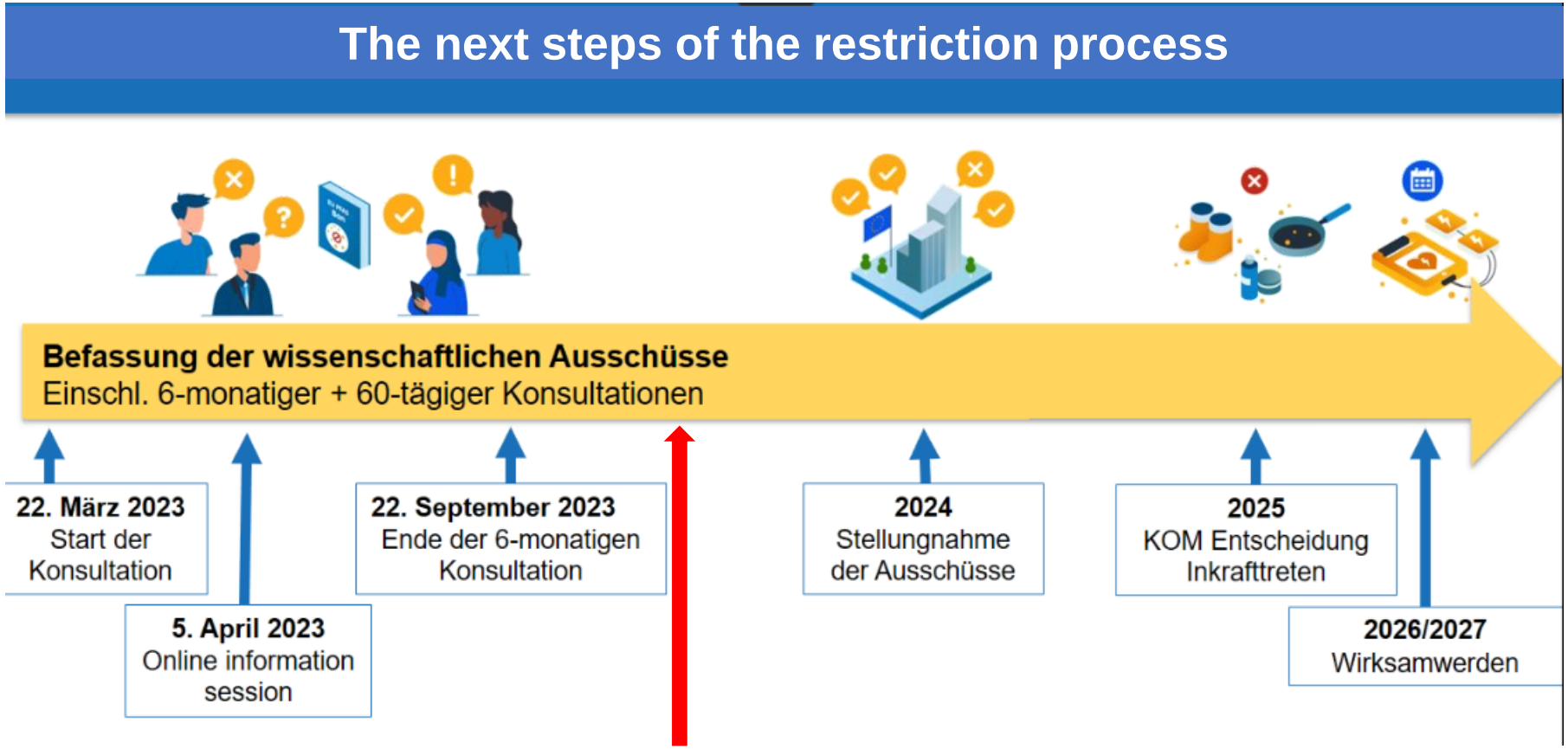
Focus on Fluoropolymers (38 Polymers), defending them to guarantee their survival is of highest importance

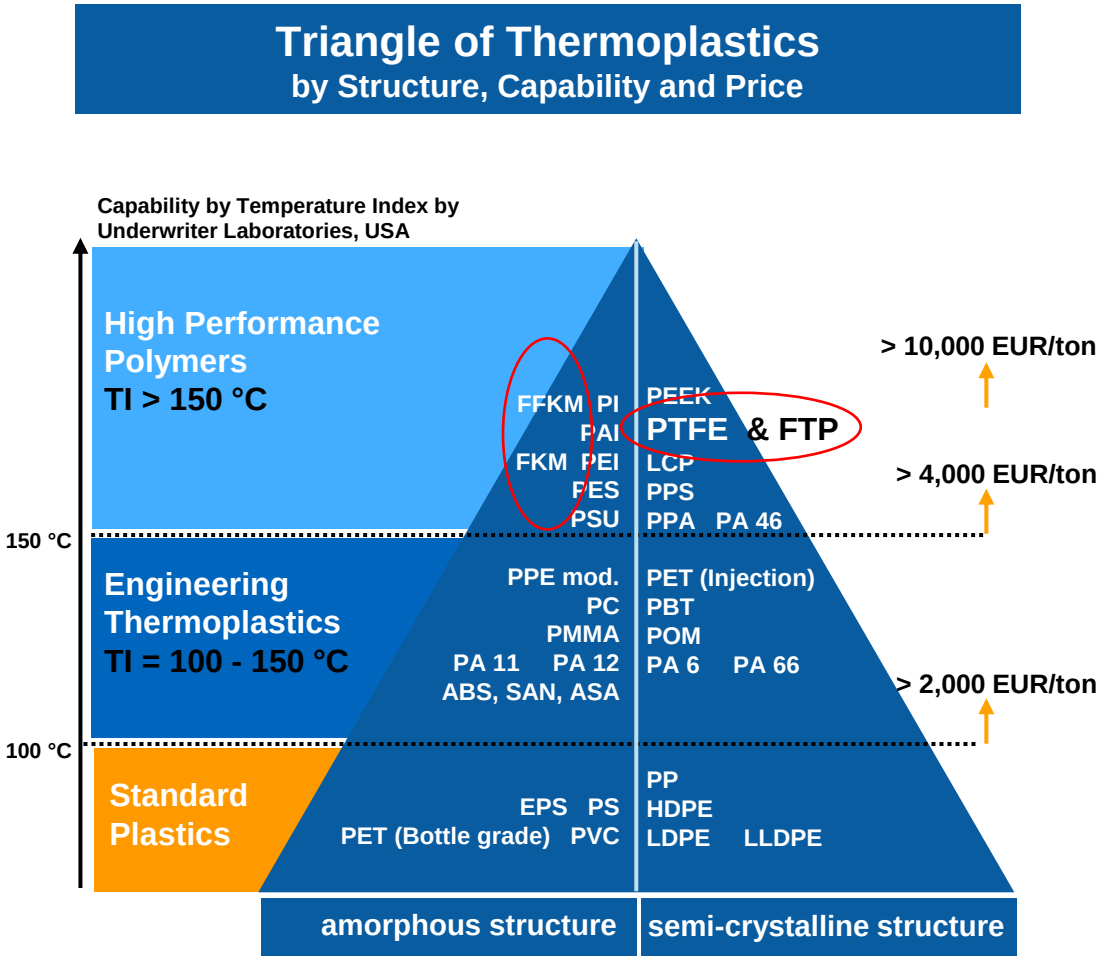
The other PFAS (> 10.000) are not within consideration today



The next steps of the restriction process



Thermoplastics Classification



Standard plastics (up to 100°C) include Polyolefins, PS, EPS, PVC and PET (Bottle grade)

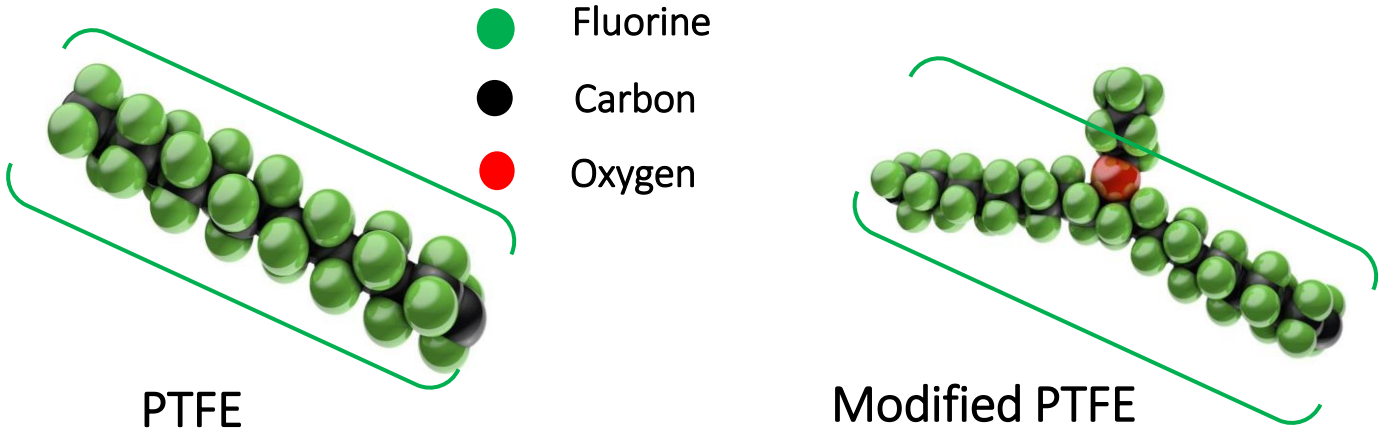
Engineering plastics (up to 150°C) with improved performance at higher costs

High performance polymers (up to 300°C) such as Fluoropolymers (PTFE, FTP, FKM, FFKM) permitting exceptional end-use-applications, specialized products at high value.

No alternatives do exist for fluoropolymers in their technical applications …. Without loosing PLC*)-status

***): PLC: Products of low concern**

The special positioning of Fluoropolymers in the triangle of thermoplastics



The three factors, that make Fluoropolymers different:

- The C-F – bond is the strongest bond in organic chemistry and cannot be replaced by a weaker bond. The bond itself is polar but due to the high symmetry of the molecule, the material itself is non-polar
- The perfect shielding of the C-backbone by the F-atoms makes chemical attacks nearly impossible
- The high molecular weight up to $M_w = 10^8$ g/mol (degree of polymerization up to $P_n = 10^6$) means long molecules which have negligible concentration of reactive endgroups

- **These factors have to be taken into consideration when searching for alternative materials**

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Essentiality of fluoropolymers

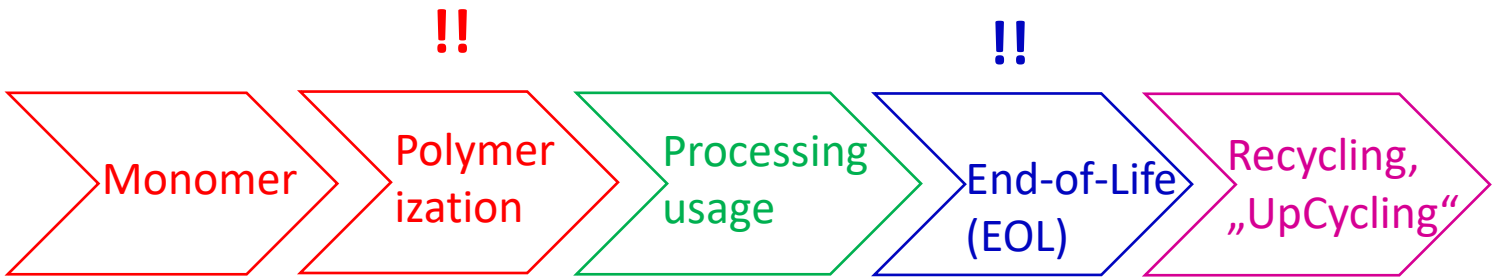
Fluoropolymers ensure safety, reliability, durability and critical performance in everyday applications

Inertness, repellency, temperature resistance, chemical resistance, abrasion resistance, low dielectric constant make them essential materials for a broad range on industries

Fluoropolymers are indispensable in achieving EU Green Deal objectives and UN Sustainable Development Goals (UN SDG)

Key sectors – Green H_2, Semiconductor, Transportation, E-mobility (batteries), Clean & Green Energy, Chemical & Power plants, Electronics, 5G data communication, Medical & Surgery

Using Fluoropolymers
The value chain of Fluoropolymers



Avoidance of fluorinated processing aids and/or minimization of emissions

Products are safe → „PLC“

To ensure that no toxic emissions are being generated after reaching EOL

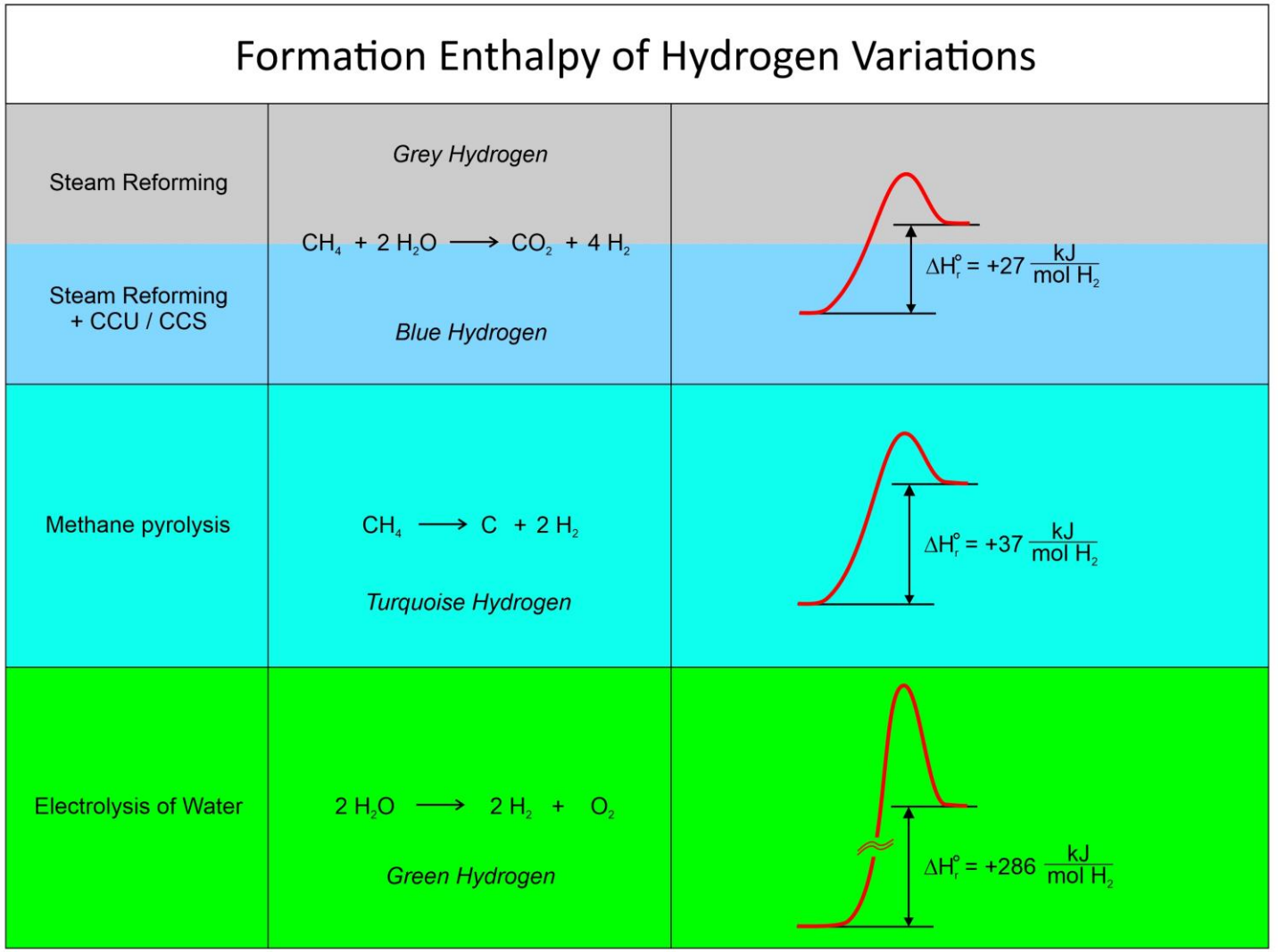
„Circular economy“ requires the participation of all players within the value chain of Fluoropolymers. Besides Co. „Invertec“ (Total engineering for UpCycling plants) another new company has been founded: „Element9 GmbH & Co.KG“ collecting and recovering EOL-products where they are generated (e.g. maintenance projects) and preparing the feedstock products for the UpCycling process

The colours of Hydrogen, H_2:

Blue Hydrogen:
„Fossile Hydrogen“

Turquoise Hydrogen:
„Fossile Hydrogen“

Green Hydrogen:
„Hydrogen, de-fossilation product“

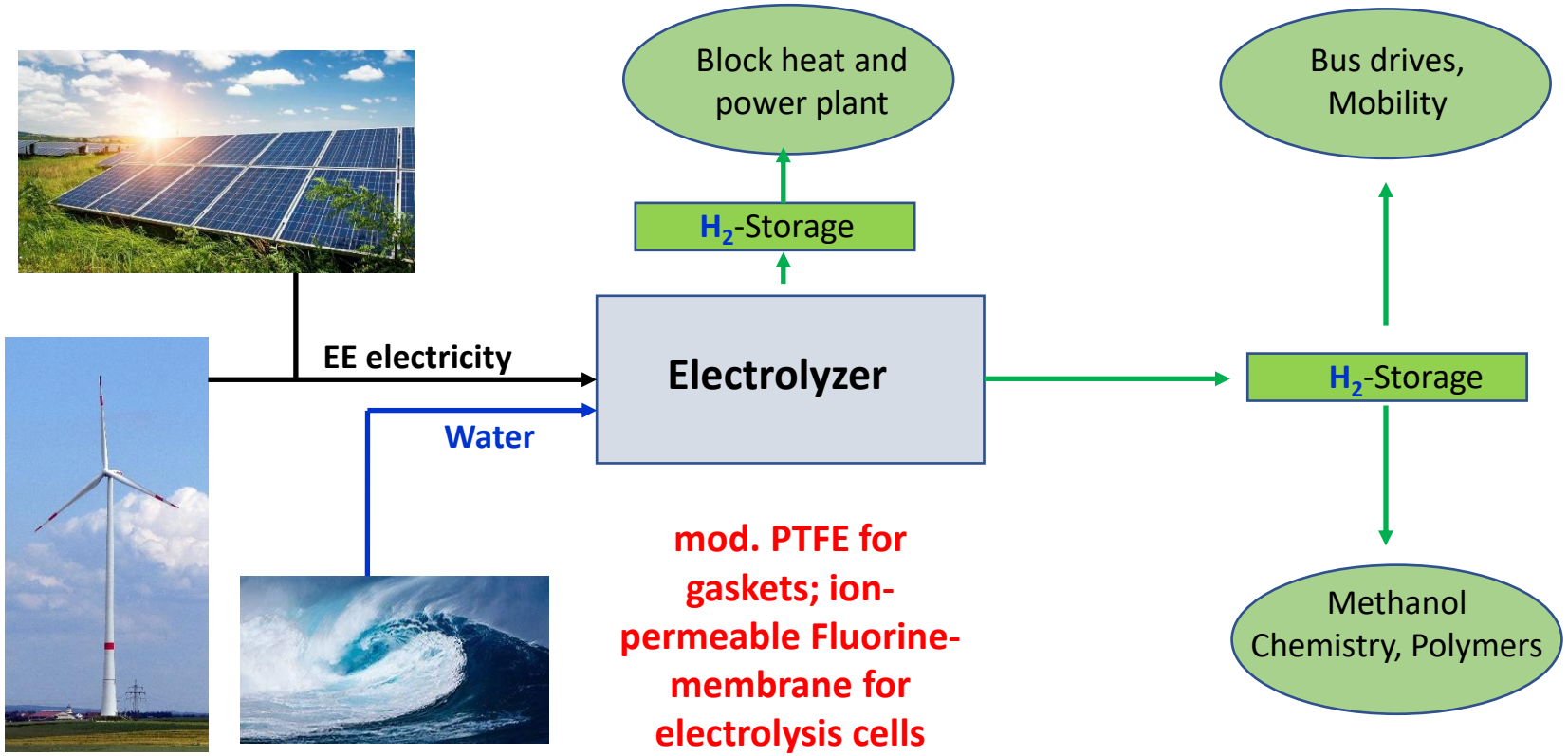


CCU:
Carbon capture and utilisation

CCS:
Carbon capture and storage

Examples in megatrends: ‘Green Hydrogen’

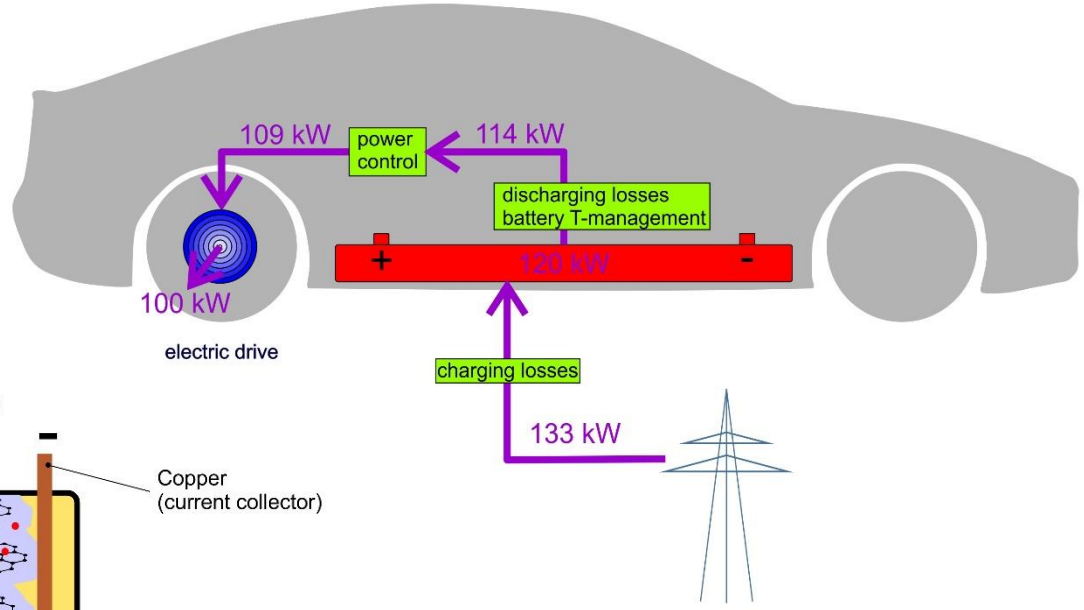
The transition from combustion engines to E-drives requires more electricity! (about 25% plus)
‚Green‘ Hydrogen H_2 can be used as a buffer for the volatile renewable energies such as wind- or photovoltaic energy

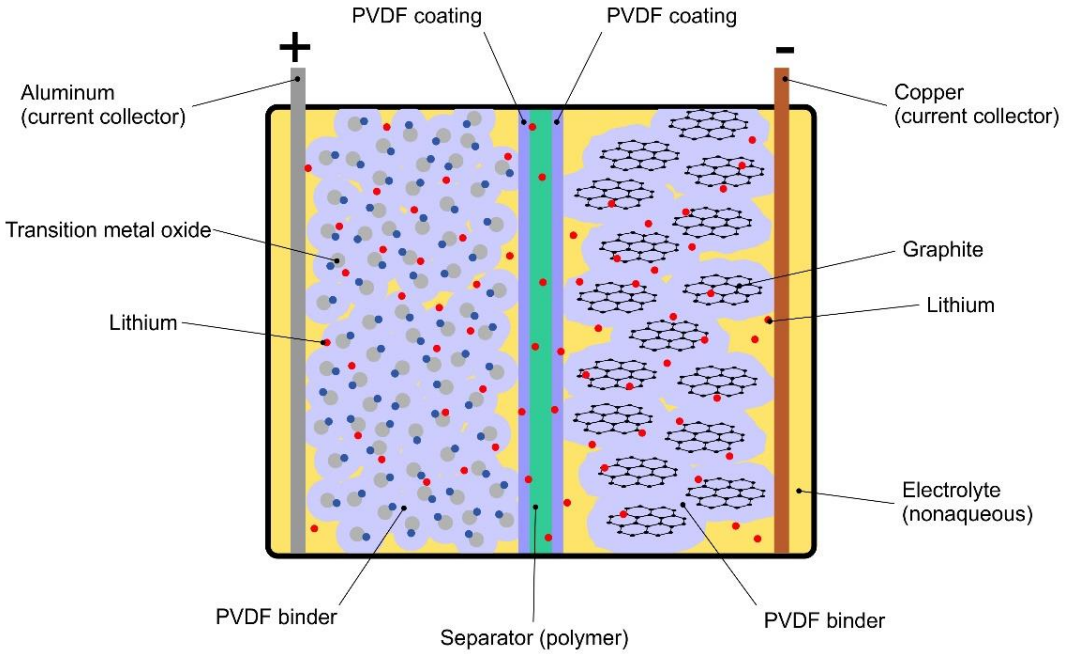


Examples in transportation sector

Megatrends: E-mobility

E-mobility will further grow applications of fluoropolymers





New applications:

- **PVDF** in various functions, e.g. as a binder, in batteries
- **ETFE** in cables
- **Porous PTFE** for ventilation
- **Porous PTFE** for safety → rupture disc function

Applications for PTFE in 5G-Data Transmission

Next to highways:

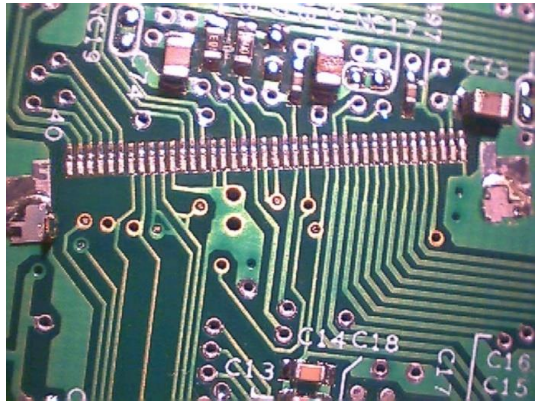
Distance from antenna tower to tower < 5 km

→ Enabling driver assist systems and self driving vehicles

Examples:
Antenna for Transmitters and Receivers; CCL for antenna bodies, cables; signal processing

Examples in electronics and semiconductor industry

Fluoropolymer linings of FRP systems to ensure ultra-high-purity of chemicals used for chip manufacturing through production, storage, transportation and usage.



Printed circuit boards in high-frequency electronics using fully-fluorinated Fluoropolymers enable better data processing.

The exclusion of any metallic ions, which would contaminate the silicon-semiconductor material, can be achieved in the best way by using metal-free-FRP base materials with Fluoropolymer linings.

To guarantee high quality, permanent control is required throughout the whole manufacturing process.

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Examples in electronics and semicon industry: Can PTFE or FEP be replaced by other materials?

The properties of PTFE and FEP in high-frequency (GHz) applications:

- Excellent dielectric properties
- Extremely low loss factor
- Brad service temperature range
- High stability of frequency
- Non flamable , LOI 95, low generation of smoke
- Glass transition of PTFE: T_G = 142 °C; higher than service temperature of electronic components
- No absorption of moisture

Property	PTFE	FEP	PI	PVC	PE	XLPE	EPDM
Dielectric constant εr	1.3-2.1	2.1	3.5	3.5-12	2.3	2.3	3.0-3.5
Loss factor (1 KHz)	<0.0001	<0.0001	0.003	0.07	0.0002	0.0004	0.004

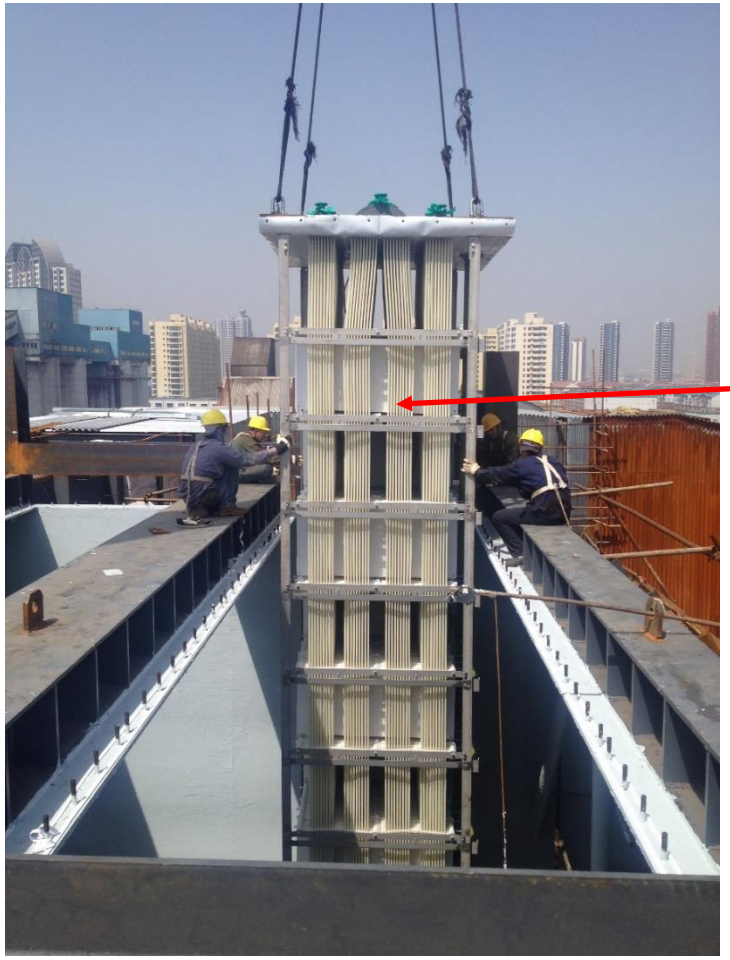
Conclusion:
For high-frequency applications, there is no alternative material to PTFE and FEP!

Megatrends: Energy and clean environment

Protection of the environment
→ make air clean!
Heat exchangers in power plants and municipal waste incineration plants for heat displacement in fluegas desulfurization units

Which products are used?

- Finepowder tubes for heat exchanger
- Skived or extruded film for lining of ducts and modules
- Machined parts for fixation of components
- Guide elements for flue gas flow control



Tube bundle heat exchangers for heat displacement:
Cooling of fluegas to make cleaning possible; reheating the cleaned fluegas for boosting the gas through the stack.

Replacing steel pipes:
1 m of steel pipe is equivalent to 1,45 m of PTFE tube …. offering the same performance in heat displacement

Pharmaceutical and medical machinery / applications

Colour-marked tubes for surgery, extruded and blow-molded

Trockar tube for minimal invasive surgery

Source:
ElringKlinger Kunststofftechnik GmbH

Dual-piston pump for dialysis

Different materials and manufacturing technologies provide ‚unlimited' solutions to the market

Regulatory Updates – United States

Congressional Committee on Appropriations

- Study on Lifecycle assessment of fluoropolymers – U.S. Department of Energy (DoE) along with Savannah River National Laboratory and Vanderbilt University
- Questionnaire to supply information to DoE on production, uses, costs and benefits of fluoropolymers relative to alternatives
- Draft study report is expected in December 2023; Final report in March/April 2024
- Data submitted on the lifecycle assessment of fluoropolymers

Regulatory Updates – United States

U.S. Senate Committee on Environment & Public Works

- In July 2023, the Senate Environment and Public Works (EPW) Committee released the draft of bipartisan PFAS legislation to mitigate and remediate PFAS contamination, and the House Energy & Commerce Committee continues to oversee current regulatory activity and potential legislation to address PFAS
- Definition of PFAS as mentioned in the EPW Bill:
- The term ‘‘perfluoroalkyl or polyfluoroalkyl substance’’ means
- (i) a non-polymeric perfluoroalkyl or polyfluoroalkyl substance; and
- (ii) a side chain fluorinated polymer that is a member of a group of human made chemicals that contain at least 2 fully fluorinated carbon atoms
- **Fluoropolymers are exempted from this definition**

Regulatory Updates – United Kingdom

- In April 2023: UK REACH published a Regulatory Management Options Analysis (RMOA) on PFAS
- PFAS group is divided into two primary categories; non-polymeric and polymeric PFAS
- Fluoropolymers and Fluoroelastomers are grouped separately under polymeric PFAS
- **Fluoropolymers fall under low hazard group and therefore exempted**
- PFAS restriction under UK REACH need not apply to low hazard groups or low risk uses. For example; fluoroplastics or fluoroelastomers (low hazard groups)
- UK REACH: Regulatory management option analysis (RMOA) (hse.gov.uk)

Regulatory Updates – China, Japan

- **Japan**
- Perfluorooctanoic Acid (PFOA) and its salts: Designated as Class I specified chemical substances & ban their manufacture, import and use.
- **China**
- Ministry of Ecology and Environment published a List of New Pollutants under Key Control whose production, processing and use are prohibited - effective from March 2023

1. Perfluorooctane sulfonic acid and its salts and perfluorooctane sulfonyl fluoride (PFOS class)
2. Perfluorooctanoic acid and its salts and related compounds (PFOA class)
3. Perfluorohexyl sulfonic acid and its salts and related compounds (PFHxS class)

Polymeric PFAS are not mentioned in these current regulation drafts, neither in Japan nor in China.

European Union

PFAS restriction proposal

- Status – ECHA Public Consultation has ended 25th September 2023
- Appr. 5.600 submissions have been received

- Risk Assessment Committee (RAC) discussions started on August 23-24, 2023
- Good amount of agreement that Fluoropolymers are Polymers of Low Concern
- Remaining concerns related to Fluoropolymer lifecycle – Manufacturing and End of Life
- Requested information on PFAS emissions during their lifecycle

- Hints regarding expected SEAC's Draft Opinion
  - SEAC supports the restriction on PFAS
  - SEAC does not have an opinion on the exemption of fluoropolymers
  - SEAC will make an opinion based on the opinion of RAC

Federal Republic of Germany

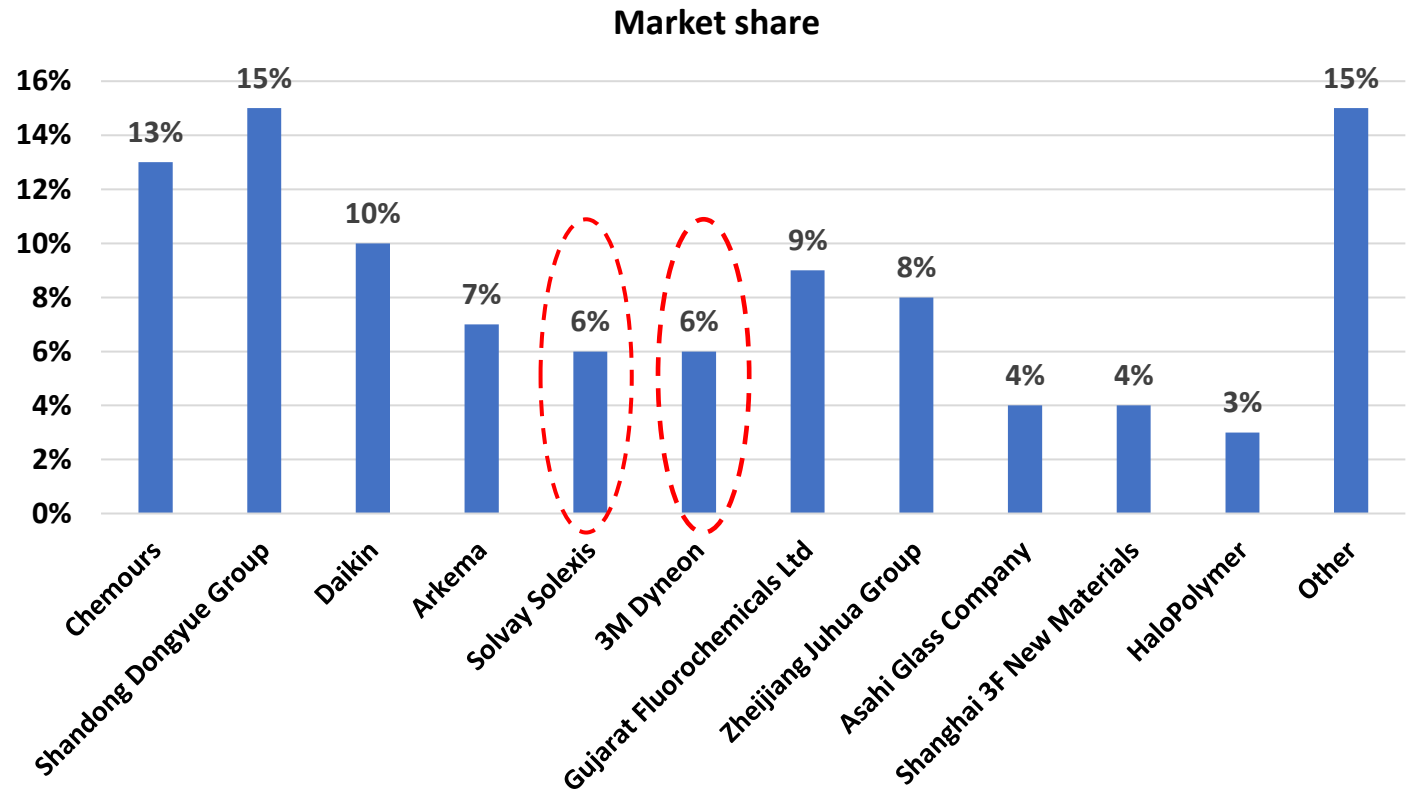
Press release from chancellor’s office: Chemistry Summit dated 27.09.2023:

- The Federal Government is committed to ensuring that the EU's benchmark for REACH substance restrictions remains risk-based.
- In the Federal Government's opinion, blanket, undifferentiated bans on entire classes of substances are not covered by the existing European legal framework and are not envisaged under the current proposal from the German and other specialist authorities.
- A total ban on PFAS is not planned and would not be supported by the Federal Government. In the Federal Government's opinion, it should remain permanent, especially in the context of the discussions about the European chemicals strategy and REACH.
- In order to avoid as much as possible the negative effects of substances on the environment and health and increasing dependencies on non-European suppliers and at the same time to further improve the industry's ability to transform, research into alternatives must also be pushed forward decisively.

Federal Republic of Germany:

Impact of the PFAS restriction proposal onto the economy:

Overview on ***manufacturer of Fluoropolymers***, the world-wide leading companies:



More information on Dyneon and Solvay see next page

Federal Republic of Germany:

Impact of the PFAS restriction process onto the industry: ***Exit scenarios in Europe***

Dyneon GmbH (Germany):

- 3M, U.S., owner of Dyneon GmbH at Gendorf site, Germany, has announced the exit from PFAS production in 2025. This involves Fluoropolymers.
- Background of this decision obviously are ‚environmental issus' in United States in the field of side-chain fluorinated polymers … not Fluoropolymers.
- After entry into force of this announcement about 40% of the Fluoropolymers, processed in Europe per year, these are around 42.000 to/a, will not be available anymore for the European Fluoropolymer market.
- UpCycling technology, the leading technology of chemical recycling of Fluoropolymers to replace linear economy by circular economy, will probably not available anymore as well. The development of this technology was funded by the DBU and the „Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit". A pilot plant of 500 to/a capacity for developing the UpCycling process in commercial quantities was erected and operated for five years at Gendorf site, Bavaria.

Solvay (Italy)

- Announced to terminate the following product lines:
  - Algoflon E-PTFE, ‚Finepowder-PTFE' and aqueous PTFE-Dispersion
  - Hyflon Fluorthermoplaste

These exits will end in an appr. 50% shortage of Fluorpolymers processed in Europe!

Federal Republic of Germany:

Impact of the PFAS restriction process onto the industry: ***Will there be alternative suppliers?***

- If local production is terminated, Europe becomes more depended on suppliers from out of Europe. **Will this be also the case for Fluoropolymers?**

The following options for alternative suppliers out of Europe can be taken into consideration:

- U.S., Co. Chemours: Doubles production of PFA HP in 2023 in order to enable the investment of Samsung‘s chip production in Texas. Supply of PFA HP into Europe cannot be expected due to the competitive situation in the chip-production area between U.S. and Europe.
- India, Co. Gujarat Fluoropolymers (GFL): Company is importing into Europe. GFL enabled the growth of the Fluoropolymer market during the last 10 years. Product portfolio (Dyneon & Solvay) is not available; some quality issues. PFA HP for chip-production just starting.
- China different manufacturers: Delivery of Fluoropolymers into Europe is ‚volatile‘. Partially quality issues; no high-tec products such as PFA HP available. China prefers to export finished products into the European market (e.g. BWD EVs). Exporting Fluoropolymers, ‚base materials‘ into Europe, appears to be second priority.
- Russia: currently not within focus.
- Japan: Manufacturers of Fluoropolymers primarily supply to home market. Daikin focussing more and more onto Europe.

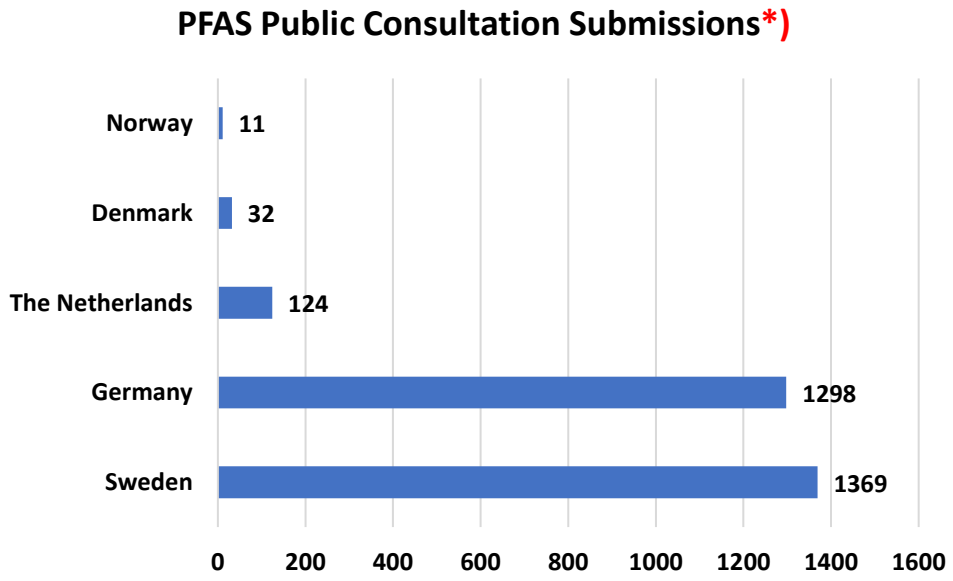
Conclusion:

- **Alternative suppliers of Fluoropolymers for Europa in sufficiant quantity and quality are not available! Investments like Co. INTEL in Magdeburg are becoming unrealistic due to lack of PFA HP!**

Federal Republic of Germany:

Impact of the PFAS restriction process onto the industry: ***Who is concerned?***

- Five countries have initiated the PFAS restriction proposal: Germany, The Netherlands, Denmark, Norway and Sweden. Within this group, GERMANY is the only country with significant Fluoropolymer industry.
- This can be seen also from the number of entries, submitted during the ‚Public consultation phase' March – September 2023 (in total 5.642):



*): Following an initiative of a swedish NGO appr. 1.200 submissions have been generated by private people, voting for an ‚overall PFAS ban'. No detailed data have been provided. Therefore for Sweden appr. 169 ‚real' submissions from the industry are left.

In case of a restriction of Fluoropolymers, the economy in Germany is concerned the most!

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Federal Republic of Germany:

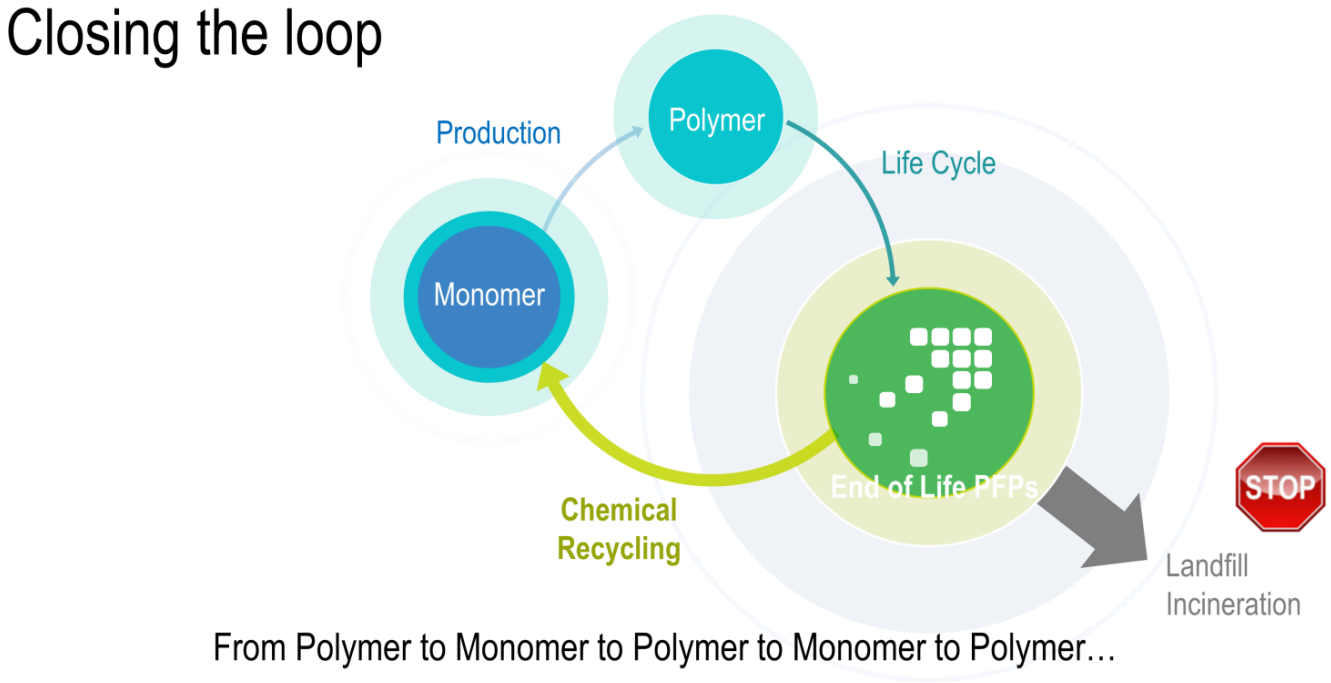
Impact of the PFAS restriction process onto the industry: ***The impact of an "adjourned game"***

According to plan and following experiences from the ongoing process, the ‚PFAS restriction process' probably will last for another four years… could be until 2027:

- Most of the companies processing Fluoropolymers are of small or middle size. They will not survive such a long-term „adjourned game" with uncertain result, at least not without taking severe damage.
- Company decisions, especially decisions on investments and future strategy, must be decided on an annual base.

- **Therefore pro-K, the association of the Fluoropolymer processing industry, with some members from the manufacturing and end-use side, request the exemption of Fluoropolymers from the PFAS restriction process. Fluorpolymers are defined by OECD to be „Polymers of low concern (PLC)" and now further regulation is required. Following this route, Europa would walk the same path as other countries are doing, such as U.S., U.K., Japan, China ….. and continuation of businss with these regions could go on!**

End of Life (EOL) safe disposal & Circularity, the future: UpCycling Process (I)



The UpCycling process:
After reaching the end-of-life (EOL), the products are colllected, thermally decomposed into the monomer Tetrafluoroethylene (TFE) and some Hexafluoropropene (HFP), which is equivalent to „Chemical recycling“, and, after purification, again use for polymerizatio to manufacture new fluoropolymers. Thus manufactured polymers do not show any difference in properties compared to the original polymers. This kind of recycling is boosting up ‚old materials‘ into new ones, quality basically is enhanced ‚back to the original‘.

End of Life (EOL) safe disposal & Circularity: UpCycling Process (II)

500 mtons pilot plant;
Funding: Umweltbundesamt UBA
Deutsche Bundesstiftung Umwelt DBU

Circular economy (CE) concept Europe:
Future example

- 52.000 to Fluoropolymer demand (2021)
- 42.000 to Fluoropolymer processing
- 25.000 to EOL- and manufacturing waste

- 500 to: UpCycling pilot plant
- 2.500 to: Commercial UpCycling plant
- 4 commercial plants = 10.000 to
- Degree of FP-recycling in CE appr. 20%

Comparison:

- Degree of recycling of all plastics in EU: 14,9%

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Conclusions:

- Based on a stable fundament, the fluoropolymer industry is expected to further continue its growth, being the fundament of many new megatrends (2022: 320.000 to → 2025: 400.000 to)
- We, pro-K, request a differentiated view at the various subgroups of PFAS: Complete exemption of Fluorpolymers, known as PLCs, from PFAS restriction process is needed

  - Targets of EU-Green Deal can only be achieved with Fluoropolymers
  - Growth in a broad variety of markets and applications
  - Driven by people‘s innovations
  - On an over-proportional level during the coming years (GDP or higher)

- **Should Europe exclude itself from these opportunities?**

- **Sustainable resource management:**
  The need for closing the loop has come