Risk governance
in the Chemicals Strategy for Sustainability
– example of PM substances and Safe and Sustainable by Design

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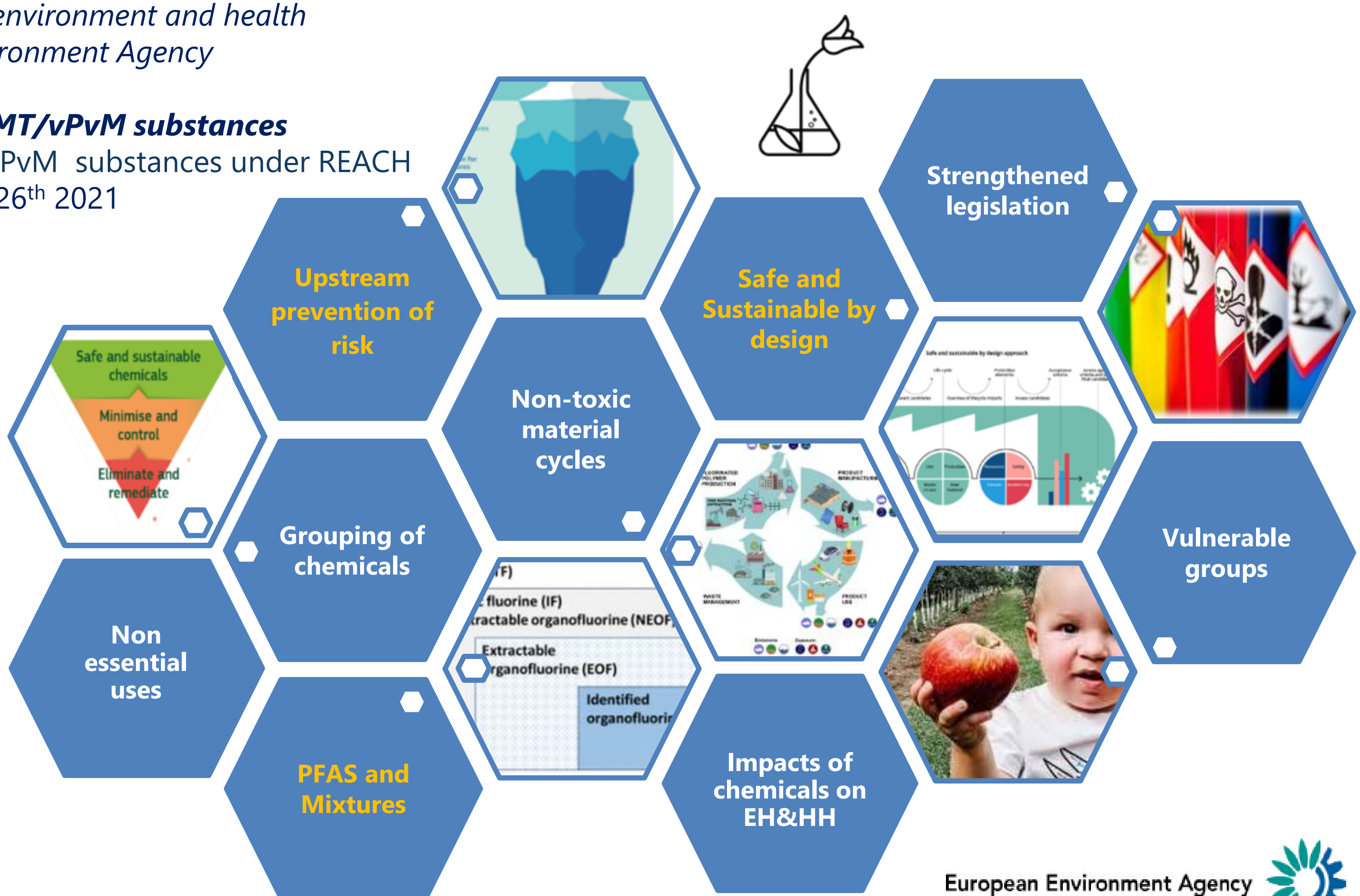
European Environment Agency

3rd workshop on PMT/vPvM substances

Getting control of PMT and vPvM substances under REACH

March 26th 2021



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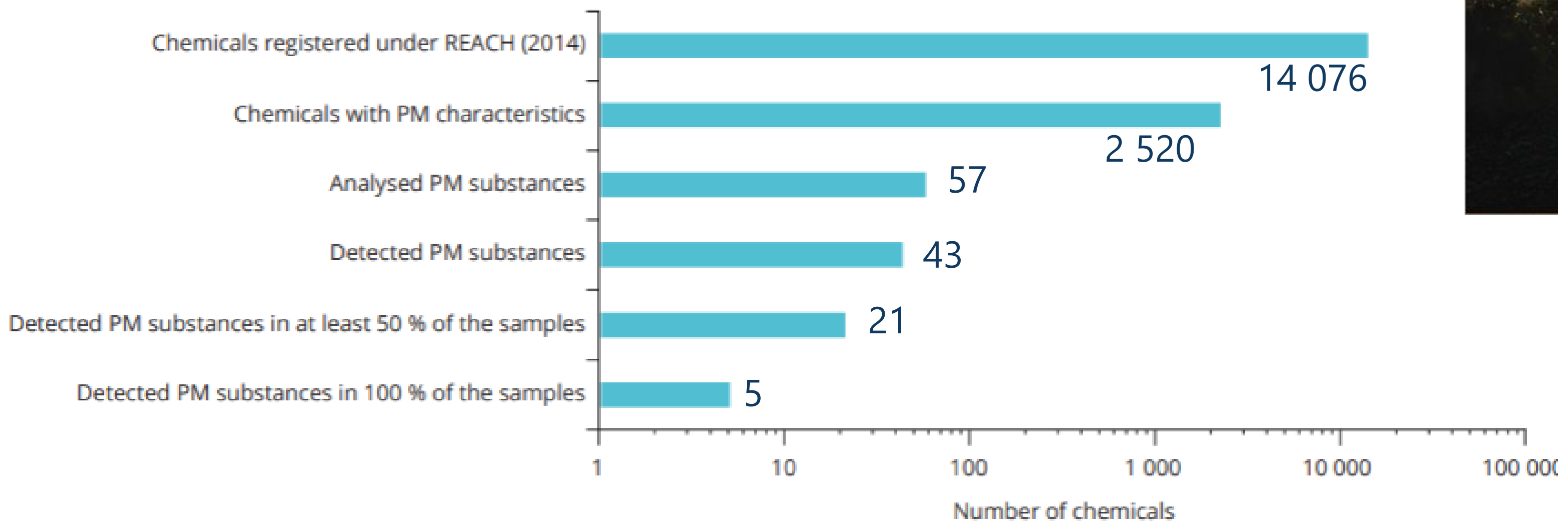
Concerns with PM substances

- **Risk assessment cannot keep up with diversity of chemicals and uses**
- **Pollution occurs along lifecycles**
- **Persistent chemicals that do not mineralise**
  => accumulation
  => exposure (E) increases
  => risk (R) increases: R= H x E
- **Pollution spreads rapidly, across boundaries**
- **Upstream prevention most effective to avoid harm to planet and people**

Read our Report [Europe's environment – State and Outlook](https://www.eea.europa.eu/publications/soer-2020/chapter-10_soer2020-chemical-pollution/)
https://www.eea.europa.eu/publications/soer-2020/chapter-10_soer2020-chemical-pollution/
Glüge et al. (2020): An overview of the uses of per- and polyfluoroalkyl substances (PFAS): https://pubs.rsc.org/en/content/articlelanding/2020/em/d0em00291g#!divAbstract
Cousins et al. (2019) Why is high persistence alone a major cause of concern? Environ Sci Process Impacts 22;21(5):781-792. doi: 10.1039/c8em00515j
Macleod et al. (2014): Identifying chemicals that are planetary boundary threats

PM substances addressed in State and Outlook of the Environment (SOER2020)

FIGURE 10.4 **Fraction of REACH chemicals that are persistent and mobile and found in water**



Note: The scale is logarithmic, PM substances classified as persistent and mobile.

Sources: Schulze et al. (2018, 2019), Brendel at al. (2018); Arp et al. (2017); Arp and Hale (forthcoming).

#SOER2020

https://www.eea.europa.eu/publications/soer-2020

https://www.eea.europa.eu/publications/soer-2020/chapter-10_soer2020-chemical-pollution/view

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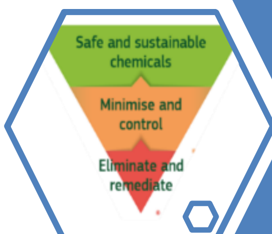
Avoid harm to planet and people

Innovation in SSBD

The EU Chemicals Strategy for Sustainability – focus areas

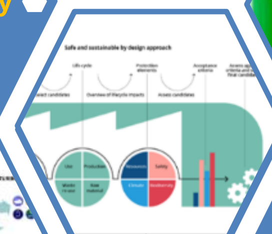


Upstream prevention of risk

Safe and Sustainable by design

Strengthened legislation

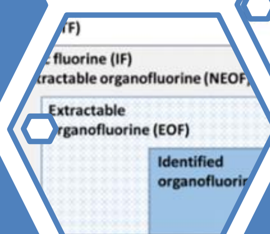
Non-toxic material cycles



Grouping of chemicals

Vulnerable groups

Non essential uses



PFAS and Mixtures

Impacts of chemicals on EH & HH

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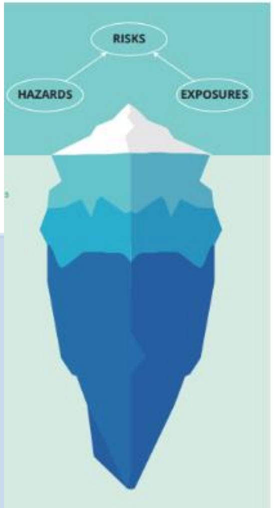
Why Safe and Sustainable by Design?



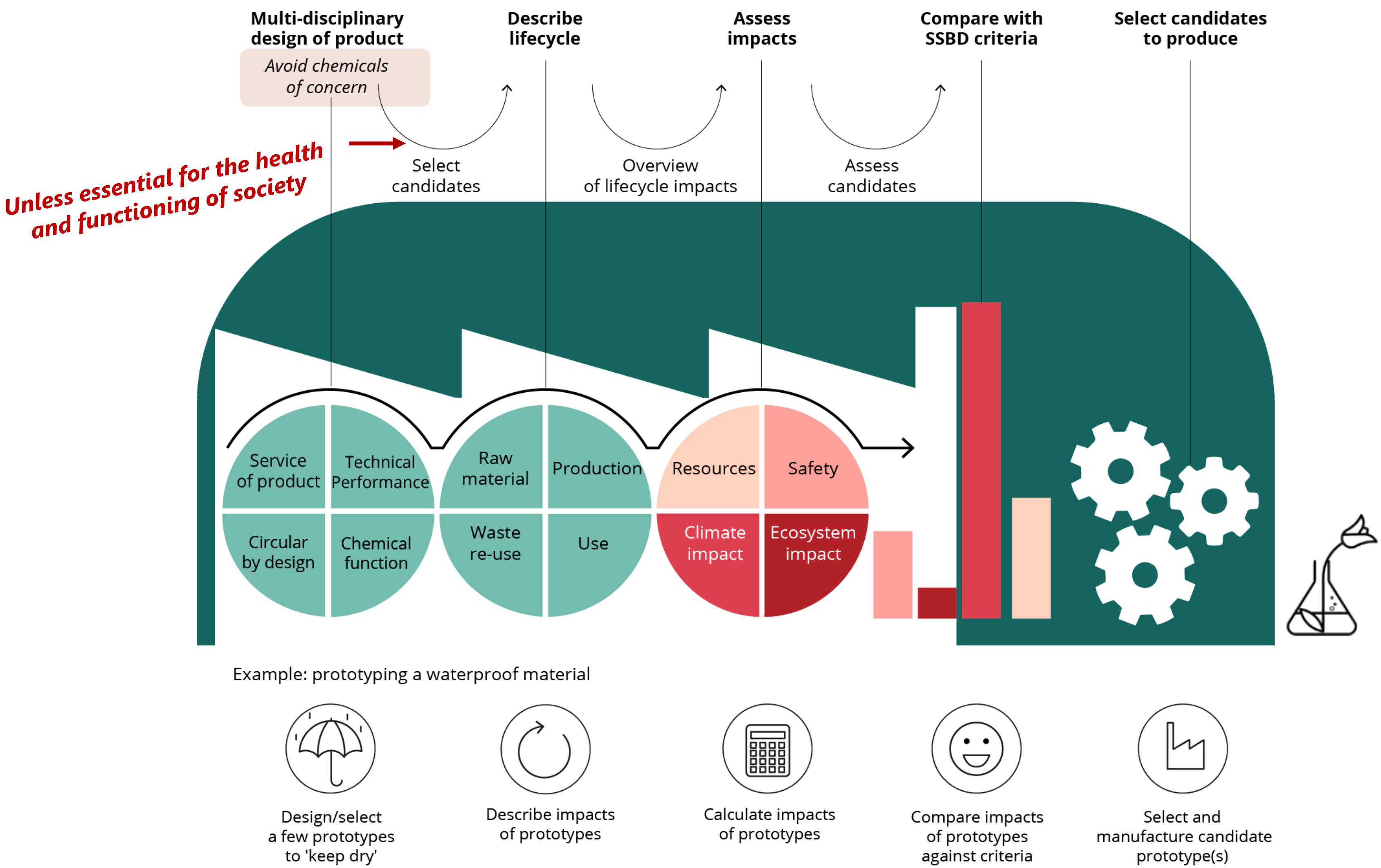
- **European Green Deal:**
  Prevent pollution, environmental degradation, biodiversity loss, resource depletion & climate change - at the same time

- **Chemical Strategy for Sustainability:**
  - **Aim:** Avoid harm to planet and the people.
    $\Rightarrow$ *harm is an absolute goal, from all chemicals and stressors*
    $\Rightarrow$ *prevention of harm is most effective and manageable*
    $\Rightarrow$ *avoid the use of groups/classes of substances of concern*
  - **Tool:** Prevent pollution by Industrial transition to SSBD

Design phase

- **Premarket approach:** applied by industry in design phase
- **More flexibility** in how to deliver a *service* of a product/material, e.g. service of 'keeping dry', 'preventing fires', 'clean surfaces' etc.
- **Lifecycles** of chemicals/materials/products/processes considered

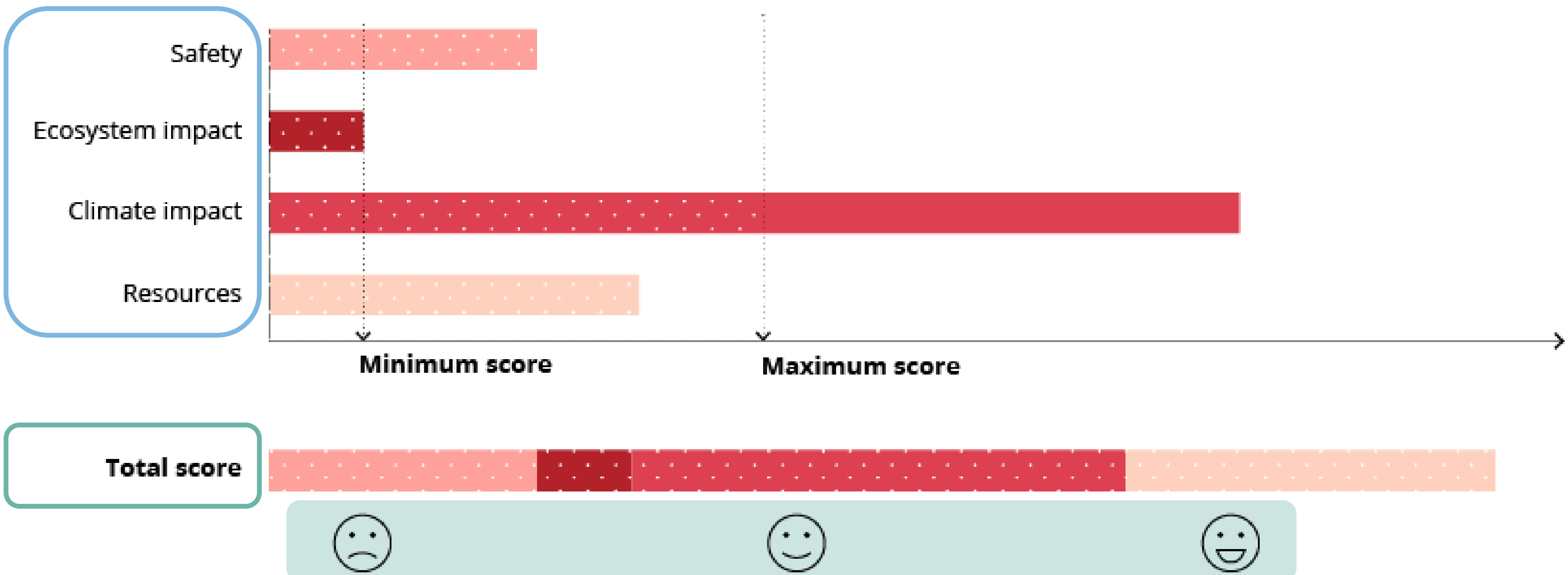
Safe and Sustainable by Design design approach



EEA briefing 2021: Delivering chemicals and products that are safe and sustainable by design.
https://www.eea.europa.eu/highlights/designing-safe-and-sustainable-products

Assessing Safe and Sustainable by Design

- **Meet sustainability goals -** without compromising health of humans and environment!
- **Methodologies need input data** *on production volumes, chemical identity, uses*
- **Avoid burden shifting and create trust in SSBD** by setting minimum scores
- **Criteria for acceptable scores informed by protection goals of society**



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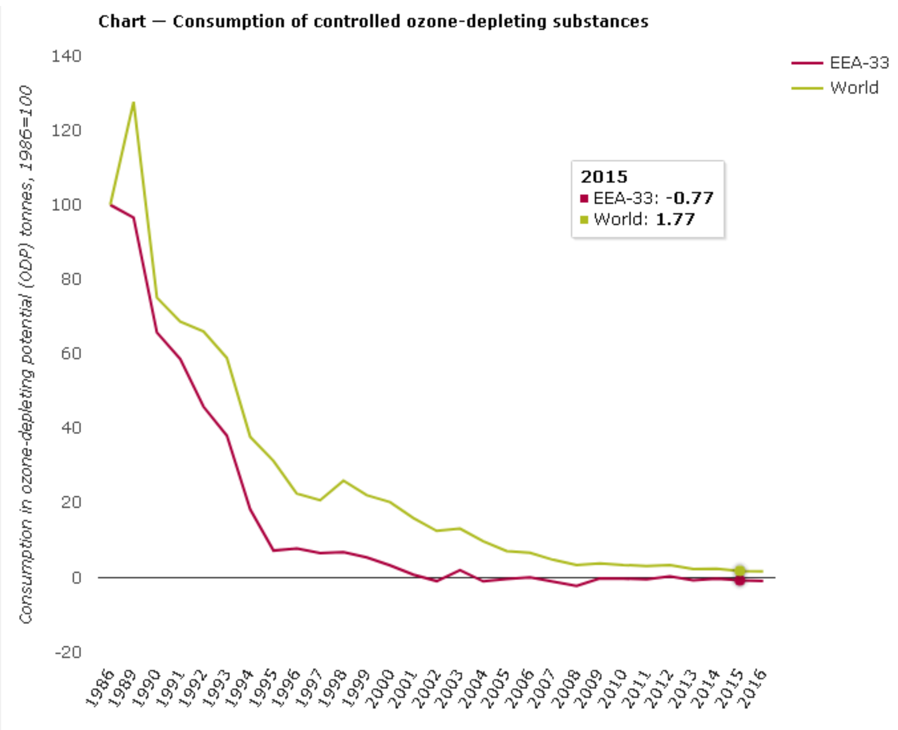
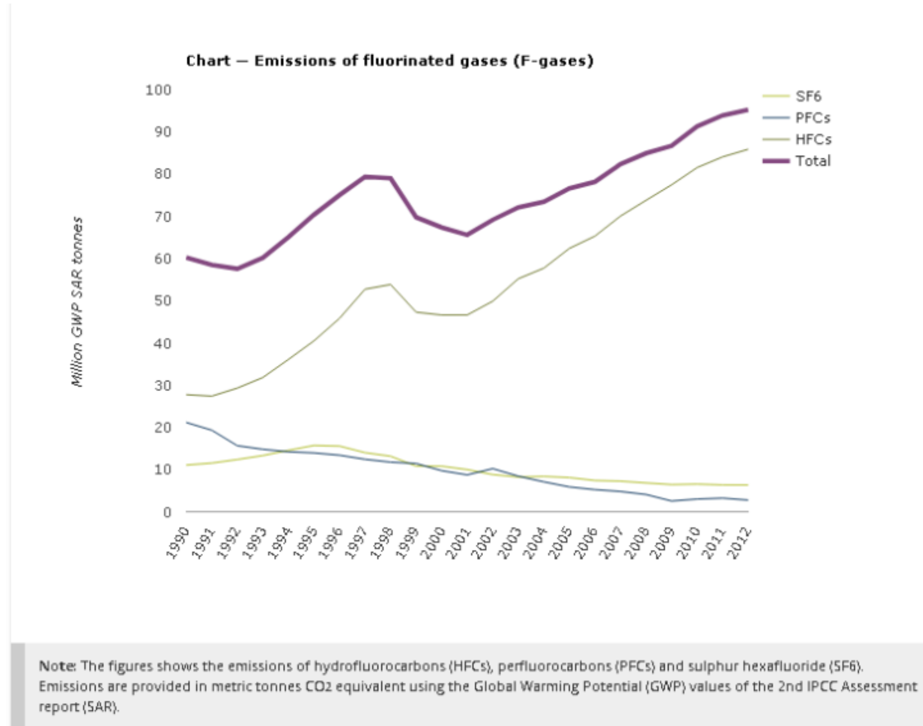
Example: Ozone depleting substances to F-gases: Regrettable substitution

- Reduction in the use of mobile Ozone Depleting Substances (ODS) – success! ☺
- Substitution to mobile, persistent GHG F-gasses => regrettable substitution - ☹
- Substitution to less GHG, mobile HFC, HFOs => Formation of persistent, mobile TFA ☹

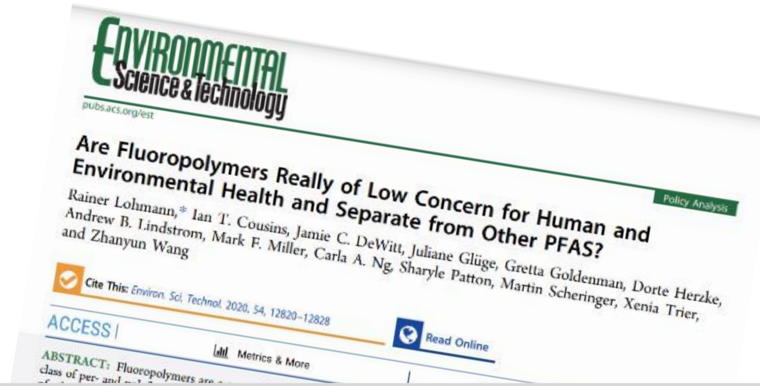




https://www.eea.europa.eu/data-and-maps/indicators/production-and-consumption-of-ozone-2/assessment-3

https://www.eea.europa.eu/data-and-maps/indicators/emissions-and-consumption-of-fluorinated/assessment-2

Example: Products for a circular economy? Fluorinated polymers in complex materials


Environmental Science & Technology
pubs.acs.org/est
Policy Analysis
Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS?
Rainer Lohmann,* Ian T. Cousins, Jamie C. DeWitt, Juliane Glüge, Gretta Goldenman, Dorte Herzke, Andrew B. Lindstrom, Mark F. Miller, Carla A. Ng, Sharyle Patton, Martin Scheringer, Xenia Trier, and Zhanyun Wang
Cite This: Environ. Sci. Technol. 2020, 54, 12820−12828
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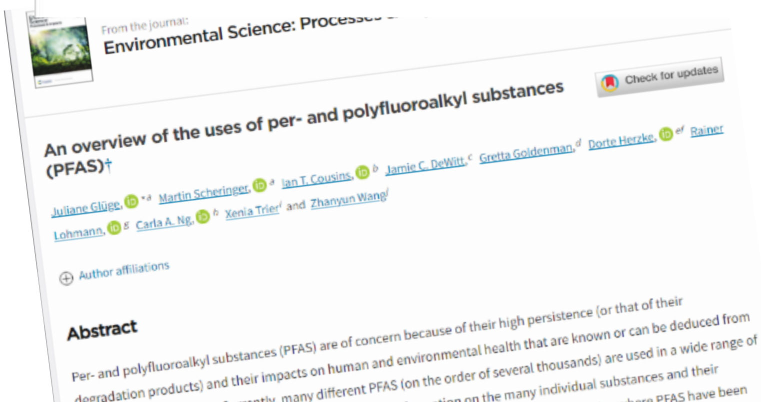
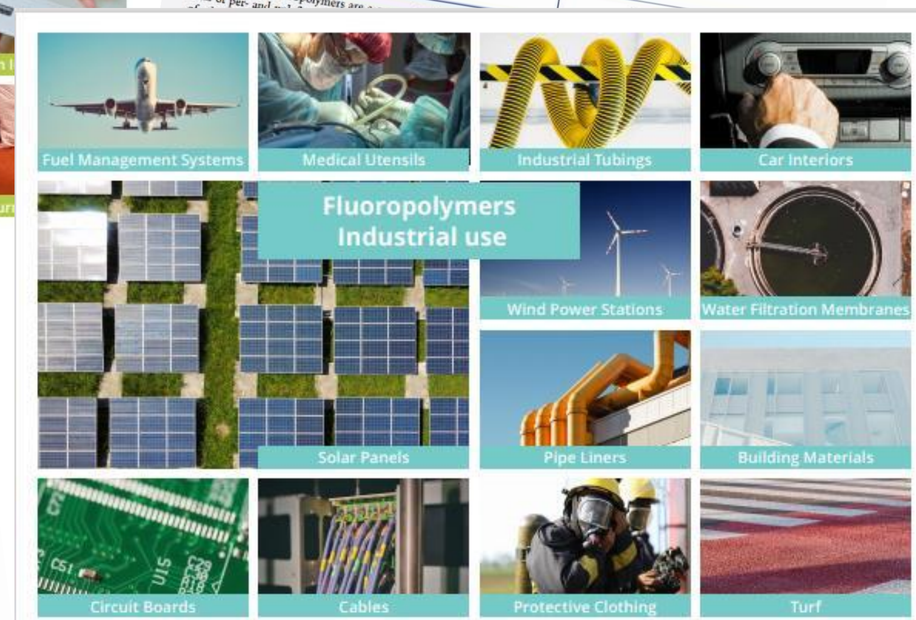
Metrics & More
ABSTRACT: Fluoropolymers are ...


From the journal:
Environmental Science: Processes ...
Check for updates
An overview of the uses of per- and polyfluoroalkyl substances (PFAS)†
Juliane Glüge, Martin Scheringer, Ian T. Cousins, Jamie C. DeWitt, Gretta Goldenman, Dorte Herzke, Rainer Lohmann, Carla A. Ng, Xenia Trier and Zhanyun Wang
Author affiliations
Abstract
Per- and polyfluoroalkyl substances (PFAS) are of concern because of their high persistence (or that of their degradation products) and their impacts on human and environmental health that are known or can be deduced from ... studied PFAS. Currently, many different PFAS (on the order of several thousands) are used in a wide range of ... source of information on the many individual substances and their ... use categories where PFAS have been



https://pubs.rsc.org/en/content/articlelanding/2020/em/d0em00291g#!divAbstract

EEA-ETC report on **'Systemic view on fluorinated polymers in a circular, low carbon and non-toxic economy'** (*forthcoming 2021*)

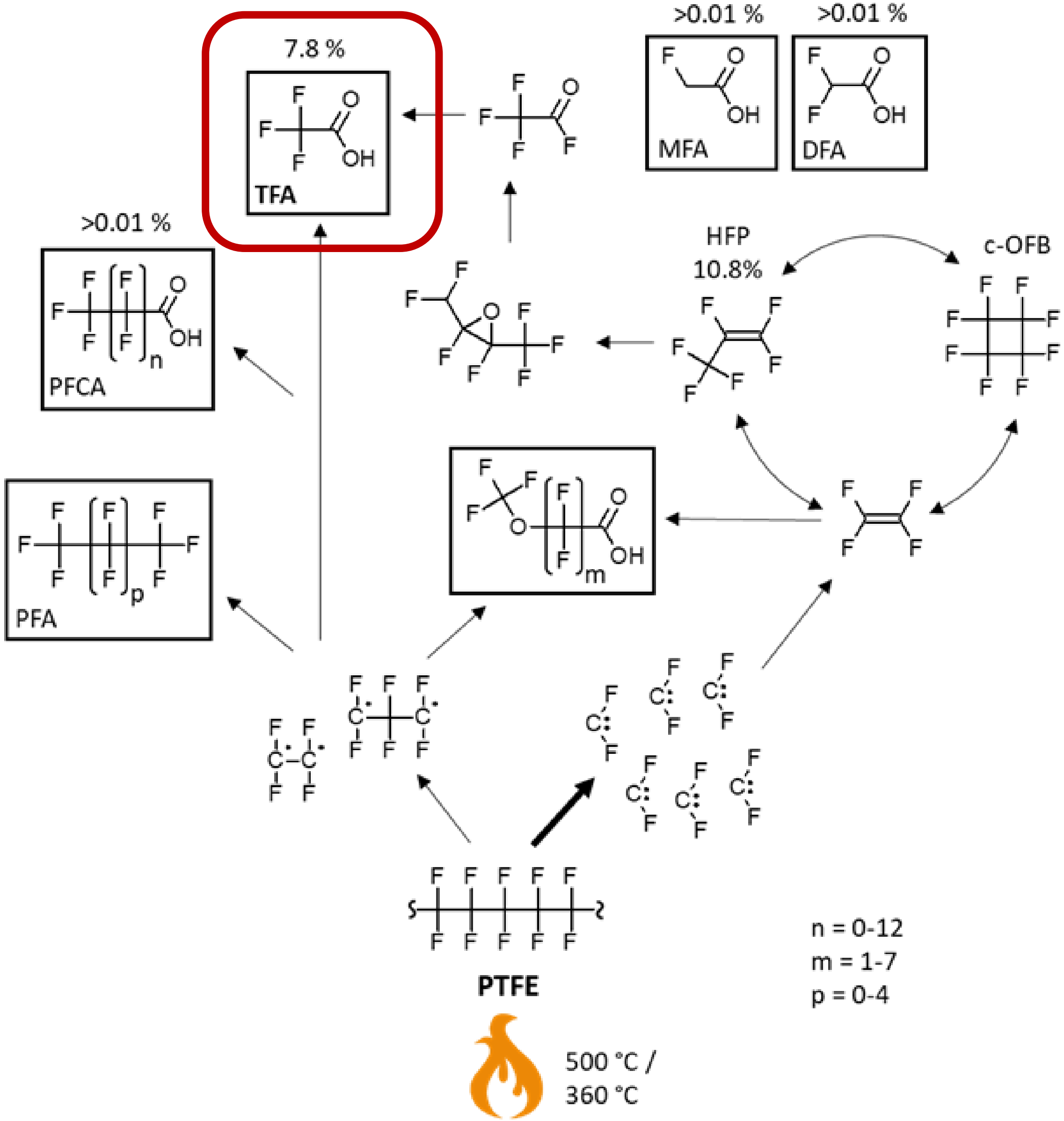
Emissions of greenhouse gases (GHG) and ozone depleting substances (ODS) during production/manufacturing?

- **Synthesis of F-polymers** mostly by exchanging Cl with F atoms on hydrochlorofluorocarbon (HCFC) backbone
- **Chlorodifluoromethane** (HCFC-22) **major feedstock for tetrafluoroethylene (TFE)**
  - HCFC-22: GWP 1,760 , ODP 0.024-0.034 (0.55 in ODS Regulation)
- **Trilfluoromethane** (HFC-23) major by-product in HCFC-22 production
  - GWP 12,400, ca. 2 % of HCFC-22 production volume (94,000 tons in 2018)
  - => 1,880 t HFC-23 (23 Mt CO2-eq)
- **Many other high-GWP/-ODP substances involved in polymerization of PTFE and PVDF** and in the production of PFPEs: **emitted quantities unknown**
  - Tetrachloromethane (CTC): GWP 1,730, ODP 0.89
  - Cyclo-octafluorobutane (PFC-318): GWP 9,540
  - Tetrafluoromethane (PFC-114): GWP 6,630
  - Hexafluoroethane (PFC-116): GWP 11,100
  - 1,2-Dichloro-1,1-difluoroethane (HCFC-132b): GWP 320, ODP 0.062
  - 1-Chloro-1,1-difluoroethane (HCFC-142b): GWP 1,980, ODP 0.023-0.057

How to control safe recycling of complex products outside of Europe?

Credit: Stephen Mudge
EEA-ETC report on 'Systemic view on fluorinated polymers in a circular, low carbon and non-toxic economy' (*forthcoming 2021*)

Emissions during end of life/waste phase - incineration

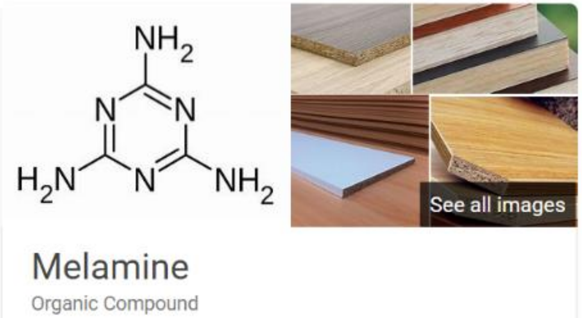


- **Which volatiles that are formed influenced by:**
  - **temperature**
  - **time heated**
  - **O_2 availability**
  - **energy added**
- **Trifluoroacetic acid (TFA) key end product: Persistent, mobile**

Example: Melamine

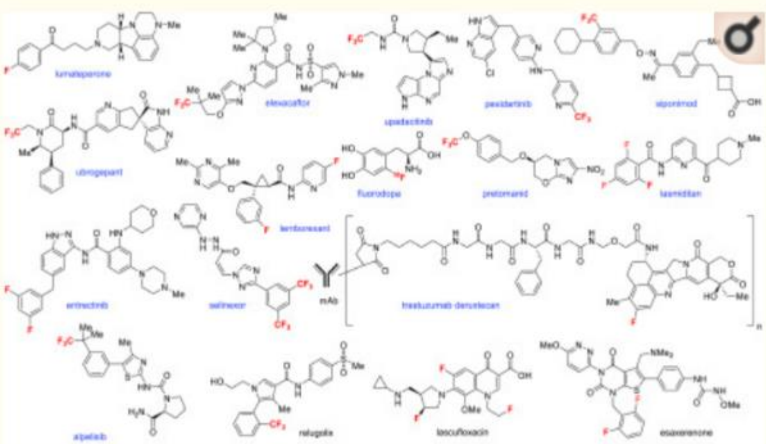
- PMT
- Used for building materials, kitchenware, etc.
- Exposure to workers during production?
- Emissions to environment: Melamine plastics depolymerize
- Service (building materials and food/liquid container) can be provided other ways

- ***=> is use of melamine essential for health and functioning of society?***



Example: Pharmaceuticals
– designed for environmental degradation?

- **Increase in innovation and number of registrations of fluorinated pharmaceuticals**
- **Safe and sustainable design?**



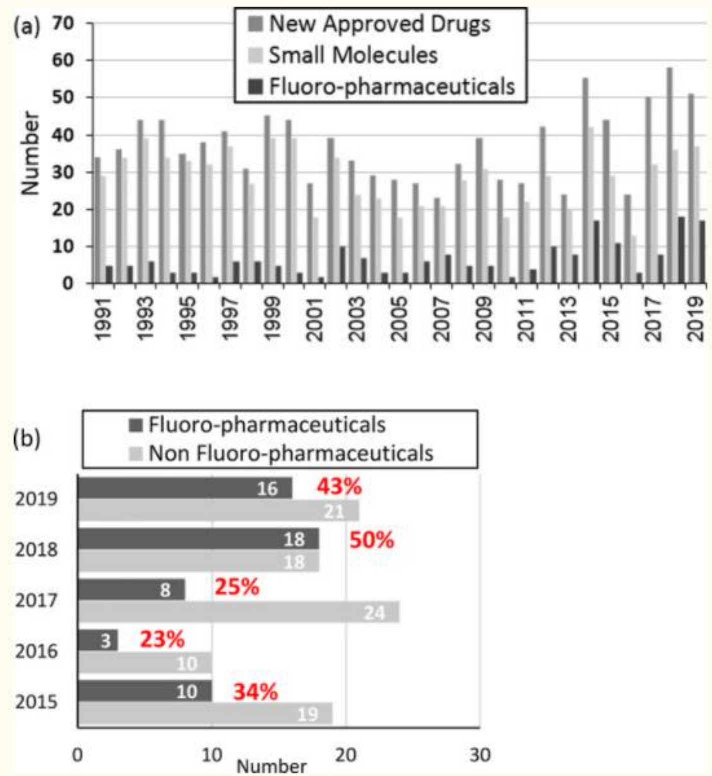


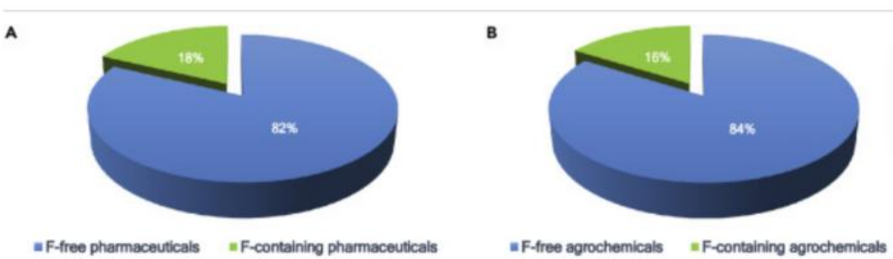
Figure 3

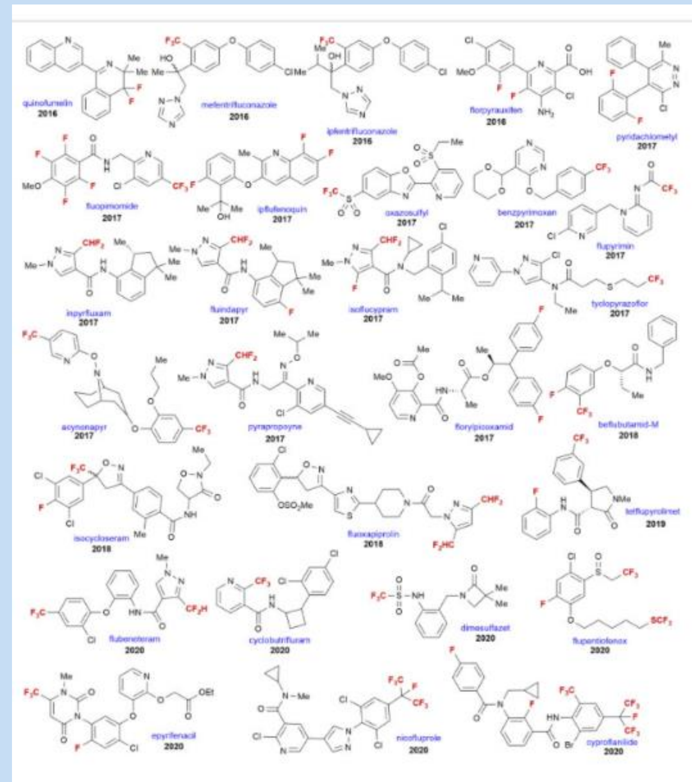
(a) Prevalence of fluoro-pharmaceuticals among globally registered drugs (1991–2019). The list of the all pharmaceuticals (1072 compounds), small-molecule drugs (839 compounds), and fluoro-pharmaceuticals (191 compounds) is provided (Table S2). (b) Data for small-molecule drugs over the past five years.

Contribution of Organofluorine Compounds to Pharmaceuticals, Inoue et al. (2020), ACS Omega. 5(19): 10633–10640.
doi: 10.1021/acsomega.0c00830, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7240833/

Example: Pesticides
– designed for environmental degradation?

- Increase in innovation and number of registrations of fluorinated pharmaceuticals
- Safe and sustainable design?

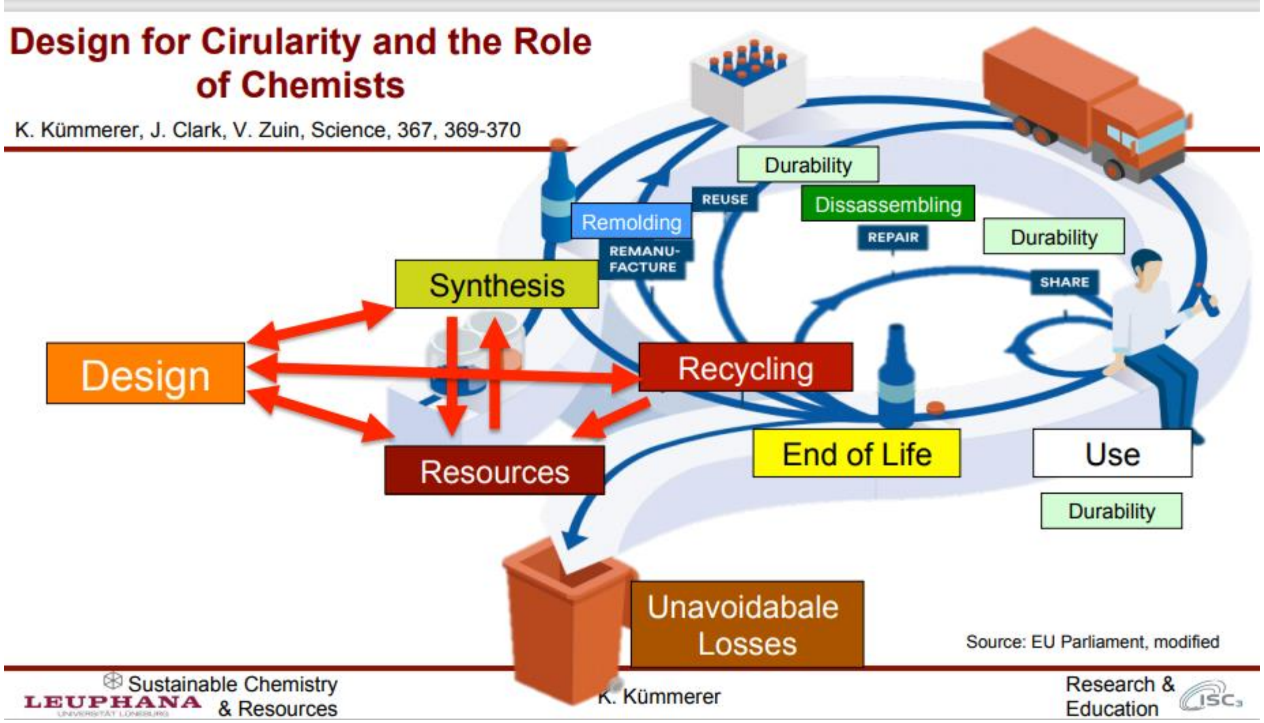




Perspective: Current Contributions of Organofluorine Compounds to the Agrochemical Industry
Ogawa et al. (2020) iScience, 23 (9), 101467. https://www.sciencedirect.com/science/article/pii/S2589004220306593

Role of chemists in designing for SSBD

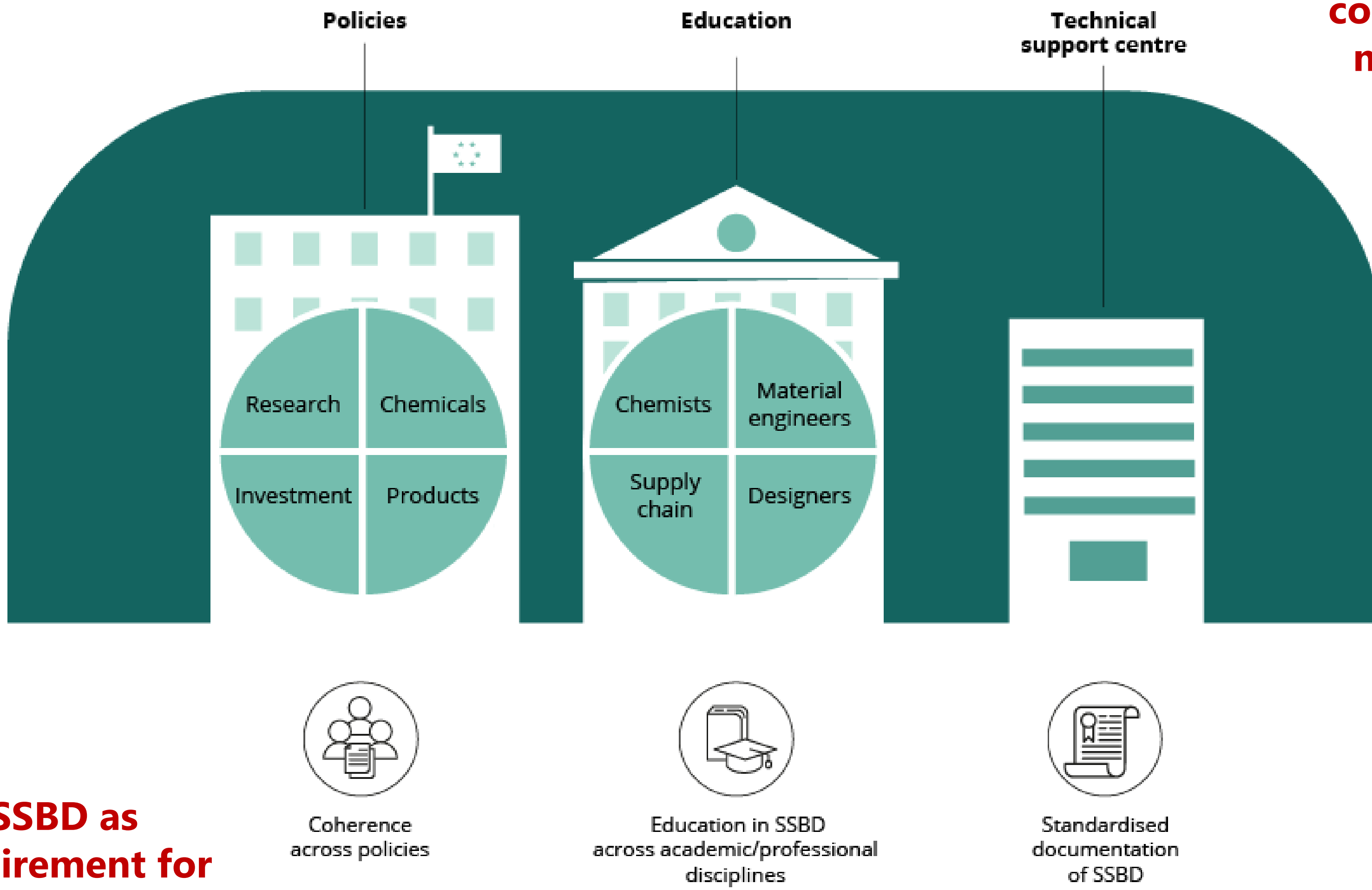
- **Ensure mineralization => avoid persistent chemicals**
- **Reduce chemodiversity and complexity of materials**
- **Increase reparability and seperability**
- **Develop methods to assess SSBD and compliance**



Credit: Prof. Klaus Kümmerer, Leuphana U.

Safe and Sustainable by Design – enabling environment

Development of compliance methods



SSBD as requirement for Sustainable Finance?

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Risk Governance: Assessing vs. Managing risks

- **Risk assessment supports understanding of risk**
- **Risk management/ implementation may require simpler methods for chemical classes, e.g. total PFAS**

IRGC. (2017). An introduction to the IRGC Risk Governance Framework

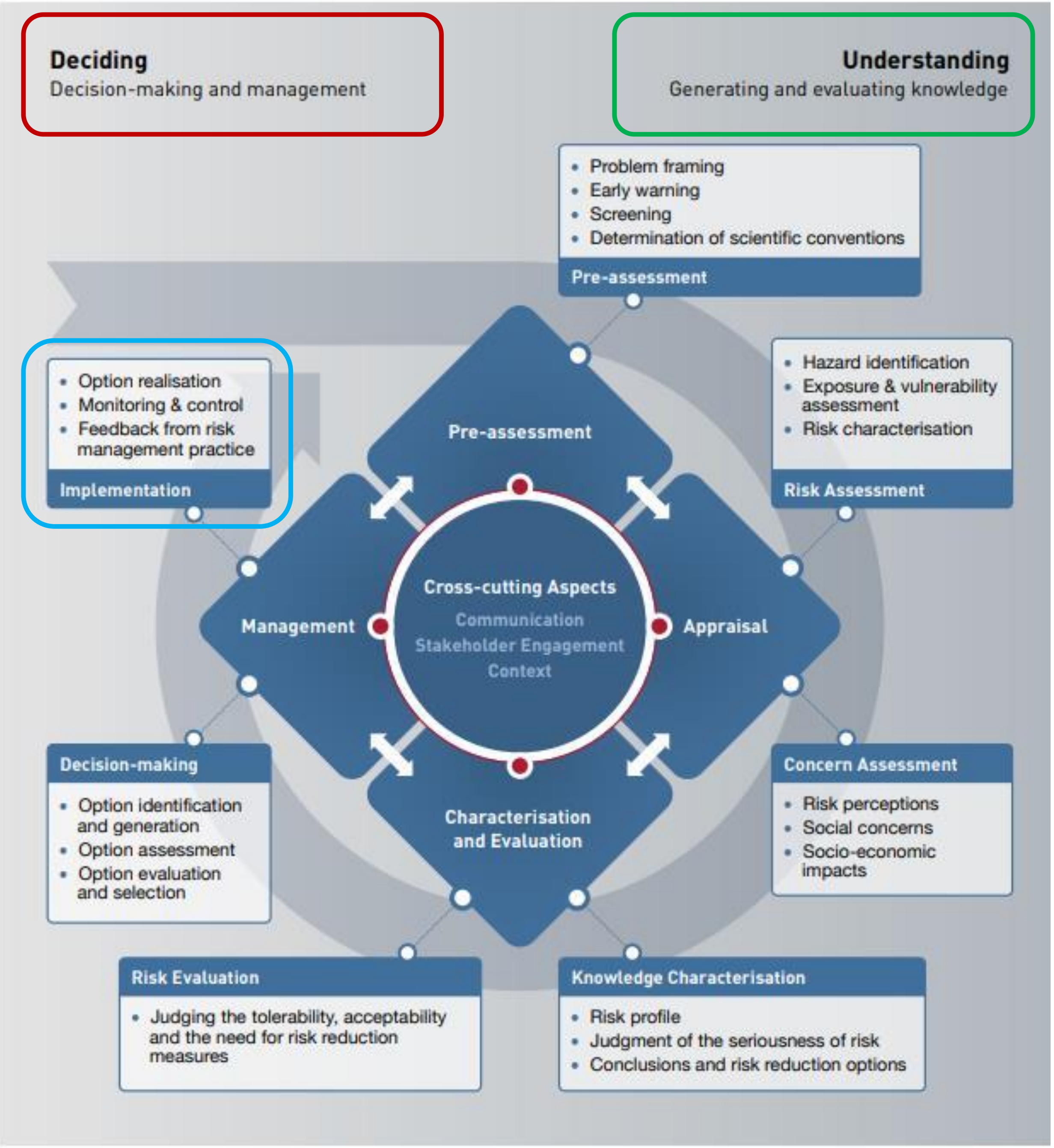

Figure 2: Detailed visual representation of the IRGC Risk Governance Framework.

Conclusions

- **Cannot manage one substance at a time**
- **Repeated regrettable substitution, not kept in technosphere**
- **PMs, and their precursors to be avoided**
- **Complexity hampers circular economy and increase risk of pollution**
- **Chemicals strategy for sustainability:**
  - Avoid harm and non-essential uses of chemicals of concern
  - Manage chemicals (e.g. PFAS) as a class
  - **Industrial transition towards innovation in safe and sustainable by design chemicals/products**, considering both safety and sustainability
- **Harmonised definitions needed for chemicals of concern**
  Tools and compliance methods to test for COCs

Thank you for your attention!

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