

# Balancing the benefits of Flame Retardants in reducing Fires versus Risks from Smoke Emissions and Toxicity

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# Co-authors

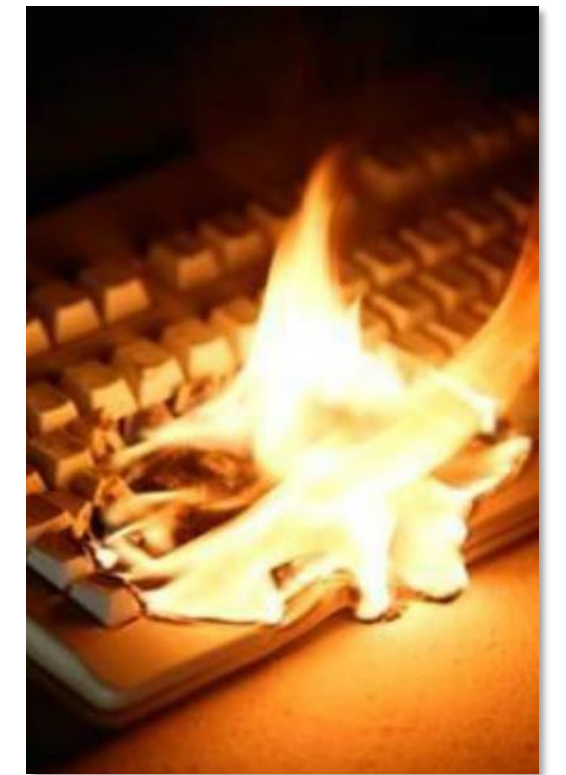
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# Presenting pinfa



# pinfa Members (EU, China & North America)



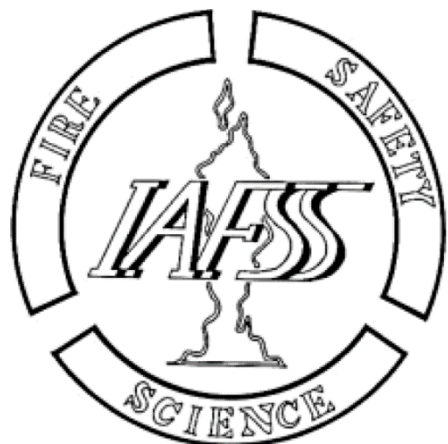
# Why do we need flame retardants ?



# Fire risks are increasing

## Challenges identified by IAFSS:

- climate change, wildfires
- new technologies
- globalisation
- population growth, ageing (and so more vulnerable) population
- urbanisation, new construction techniques, tall buildings
- resiliency and sustainability, green buildings



International Association for Fire Safety Science (IAFSS)  
Agenda 2030 for a Fire Safe World (2019)  
<https://doi.org/10.1016/j.firesaf.2019.10288>



## Buses burn, trains don't

Reaction-to-fire testing of bus interior materials: Assessing burning behaviour and smoke gas toxicity", 2023  
<https://dx.doi.org/10.1002/fam.3108>  
Reducing the risk of bus fires", 2016  
[https://www.intersecexpo.com/uploads/editor\\_images/file/fr edrik.pdf](https://www.intersecexpo.com/uploads/editor_images/file/fr edrik.pdf)

Photo: Shutterstock 1791820100



# Flame retardants

*are part of the fire safety toolbox*

- fire safe design (buildings, products)
- Inherently non-flammable materials
- smoke and fire alarms
- sprinklers
- education & awareness
- fire services
- maintenance, verification



# Role of flame retardants in fire safety



# The Fire Curve for a Room Fire

Protective role of flame retardants in different phases of a fire :



## Ignition

- Prevent ignition
- Possibly self-extinguish



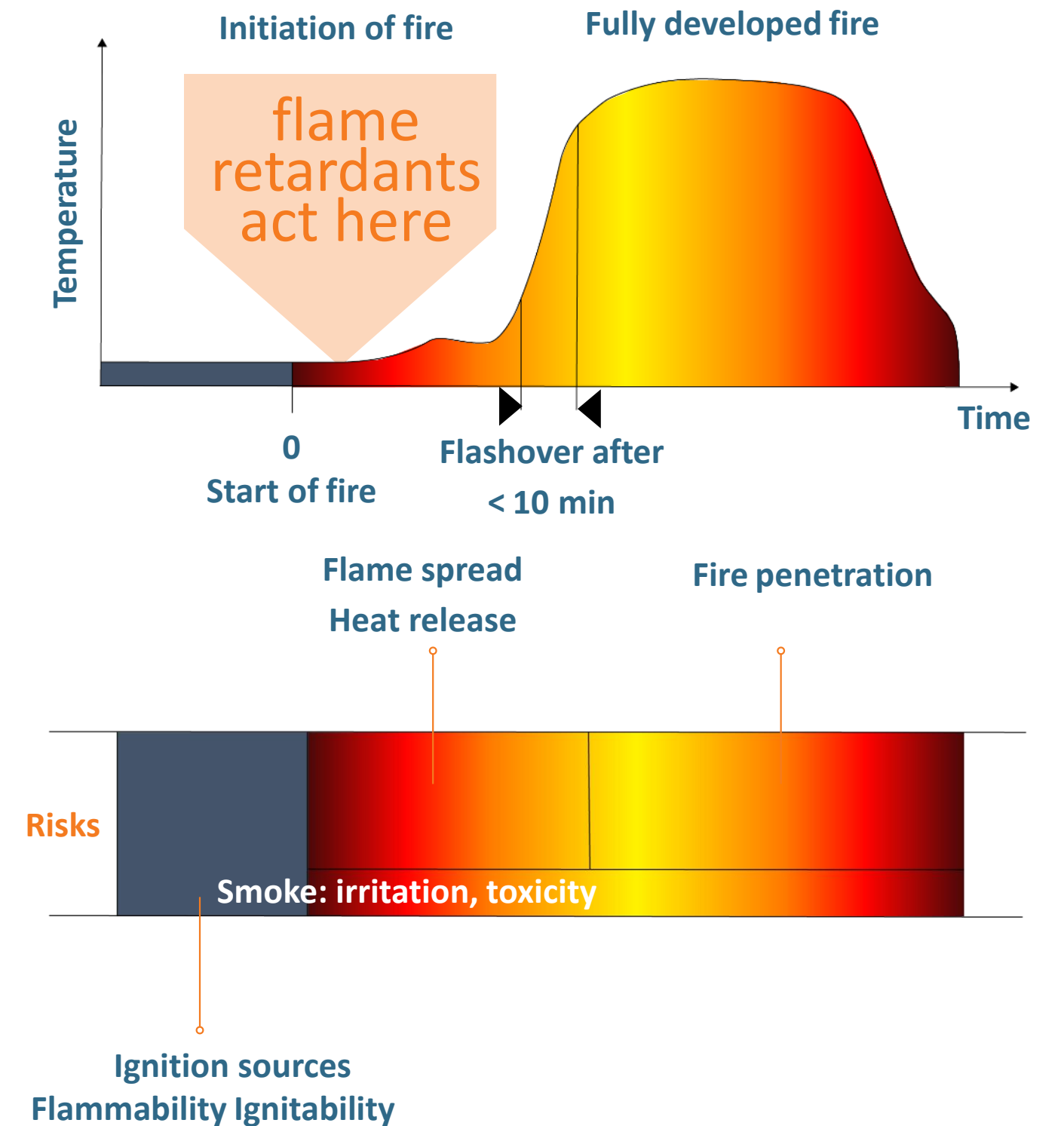
## Flame spread

- Slow down flame spread
- Reduce heat release
- Delay flash-over



## Fire penetration

- Prevent the collapse of structures, e.g. steel columns protected by intumescent coatings
- Prevent fire moving to adjacent room or building compartment



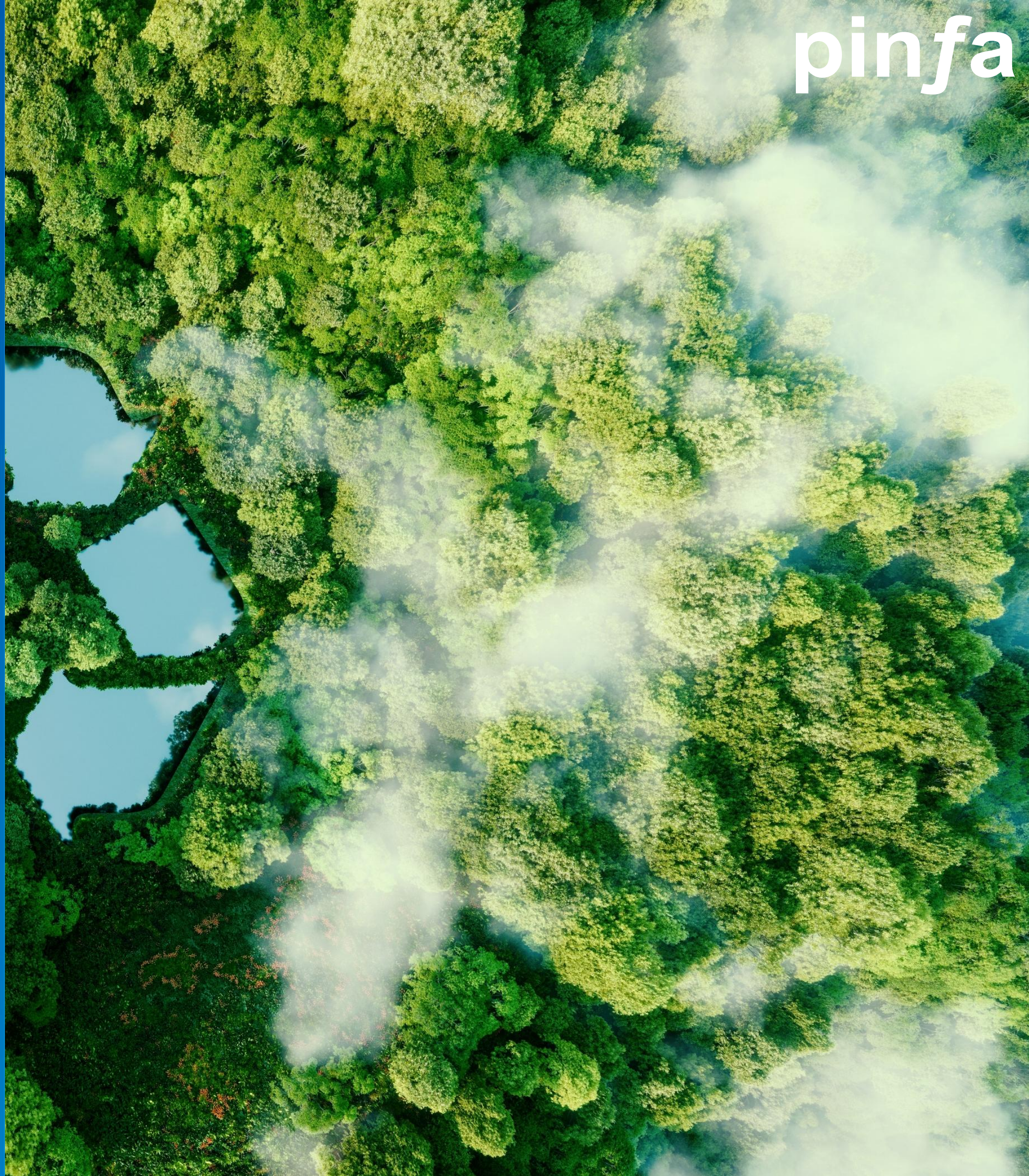
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# The fire which didn't happen



Question:  
Do Flame Retardants  
impact smoke toxicity ?



# Smoke and Toxicity

- All fires generate toxic smoke
- Inhalation of smoke is the main cause of death for fire fatalities (> 70%)
- The total toxicity related to the quantities of materials burned
- Dense smoke can make orientation impossible
- Acutely toxic components
- Compounds with long term effects



# PIN smoke suppressants

- can significantly reduce emitted smoke
- also act as flame retardant synergists

## Examples:

- Molybdenum minerals, e.g. ammonium octamolybdate
- Zinc minerals, e.g. zinc oxide, zinc phosphate, zinc stannates, zinc borate
- Calcium, copper, iron, nickel, silicon, tin minerals



Smoke chamber ISO 5659.  
Photo © courtesy of Crepim



# Do PIN Flame Retardants Make Smoke More Toxic?

Polymer	Toxicity Concern	PIN FR Effect Toxicity	Smoke Density	Halogen / Br-FR Effect Toxicity	Smoke density
Polyolefins (PE, PP)	CO, CO <sub>2</sub>				
Polystyrene (PS)	CO				
Polycarbonates (PC)	CO, CO <sub>2</sub>				
Polyesters (PBT)	CO, HCN, NO <sub>x</sub>			Not evaluated	Not evaluated
Epoxy resins	CO, HCN				
Polyamides (PA6, PA66)	CO, HCN, NO <sub>x</sub>				
Polyurethanes (PUR, PIR)	CO, HCN, NO <sub>x</sub>				
Polyvinylchloride (u-/p-PVC)	HCl	(1)	(1)	(1)	(1)

*Effect compared to neat polymer*

- Much worse
- Slightly worse
- Neutral
- Neutral to Better
- Better

(1) Minor impact of flame retardants on toxicity and smoke. In all cases huge contribution from HCl far exceeding threshold values

In 2019, the French institute CREPIM completed a study testing 94 polymer samples from 12 companies, with and without flame retardants.



## Different messages

“FRs do not significantly impact smoke toxicity in real fires”

“UK study, based on fire tests of four mock-furniture items, suggested higher smoke toxicity but lower fire growth rate with FRs”


“gas phase FRs potentially increase incomplete combustion products”

“char-forming FRs reduce toxicity”

“LSZH (Low Smoke Zero Halogen) FR cables reduce smoke and corrosivity”

### Low smoke zero halogen cabling range enhances electrical and fire safety

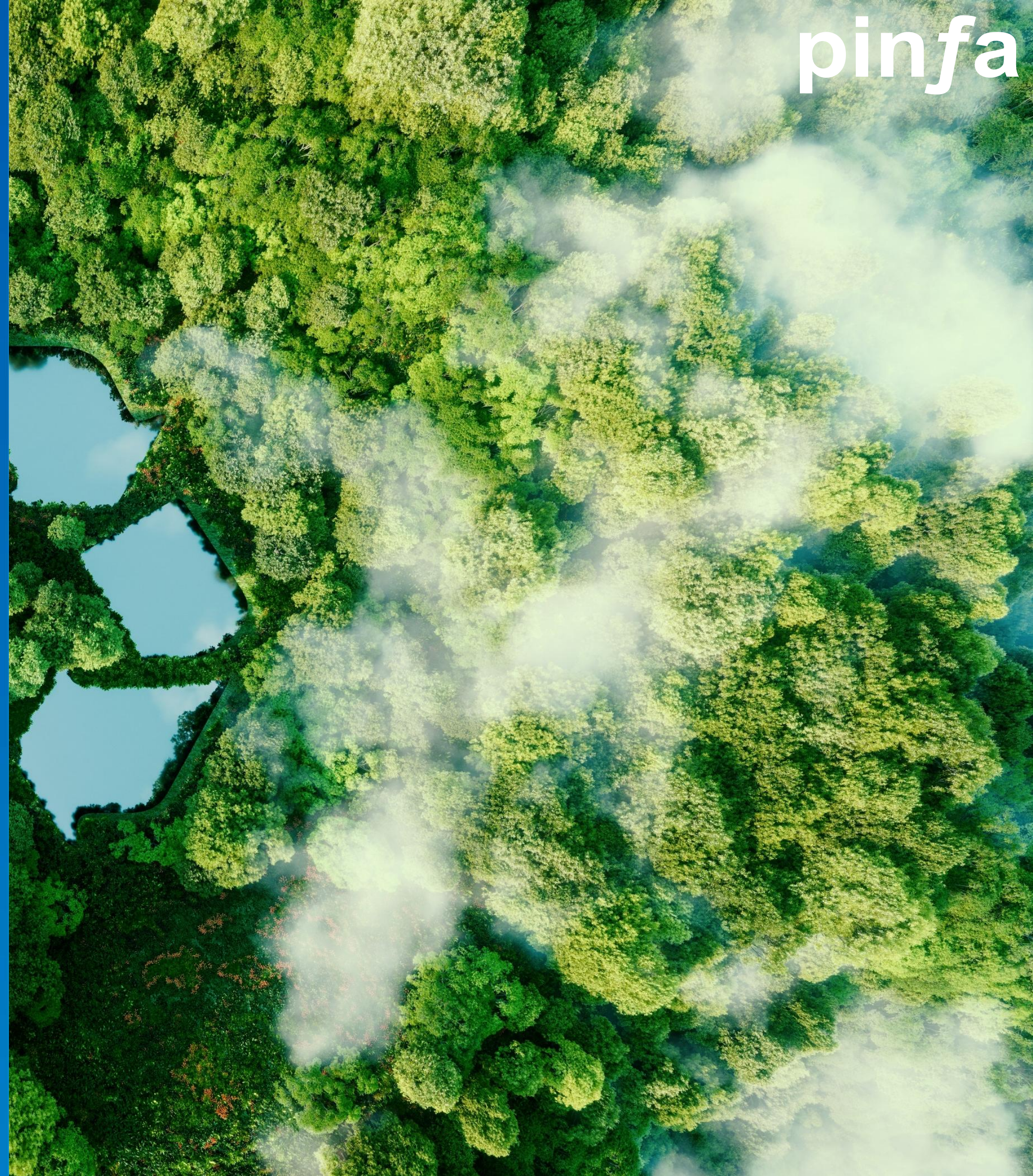
<https://www.safetysolutions.net.au/content/electrical/case-study/low-smoke-zero-halogen-cabling-range-enhances-electrical-and-fire-safety-1243520876>

 Fidra  
No smoke without fire  
and lower smoke toxicity without  
chemicals?

<https://www.fidra.org.uk/sustainable-fire-safety/no-smoke-without-fire-and-lower-smoke-toxicity-without-chemicals/>



Question:  
What impacts  
do Flame Retardants have  
on Fire Fighters?



# Different messages: Fire Safety vs. Potential Health Impacts

- Firefighters say fire safety standards are essential to save lives [10] [11].
- However, respecting fire safety specifications is not possible in many flammable materials without flame retardants
- Including non-flammable fire safety barriers is often not feasible or incompatible with consumer design requirements, cost or light-weighting.
- Occupational exposure to fires and smoke is recognized as a cancer risk for firefighters [12].
- Some firefighters reported in media suggest that FRs are a cause of this risk [13].

*More research is needed*



Home > News > Scrapping furniture safety ...

## Scrapping furniture safety regulations will cost dozens of lives a year, warns fire union

December 22, 2023



The Fire Brigades Union has warned that a government plan to deregulate furniture regulations could cost dozens of lives every year.

### Latest news



FBU seeks Supreme Court appeal for pensions challenge

17 May, 2024 / News



Firefighters' union leader raises alarm over Elphicke defection in letter to Starmer

13 May, 2024 / News



FBU responds to HMICFRS 'State of Fire and Rescue' report

# Science controversy over effectiveness of flame retardants

- There is confusion over what flame retardants can and cannot do
- Babrauskas 1998 [14]:  
*“in these [large-scale] tests, the fire retardant additives did decrease the overall fire hazard of their host products.”*  
*“none of the [small-scale] test specimens produced smoke of extreme toxicity. The smoke from both the FR and the NFR products was similar in potency ...”*
- Babrauskas 2011 [15]:  
*“extensive use of chemical flame retardants to meet the California Furniture Flammability Standard Technical Bulletin 117 ... has not been shown to have a measurable fire safety benefit.”*




Forum/Discussion Articles

JOURNAL OF FIRE SCIENCES



## The well-meaning but misguided rollback of fire safety in the United States

Alexander B Morgan 

Journal of Fire Sciences

1-5

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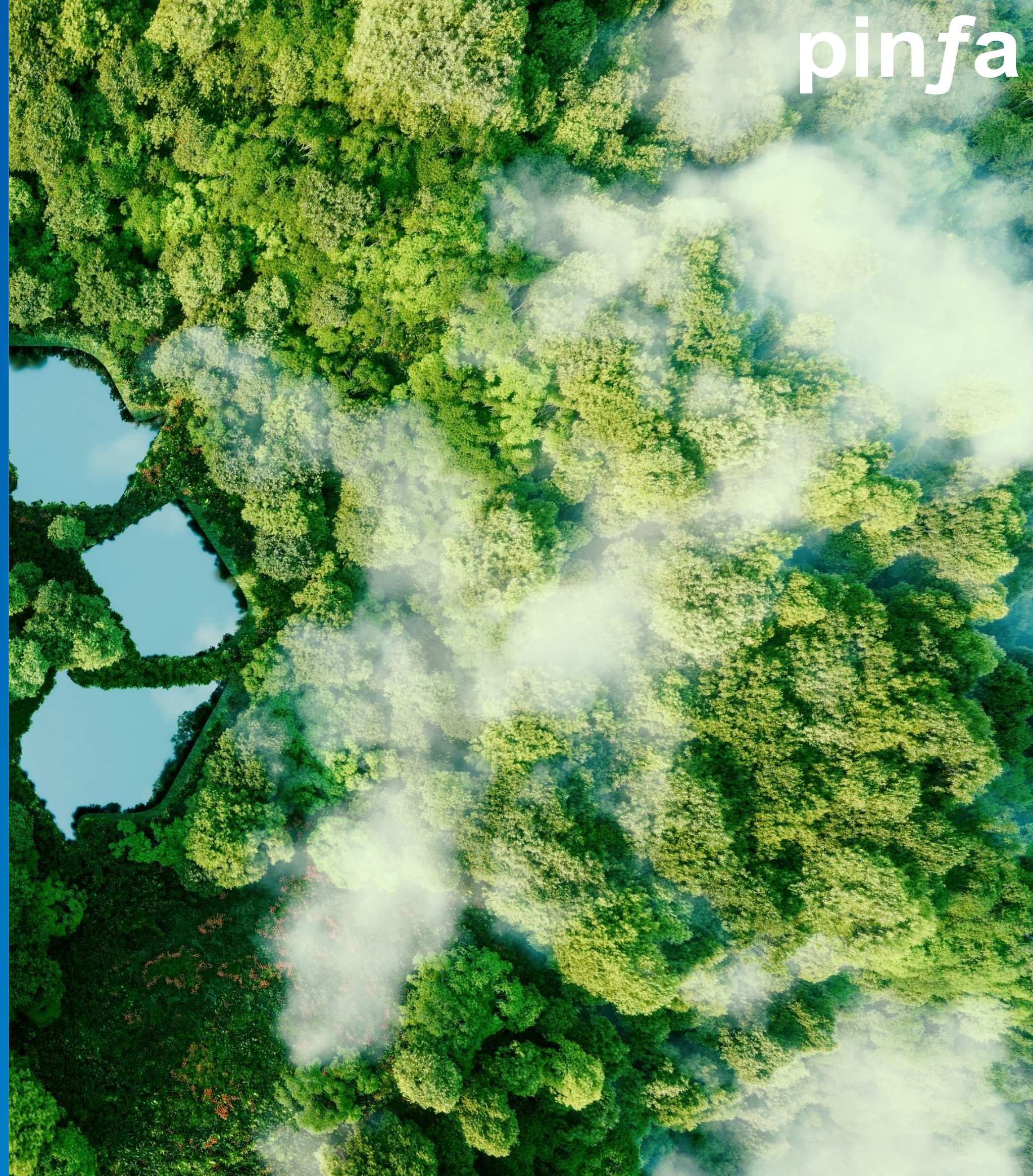


Photo © udayton.edu

***“It is a blatant falsehood that flame retardants do not work, and it is something that all fire safety scientists should speak up about. ... It is possible to have fire safety AND environmental safety”.***

<https://doi.org/10.1177/07349041221096609> [16]

Question:  
Flame Retardants –  
risks versus benefits ?



# Balancing risks and benefits of flame retardants

- ❑ *How to show to what extent FRs contribute to fire safety ?*
- ❑ *How to ensure that “risks” address today’s FRs and not ‘legacy’ FRs ?*
- ❑ *Use EU chemicals regulation REACH to ensure that only safe FRs are on the market, including in imported articles.*
- ❑ *What approaches are needed for risk-benefit analysis of FR use (use of different FRs, use in certain applications or conditions ...) ?*



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