The Essential Use Concept: Practical application for phasing out hazardous substances

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Phasing out uses of hazardous substances

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- Impractical to ban all uses in one step. Uses may be:
  - **Essential** because they serve a critical role for which alternatives currently do not exist
- On the other hand uses may be:
  - **Non-essential**, and can be eliminated without having to first find functional alternatives
  - **Substitutable**, i.e. functional alternatives exist

- Montreal Protocol on Substances that Deplete the Ozone Layer
  - Introduced concept

- We tested the idea on PFAS

Essentiality of hazardous substances?

- To critically evaluate the idea that uses of hazardous substances are essential in modern society, the essentiality of their uses tested against available evidence
- Adapt the criteria of essentiality from the Montreal Protocol

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The concept of essential use for determining when uses of PFASs can be phased out

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Defining essentiality

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Category	Definition	PFAS examples
1 "Non-essential"	Uses that are not essential for health and safety, and the functioning of society. The use of substances is driven primarily by market opportunity.	Dental floss, water repellent surfer shorts, ski waxes
2 "Substitutable"	Uses that have come to be regarded as essential by society because they perform important functions, but where alternatives to the substances have now been developed that have equivalent functionality and adequate performance, which makes those uses of the substances no longer essential.	Most uses of AFFFs, certain water-resistant textiles.
3 "Essential"	Uses considered essential by society because they are necessary for health or safety or other highly important purposes *and* for which alternatives are not yet established.*	Certain medical devices, occupational protective clothing.

* This essentiality should not be considered permanent; rather, a constant pressure is needed to search for alternatives in order to move these uses into Category 2 above.

Application of essentiality to uses of PFAS in food packaging

Useful functions of PFAS

- Major characteristics of perfluoroalkyl moieties:
  - **high chemical stability** strength of C-F bond
  - **hydrophobic** and **oleophobic** nature

- Especially useful as:
  - **Fluorosurfactants**
    - can lower the surface tension of water to 16 mN/m (half that compared to hydrocarbon surfactants)
  - **Surface protectors**
    - very low surface energies, simultaneous water and oil/stain repellence
    - used in food packaging

PFAS in food packaging

- Historically precursors to PFOS and PFOA used in food packaging

- Now, short-chain ("C6") fluorotelomer-based polymeric products, and poly- and perfluoropolyethers
  - water and grease/oil repellency plus breathability
  - safe?

- Some products need repellency to oil for weeks-months (e.g. butter wrappers), others for minutes (e.g. fast-food wrappers)

Research

A Section 508–conformant HTML version of this article is available at https://doi.org/10.1289/EHP4092.

Dietary Habits Related to Food Packaging and Population Exposure to PFASs

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What are the alternatives to PFAS?

- Physical barrier
  - plastic or aluminium coatings (recycling issues, lack of breathability)
- Chemical barrier
  - Natural Greaseproof or Vegetable Parchment: dense cellulose structure
  - Hydrocarbon- and silicone polymer based alternatives
- POPFREE (Promotion of PFAS-FREE alternatives)
  - novel chemistry developed by BIM Kemi
  - tested by paper manufacturers (NordicPaper and Billerudkorsnäs)
  - promising results

https://www.ri.se/en/popfree/about-popfree-project

Are PFAS essential in food packaging?

- Historically many non-essential uses (category 1)
- Applications are today non-essential (category 1) or substitutable (category 2)
- Innovation ongoing in some applications where durable repellency against oil needed

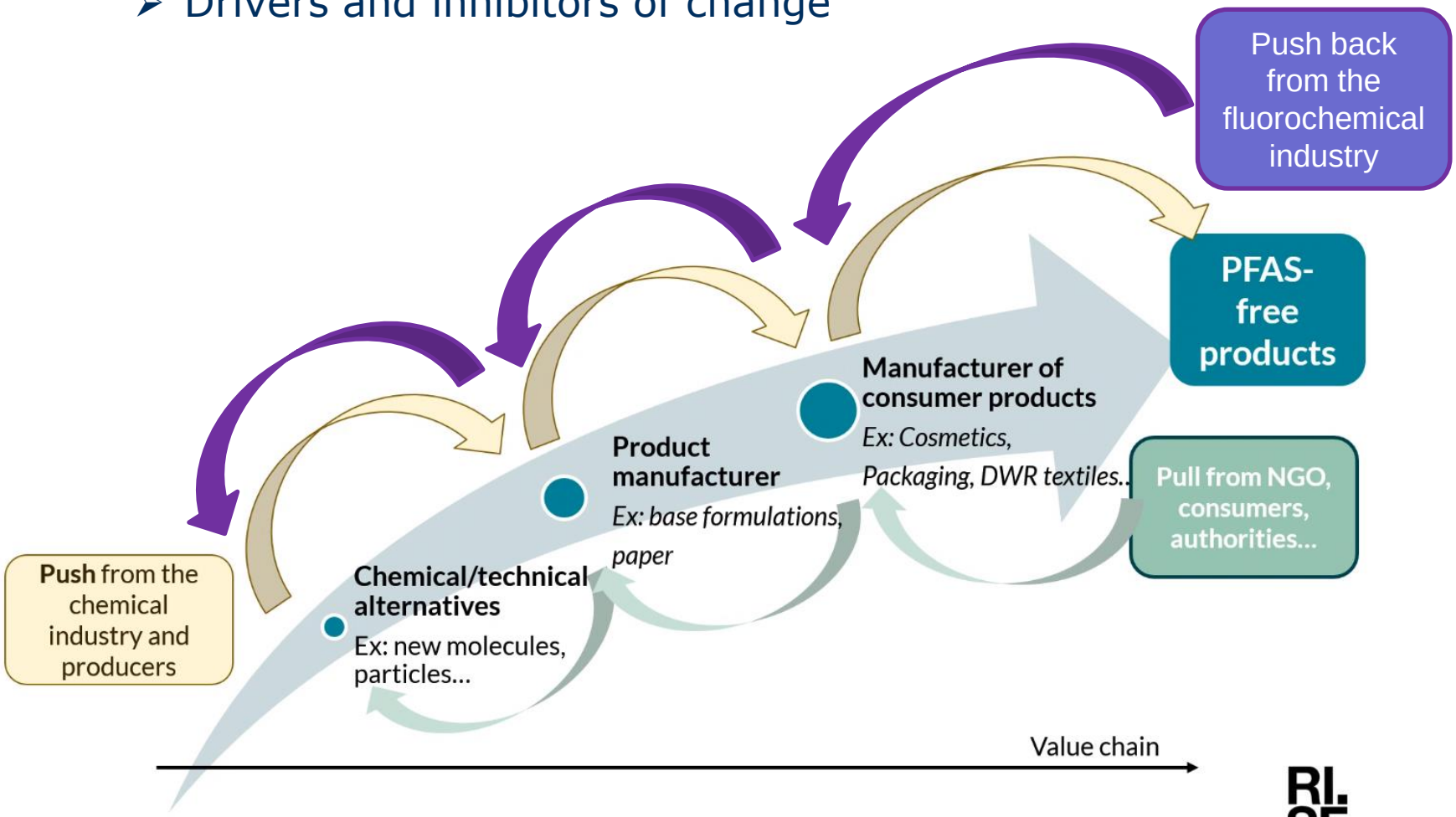
Increasing performance requirements

PFAS can be phased out of food packaging materials

Denmark already decided to do that in 2020

Systemic change underway

- PFAS under global pressure
- Drivers and inhibitors of change



Conclusions/way forward

- Essential use concept can guide phase-outs
  - Focus on category 1 (non-essential uses)

- Category 2 (substitutable uses)
  - avoid regrettable solutions: chemical alternatives assessment (CAA)
  - US EPA's **Design for the Environment (DfE)**, Clean Production Action's **GreenScreen** and McDonough Braungart Design Chemistry **Cradle to Cradle™**

- Innovation for category 3 (essential uses)

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Thank you for your attention!

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GLOBAL PFAS SCIENCE PANEL