OECD REPORTS ON ALTERNATIVES IN PAPER AND PAPERBOARD FOR FOOD PACKAGING AND IN THE COATINGS, PAINTS AND VARNISHES SECTOR

Global PFC Group Webinar

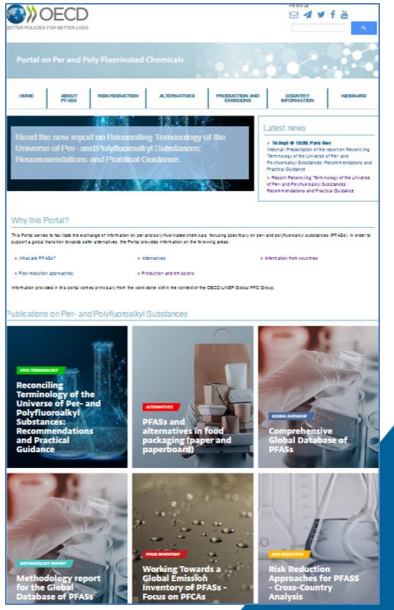
October 2022

Eeva Leinala, OECD

BETTER POLICIES FOR BETTER LIVES

Background to the OECD/UNEP Global PFC Group

- Established in 2012 in response to ICCM Resolution II/5;
- Set up to facilitate exchange of information on PFAS, and to support a global transition towards safer alternatives;
- Brings together experts from OECD member & non-member countries in academia, governments, industry, IGOs, NGOs.



http://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/

Collection of Information on Alternatives

Collect info on commercial availability & current uses of alternatives in different industry sectors and on their hazard profile

- PFAS & alternatives in food packaging (paper and paperboard), *published in 2020*
  - ➢ Collection of hazard information on the alternatives identified, *published in February 2022*
- PFAS & alternatives in coatings, paints and varnishes, *published in March 2022*
  - ➢ Collection of hazard information on the alternatives identified, *under development*

PFAS & alternatives in food packaging (paper and paperboard)

- Short-chain (SC) PFAS and non-fluorinated substances are being used as alternatives to long-chain (LC) PFAS
- Equivalent or superior performance
- Current market share of non-fluorinated alternatives ~1 % or less
  - WHY?

    $ COST $

PFAS & alternatives in food packaging (paper and paperboard)

Table 3. Comparison of the costs of alternatives used in paper and board food packaging

Paper/board and treatment	Average* product cost (€/tonne paper)	Average cost differential between base paper and PFAS-treated and non-fluorinated paper (€/tonne paper)	Average difference between base paper and PFAS-treated and non-fluorinated paper (%)	Average difference between PFAS-treated and non-fluorinated paper (%)
Base paper	1 250	0	0	Not applicable
Short-chain PFAS	1 400	Plus 150	Plus 12	Less 11 to 32
Chemical alternative	1 550	Plus 300	Plus 24	Plus 11
Physical alternative	1 850	Plus 600	Plus 48	Plus 32

*Key: * These figures are averages from a range of figures collected and depend upon factors such as the level of refinement of the starting base paper. Also, the figures indicate the relative costs and do not necessarily reflect actual costs. These indicative figures are based on evidence obtained from industry for this study and are non-attributed to protect the business interests of contributors.*

Hazard Profile: PFAS & alternatives in food packaging (paper and paperboard)

Table 3.1. Level of data availability for each alternative

		Authority Classifications	Industry Classifications	HH Hazard Assessments	Environmental Hazard Assessments	Persistence & Bioaccumulation Assessments
Fluorinated alternatives	Data available	9	20	20	24	24
	Data unavailable	36	25	25	21	21
Non-fluorinated alternatives	Data available	1	9	1	2	2
	Data unavailable	12	4	12	11	11
Total	Data available	**10**	**29**	**21**	**26**	**26**
	Data unavailable	**48**	**29**	**37**	**32**	**32**

No classifications or hazard assessments were identified for 18 alternatives.

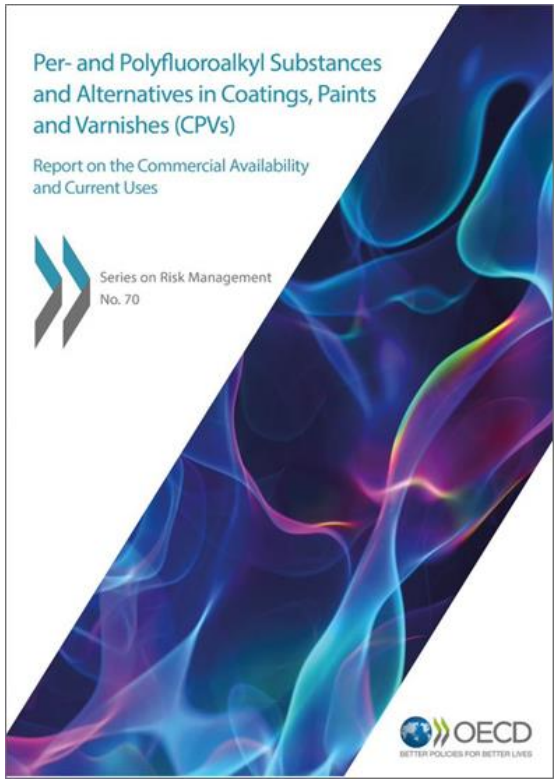
Availability of Hazard Profile: PFAS & alternatives in food packaging (paper and paperboard)

Non-fluorinated Alternatives

Substance Name	CAS	Authority Classifications	Industry Classifications	HH Hazard Assessments	Environmental Hazard Assessments	Persistence & Bioaccumulation Assessments
TopScreenTM formulations	Confidential					
Natural greaseproof paper (NGP)	N/A					
Silicone oils (with added preserving agents)	N/A					
Silicone resins	N/A					
Silicone elastomers	N/A					
Natural and synthetic cellulose fibres bleached or unbleached	N/A					
Wood pulp bleached or unbleached	N/A					
Recycled fibres made from paper or paperboard	N/A					
2-hydroxy-2-methylpropiophenone	7473-98-5					
Siloxanes and Silicones, di-Me, hydrogen-terminated, reaction products with acrylic acid and 2-ethyl-2-[(2-propenyloxy)methyl]-1,3-propanediol	155419-56-0					
Cyclohexane-1,2,4-triyltris(ethylene)	2855-27-8					
Siloxanes and Silicones, di-Me, Me vinyl, hydroxy-terminated, reaction products with 2-((3-(trimethoxysilyl)propoxy)methyl)oxirane	102782-94-5					
Siloxanes and Silicones, di-Me, Me vinyl, hydroxy-terminated, reaction products with 3-(2-(trimethoxysilyl)ethyl)bicyclo(4.1.0)heptane	917773-10-5					

Note: Red shading indicates no data identified and green shading represents where data was identified

PFAS & alternatives in coatings, paints and varnishes



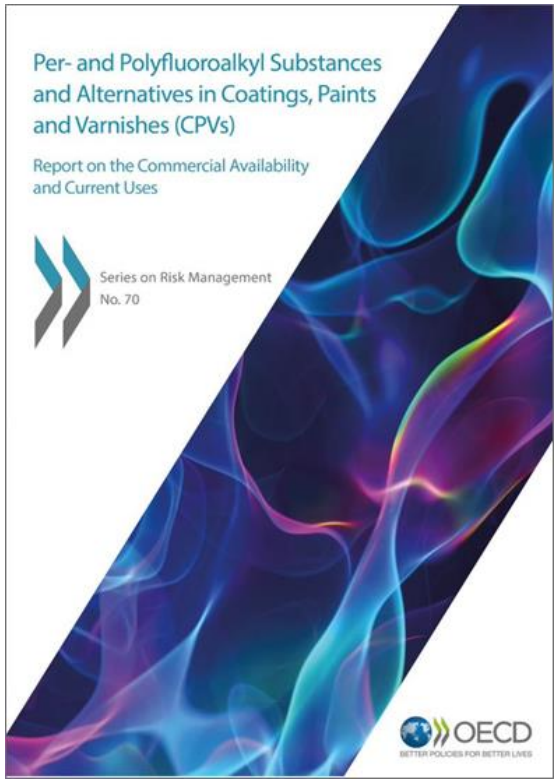
- Fluoropolymers (FPs) are added to CPVs to provide resistance to corrosion, weathering, abrasion and scratching, UV and overall provide durability

- SC PFAS used in paints to act as levelling and wetting agents, have anti-blocking properties or confer oil and water repellence

	OECD Product Categories	Applications	Use examples	Fluoropolymers	Other PFASs (Non-polymeric PFAS)
Coatings	Powder coatings	Architectural	Exterior surfaces of bridges, buildings	PTFE, PVDF, ECTFE, FEVE, FEP	None identified
		Chemical industry	Lining of reaction vessels, metal surface coating		None identified
	Radiation curable coatings	Electronics	Phone and tablet screens	PTFE, PVDF	Perfluoropoly-ether and polyurethane blend
	Other coatings	Cable and wiring	Commercial indoor local area network (LAN) cables, cables in aircraft	PTFE, FEP, PFAECTFE and ETFE	None identified
		Anti-reflective coatings	Coating for semi-conductors	FP with a short fluoroalkyl side chain which is less than C4	PFOA, PFOS*
		Ant-graffiti coatings	Walls, public transport, bridges	PTFE has been used	None identified
		Renewable Energy	Solar panels, wind turbine blades	FEP, ETFE, FEVE, ECTFE	Formulations of fluoro- sulphonamides
Paints	Aerosol spray paints	Automotive paints	Car coatings	PTFE	None identified
		Architectural, Chemical industry	Architecture: bridges, construction Chemical: metal surface protection	PVDF, PTFE, FEVE	None identified
	Water-based paints	Architectural, Chemical industry, Domestic	Architecture: bridges, construction Chemical: lining of vessels, metal surface protection Domestic: doors, walls	PVDF, FEVE, ECTFE, PTFE, FEP	C4-PFBS and C4-fluorinated ethers**, C6-based PFAS
	Solvent-based paints				
Varnishes	Floor and surface finishes/ lacquers and stains	Domestic, Construction Printing	Protection for stone and tiles, work surfaces, floor polishes, table-top waxes, night-reflective road, pavement and traffic signs and reflective sheeting, printing inks, wood and cellulose shrinkage/swelling protectors	None identified	C4-based PFAS e.g. PBSF, fluorinated polyethers**, short-chain PFAS mixtures with silicone†. None identified for printing inks. Wood protectors: fluorinated hydrocarbons, fluorinated acrylic or methacrylic acid esters, fluoroalkane sulfonic acids and salts of fluorinated carboxylic acids

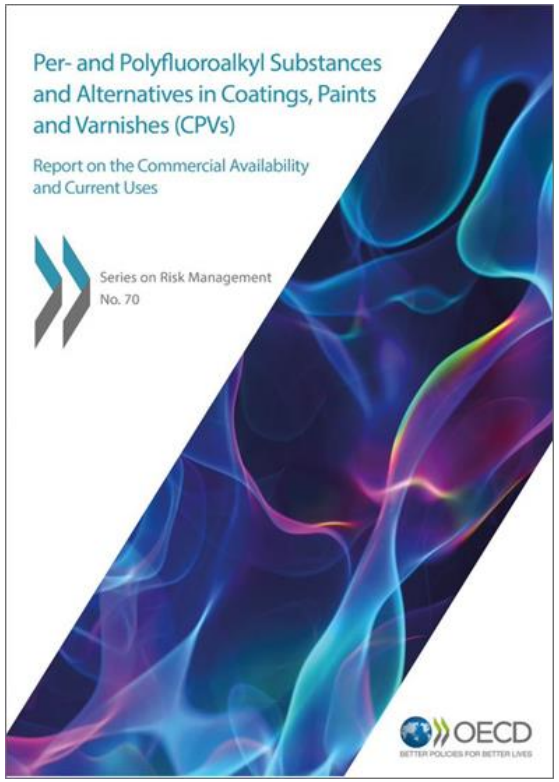
	PFAS function	PFASs	Alternatives
Coatings	Thermal stability	PTFE, FEP	Epoxy, polyolefin, polymethylmethacrylate
	Flame resistance	PTFE, FEP, ETFE	PVC
	Corrosion resistance	PTFE, FEP, PVDF, ETFE, Formulations of fluoro sulphonamides	Epoxy, polyurethane, polyolefin, polymethylmethacrylate; galvanization and anodization are alternatives for some applications.
	Weather resistance	PTFE, ECTFE, PVDF, PCTFE, ETFE, Formulations of fluoro sulphonamides	Polyurethane, polyester, silicone modified polyester, polysiloxane, epoxy; galvanization and anodization are alternatives for some applications.
	Durability / abrasion resistance/ scratch resistance / UV resistance	PTFE, ECTFE, PVDF, FEVE, ETFE	Polyurethane, polyester, polysiloxane, polymethylmethacrylate
	Dielectric properties	PTFE, FEP, PFA	PVC, epoxy, polyurethane, polyolefin
	Smudge resistance	PVDF, Perfluoropoly-ether and polyurethane blend	Silica-based coatings
	Anti-graffiti coatings	PVDF, FEVE, PTFE and ECTFE	Polyurethane, polyester.
	Lubricity*	PTFE	HDPE-based products that contain nano ceramic and nano aluminium oxide
Paints	Corrosion resistance	PVDF, PTFE, FEVE, ECTFE, FEP	Epoxy, polyurethane, polyolefin, polysilozane, aliphatic diisocynates-based polyurethane
	Weather resistance	PVDF, PTFE, FEVE, ECTFE, FEP	Acrylic, polyurethane, polyester, polysiloxane, epoxy, 'Hexafor', silicone polymers, alkyds, phenolic or silicone alkyds, phenolic, polysilozane, aliphatic diisocynates-based polyurethane and vinyl
	Durability / abrasion resistance/ scratch resistance / UV resistance	PVDF, PTFE, FEVE	Polyurethane, polyester, polysiloxane, polysilozane, aliphatic diisocynates-based polyurethane
	Lubricity*	PTFE	HDPE-based products that contain nano ceramic and nano aluminium oxide
	UV 'cool roof' property	PVDF	None identified
	Levelling and wetting agent	C4-PFBS and C4-fluorinated ethers**, C6-based PFAS	Silica based and sulfosuccinates: e.g. Hydroplat
	Anti-blocking properties	C6 short-chain: 'Hexafor'	None identified
	Oil repellence	C6 short-chain: 'Hexafor'	None identified
Varnishes	Anti-soiling	C4-based PFAS e.g. PBSF, fluorinated polyethers**, short-chain PFAS mixtures with silicone†. Wood protectors: fluorinated hydrocarbons, fluorinated acrylic or methacrylic acid esters, fluoroalkane sulfonic acids and salts of fluorinated carboxylic acids	None identified
	Levelling and wetting agent	C4-based PFAS e.g. PBSF, fluorinated polyethers**, short-chain PFAS mixtures with silicone†.	Sulfosuccinates: 'Hydropalat 875' and 'EDAPLAN LA 451'
	Anti-blocking properties	C6 short-chain: 'Hexafor'	None identified
	Lubricity*	PTFE	HDPE-based products that contain nano ceramic and nano aluminium oxide

PFAS & alternatives in coatings, paints and varnishes



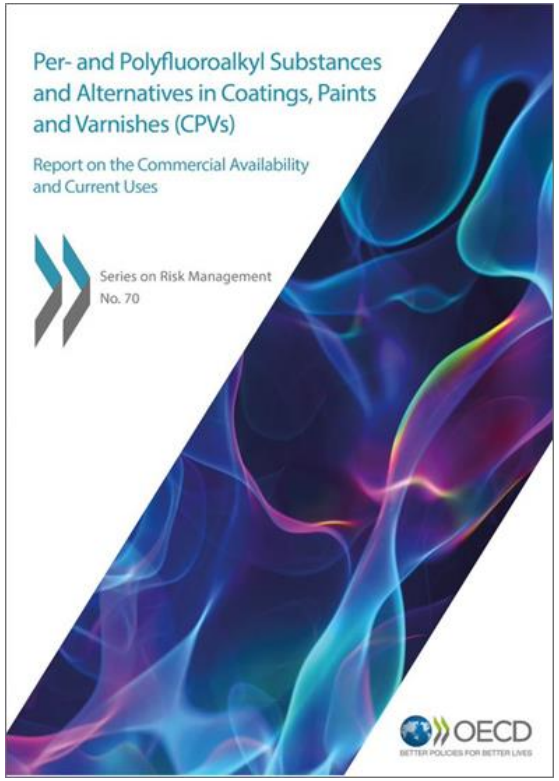
- Cables and wiring
  - Fluoropolymers (FPs) used if high performance is required over a wide range of parameters, including fire safety.
    - FPs are less than 10% of market share.
  - Majority of cable and wire applications do not require such high performance
    - alternative materials such as polyurethane (PU), polyethylene and polyvinylchloride are used
  - Significant cost differential between using FPs or alternatives

PFAS & alternatives in coatings, paints and varnishes



- Coatings for solar panels
  - FPs are used in solar panel coatings as frontsheets or backsheets, to increase the amount of sunlight reaching the solar panels or protect the photovoltaic cells that make up the solar panels, from dirt, moisture and UV rays.
  - FPs highest performance, but there are performance issues over long term
  - Alternatives include glass, polyester, polyamides and polyethylene terephthalate
  - Detailed publicly available market penetration data has not been identified but FPs dominate
  - Shift will occur to the most durable, cost-effective and lightweight materials

PFAS & alternatives in coatings, paints and varnishes



- Architectural paints
  - FP-based paints are available for use on bridges
    - weatherability and durability performance is superior to that of alternatives such as PU.
  - FP-based paints are significantly more expensive at the outset
    - after 30 years PU coatings are more expensive than PFAS coatings because they require more frequent recoating, with associated labour, stoppage and material costs.
  - The overall market penetration for FPs in architectural protective coatings is very low, approximately 1% compared to alternatives at 99%.

	Regions	Year of Data	Alternative Materials Market Share (%)	PFAS Materials** Market Share (%)
Paint Market	EU, NASA, Asia	2011	92	8
Architectural Protective Coatings	Global	2021	99	1
Powder Coatings	US	2018	99	1
Cable & Wire Coatings	EU, NASA, Asia	2021	>90	<< 10
Coil Coatings*	EU	2011	88-91	3-12
	NASA	2011	83	17
	Japan	2011	50	50
Smart Phone and Touch Screen Coatings (upper end models /commercial/industrial)	Global	2021	~0	~100
Smart Phone Coatings (lower or mid-range models)	Global	2021	~100	~0

Hazard Profile - PFAS & alternatives in coatings, paints and varnishes

- Underway
- Similar trends to report on food packaging hazard profiles

Challenges with Analysis

- Limited publically available information on:
  - Alternatives used
  - Substance identity of the alternative
  - Costs
  - Market penetration

- Due to gaps in substance identity, analysis of availability of hazard classification/assessment is hampered

Thank you!

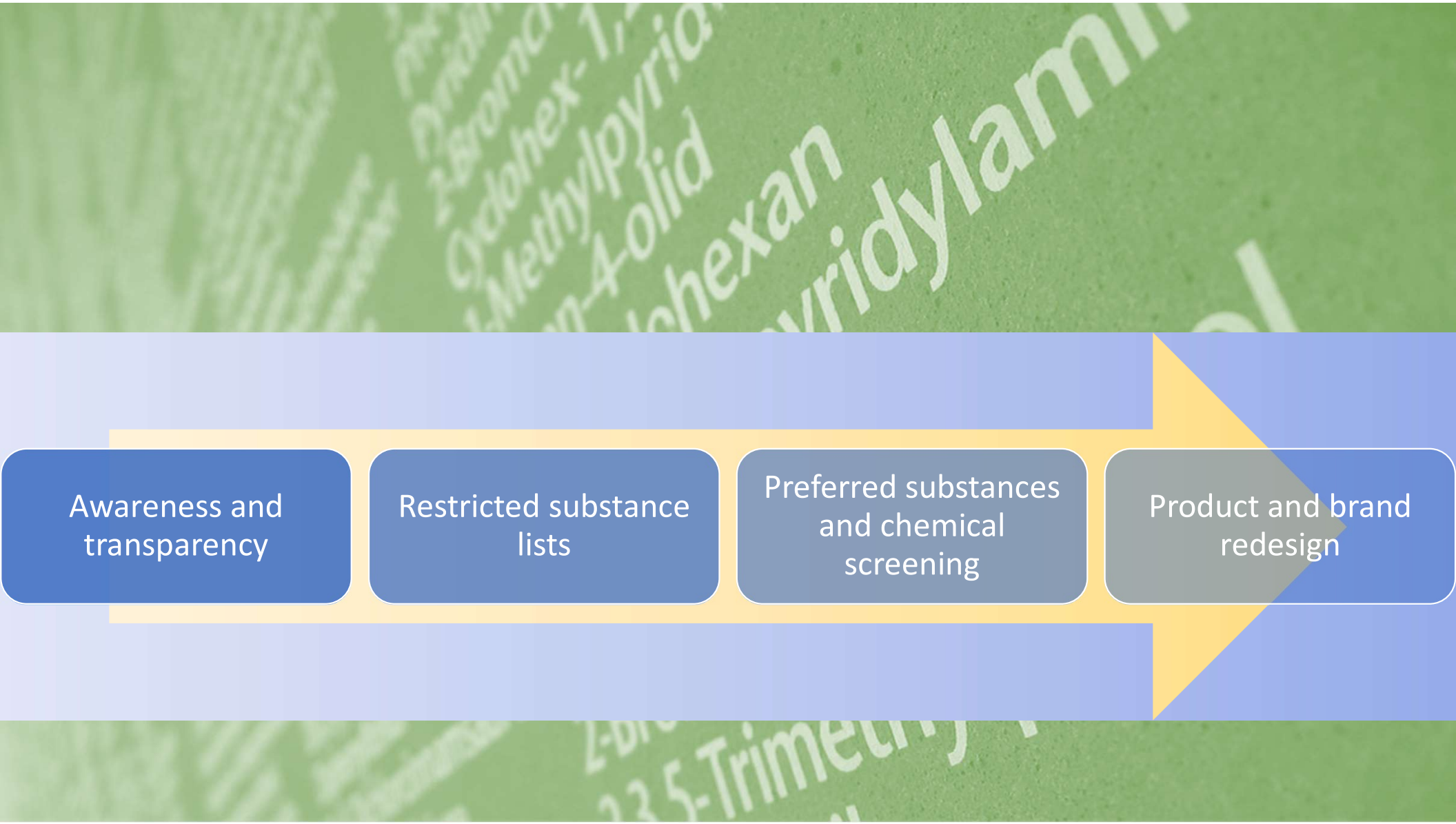
eeva.leinala@oecd.org

www.oecd.org/chemicalsafety

Investing in alternatives to PFAS

Marty Mulvihill, PhD
Managing Partner, Safer Made
Martin.Mulvihill@safermade.net


People’s concern about their families’ chemical exposure translates into demand for safer products.


Awareness and transparency
Restricted substance lists
Preferred substances and chemical screening
Product and brand redesign

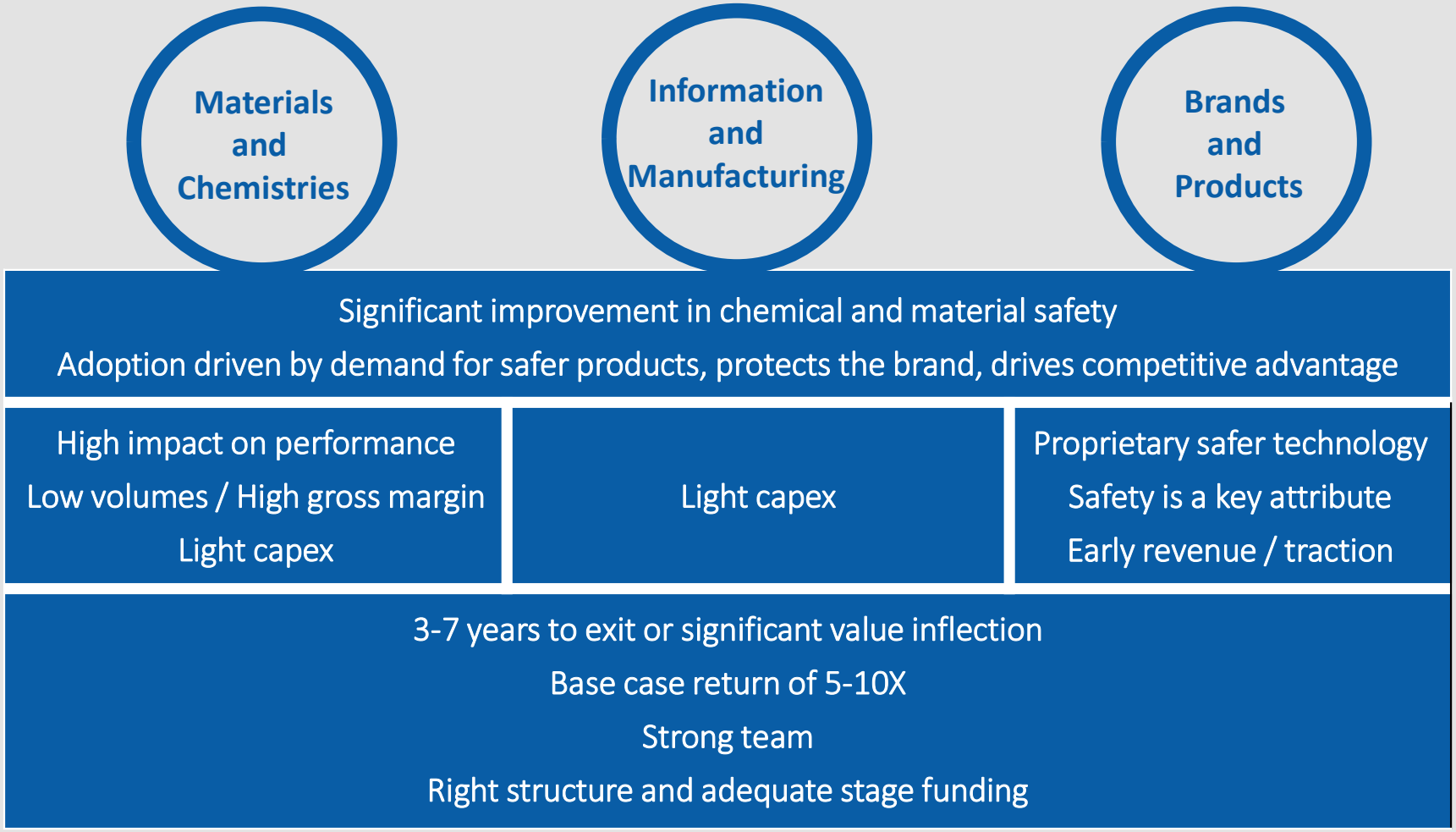
Material choice drives environmental impact.
Additives and coatings drive health impacts.

Innovation opportunities by sector and function

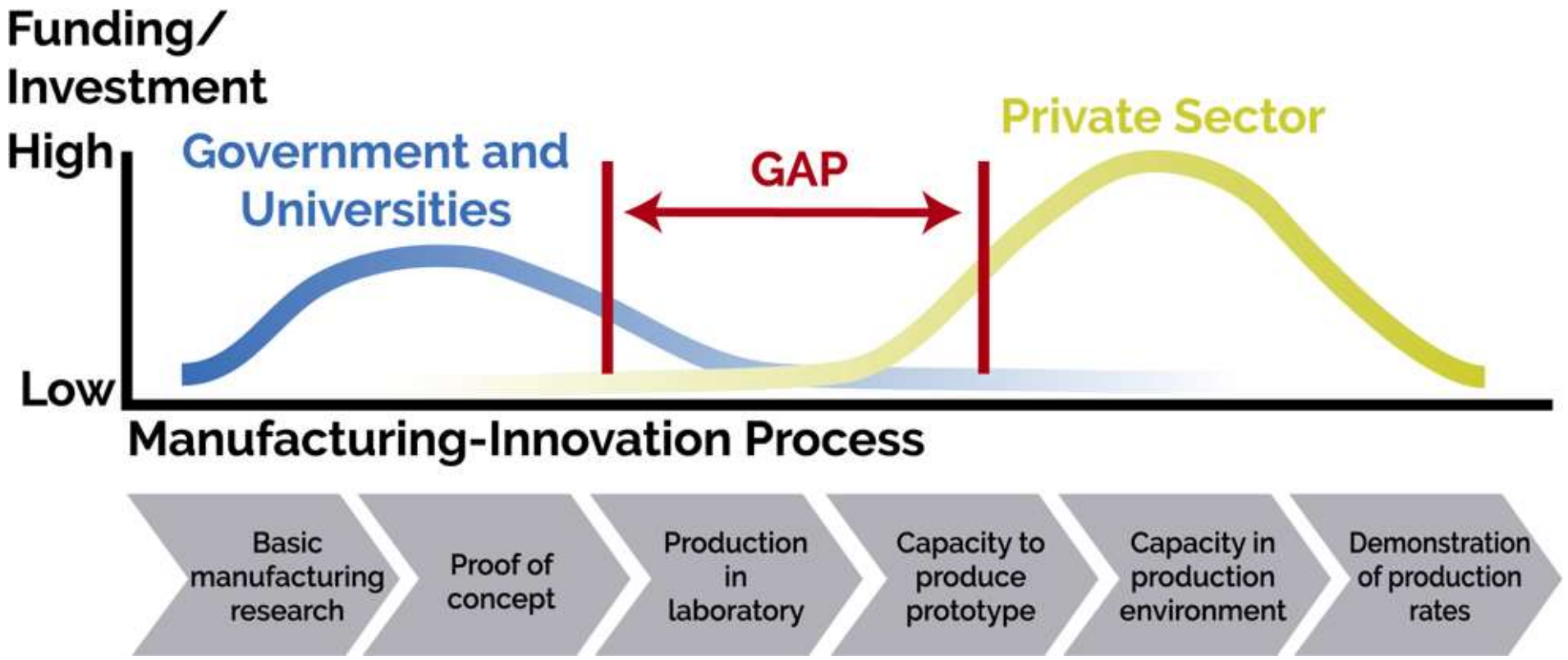
PFAS Functions and Alternatives

Function	Alternatives
Water Repellency	**Chemicals**: waxes, oils, polymers, silicones **Change Base Material**
Paper Barrier	**Chemical**: Polymers **Process Change**: increase density
Slip	**Chemicals**: Silicones **Design Change**: Surface roughness
Stain Repellency	**Change Base Material**: decrease porosity

Types of Companies Supporting Safer Alternatives

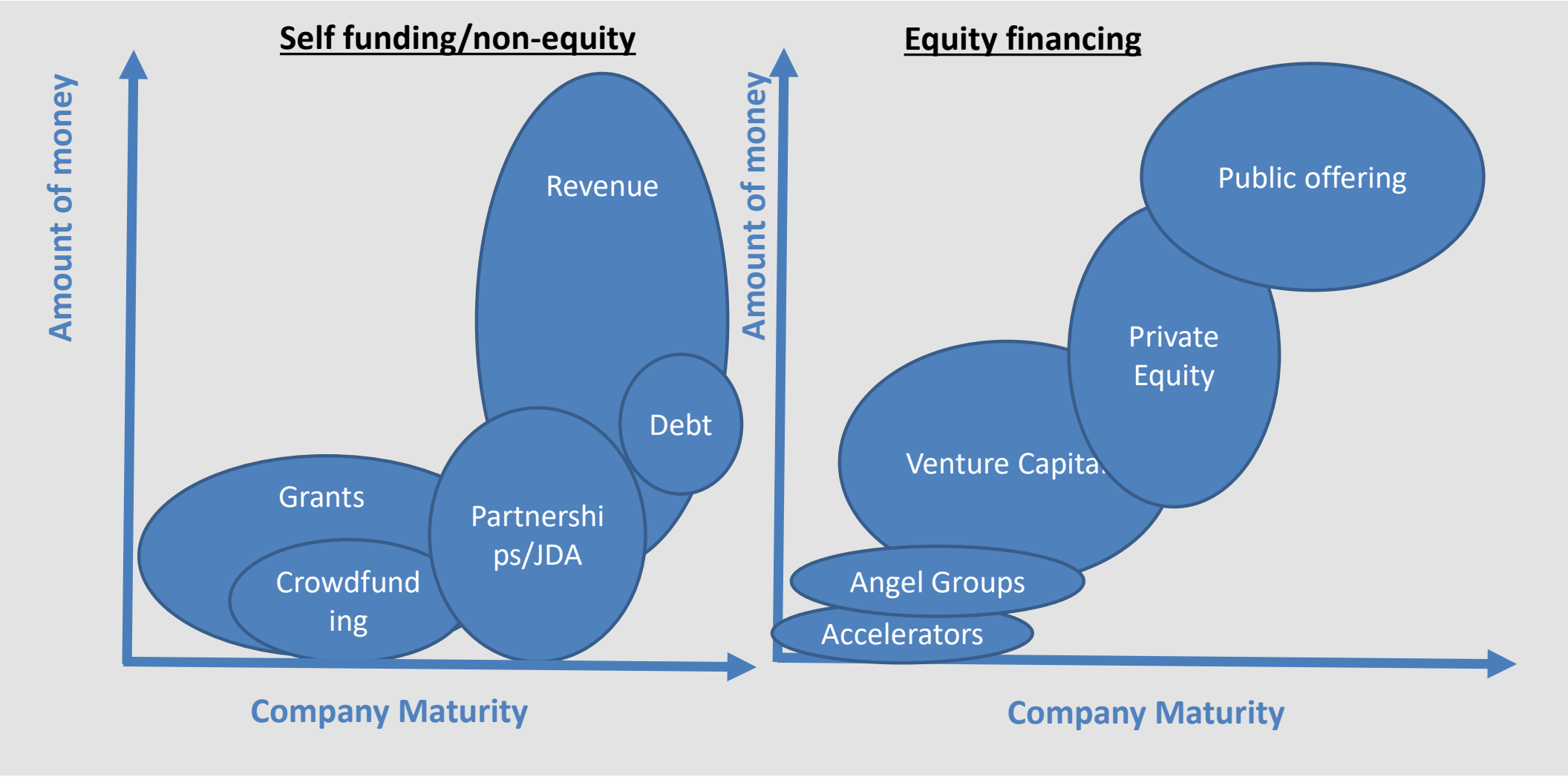


New Material Development Timeline and Support



https://www.nist.gov/blogs/taking-measure/mind-gap-bridging-valley-death-us-biomanufacturing

Sources of Capital for a Small Company



Examples from the Safer Made Portfolio

ecologic
packaging the earth can live with

Sustainable packaging

MIMIKAI
INSECT REPELLENT

Effective and safe insect repellent alternative to DEET

Repurpose.

Compostable single use food service

FORCE of NATURE™

Safer home cleaner and disinfectant

P2 Elegant Processes. Sustainable Products.

Safer personal care and beauty ingredients

nohbo

Personal care without plastic and preservatives

SYNERGIO
A Higher Form of Nurture

Plant derived preservatives

defunkify

Sustainable laundry and household cleaning

dimpora

PTFE free Membranes

gtt

PFAS free textile finishing

Investing in safer chemistry addresses has sustainability co-benefits

Cumulative Direct Impact of Safer Made Portfolio Companies:

4,650 Metric Tons

Plastic Waste

3,025 Metric Tons

Fiber Waste

460 Metric Tons

Carbon Dioxide

90,595 Kg*

Hazardous Chemicals

NG(1

Our Team

Adrian Horotan is an experienced early stage investor.

Marty Mulvihill is a well - respected green chemistry expert.

Advisers

Arlene Blum, **Green Science Policy**
Bill Orts, **USDA**
Jim Barber, **Investor**
Joel Tickner, **GC3**
Kaj Johnson, **Method**
Larry Weiss, **Symbiome**
Mia Davis, **Health and Beauty**
Dawn Dobras, **Credo**
Rita El-Khouri, **Clorox**
Laura Hoch, **Patagonia**
Scott Leonard, **Indigenous**
Silda Wall Spitzer, **Investor**
Chris Ueker, **Target**

Investors

Safer Made's investors include foundations, family offices, and individuals as well as one corporate investor.


www.safermade.net