

pinfa

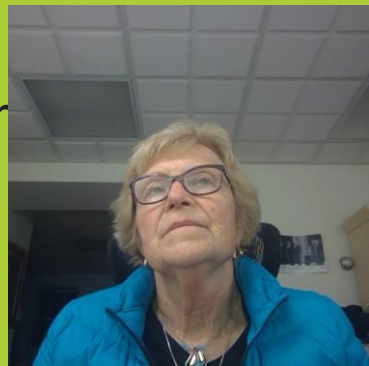
FIRE SAFETY AND E-MOBILITY: TRENDS AND CHALLENGES

Maggie Baumann

Vice Chair of Pinfa North America/FRX Polymer

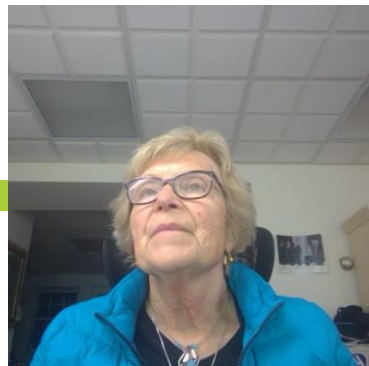
AMI FR Virtual Conference- May 5-2021

AMI



Outline of Presentation

- Who is Pinfa (Phosphorus, Inorganic and Nitrogen Flame retardant Manufacturers Association)
- Market and Trends - EV and HEV vehicles
- E-Mobility Trends and Challenges
- Role of Flame Retardant Additives- Why do you need them?
- E-Mobility and Fire Safety





- Since 2009
- 3 continents
EU, NA & China

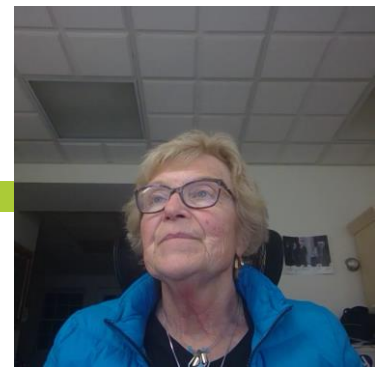
Pinfa is the voice of PIN Flame Retardants Manufacturers and Users

Vision

Continuous improving the environmental and health profile of the PIN flame retardant products.

Mission

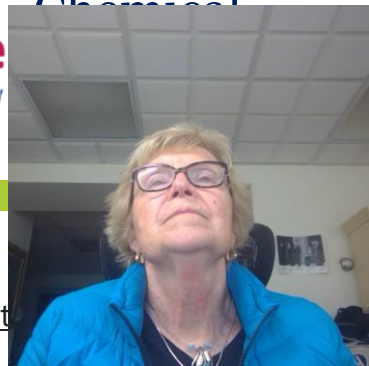
To maintain high fire safety standards across the world, standards which minimize the risk of fire to the general public.



40
Member
Organizations



FR Adviser LLC

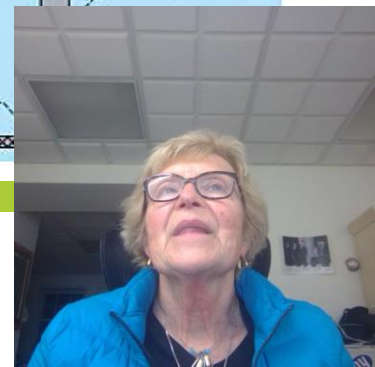
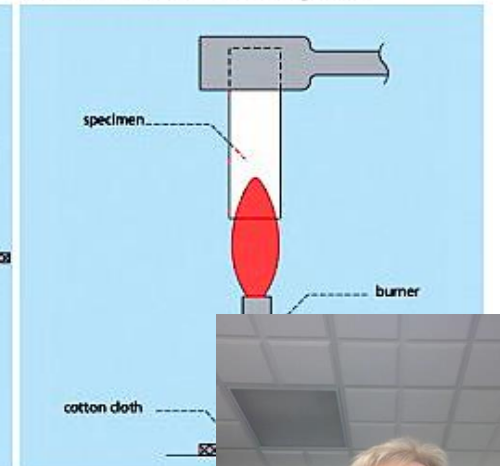
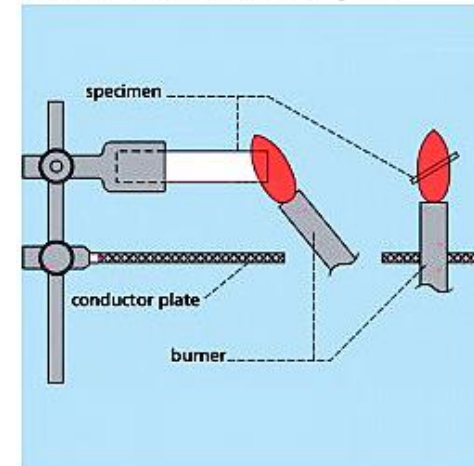


- Pinfa NA has scheduled its first virtual formulator's workshop with co-sponsor SPE (Society of Plastics Engineers)
- Series of 4 webinars covering materials, testing, emerging technology and markets
- June 1,8,15,21- 2021
[Non-Halogenated Flame Retardants Workshop - SPE \(4spe.org\)](https://www.4spe.org)



UL94 HB – Horizontal Burning Test

UL94 V – Vertical Burning Test



MARKET DATA FOR E-MOBILITY



DRIVING FACTORS FOR THE SUBSTANTIAL GROWTH OF THE EV MARKET IN 2021-2025

Regional Policies

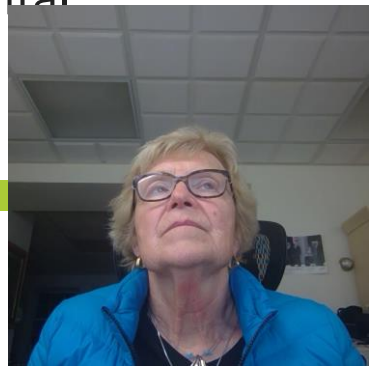
- Commitment to carbon Emission policy in various countries
 - Some countries have put in place plans to phase out ICV
- Layout and investment by automobile manufacturers
 - Traditional auto manufacturers have made long-term investments in EV
 - Recent announcement by GM (Bloomberg EV Outlook, Forbes)

Continuous Breakthroughs in Battery Technology

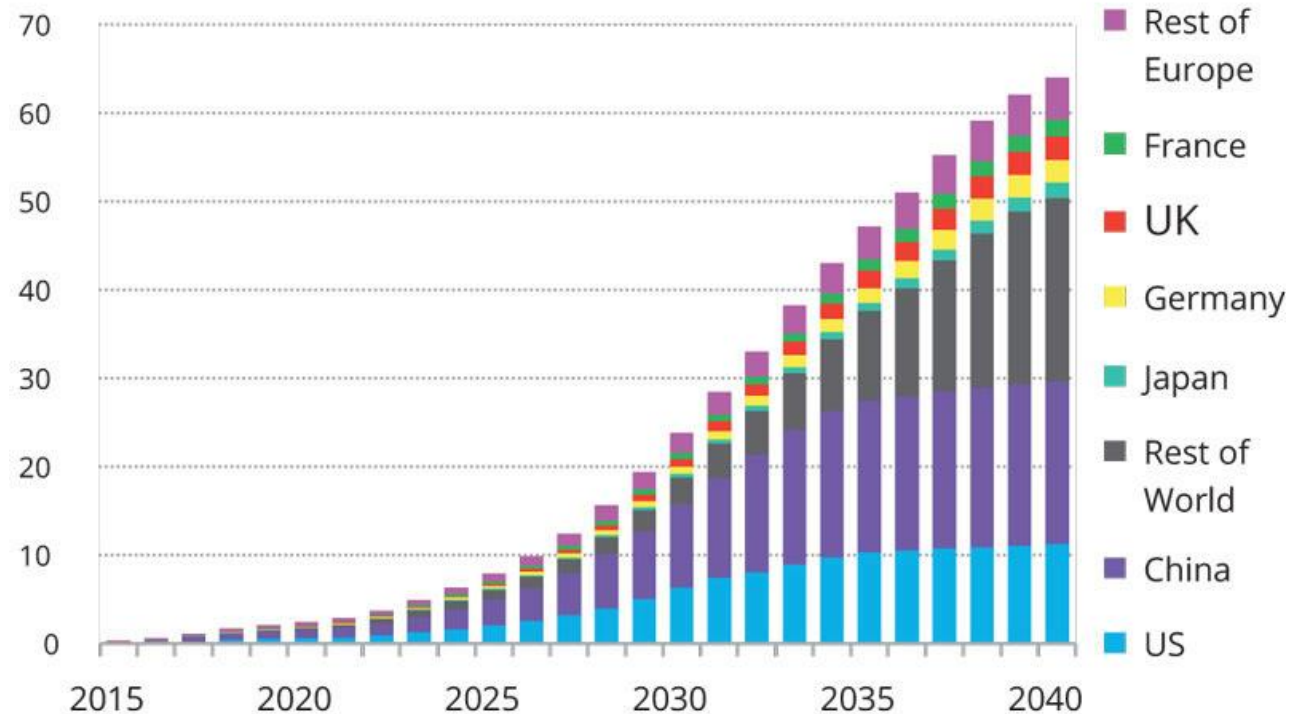
- Batteries exceeding 180 Wh/kg (watt hour/kg) can achieve a range of 550-650 km (340-403 mi.)
- The price of Battery technology declined continually with the price dropping nearly 90% in the last 10 years

Consumers are more open to electric and hybrid vehicles

- Consumers are gradually considering the advantages of EV in energy saving, environmental protection and costs



Mln. of cars per year

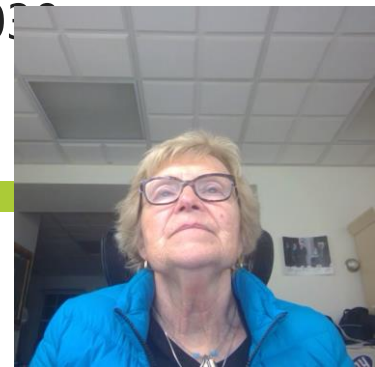


Graph based on estimates at <https://www.vpsolar.com/en/electric-cars-market-statistics/>





Global Electric Vehicle (EV) is estimated at 160 US \$Billion in 2019
 Expected growth 800 \$B by 2027

Resisted better the Covid downturn in first half of 2020-up 57% in EU while overall market -37%

It is estimated that around one-third of the world car market will be electric or hybrid by 2030



Dynamic BEV (Battery Electric Vehicles) and PHEV (Plug-in Hybrid Electric Vehicles) sector

	China 	EU 	USA 	Global 
Current Market Share	4.7%	1.9%	1.3%	1.7%
%growth	+70%	+84%	+50%	+66%

A 100% Electric market in 2050?

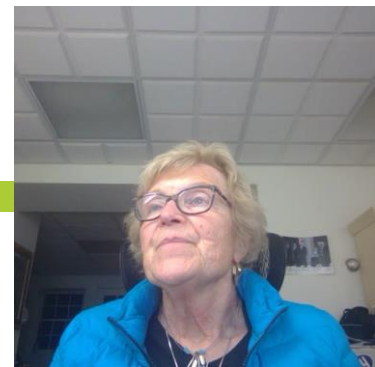


Source: Joeri Van Mierlo, MOBI-VUB

Global trends are clear:

Chinese market is experiencing a **very fast** increase in BEV and PHEVs

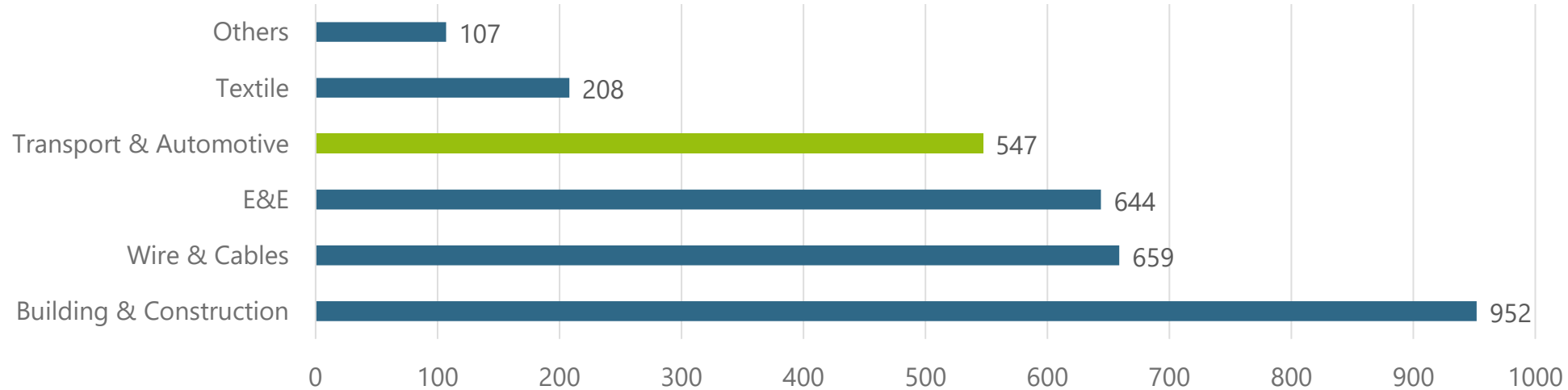
- 600,000 units sold in 2017 which is more than Europe with 215,000 vehicles and United States with about 150,000 units.



Flame Retardant Markets

Automotive & Transport is the **4th Largest Market**

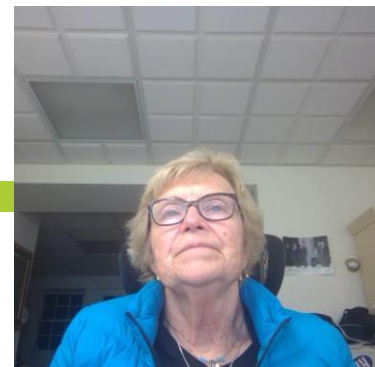
2021 expected FR sales (kt)



Automotive growth forecasts:

Strong global CAGR > 6%

APAC as the leader: China producing 55% of BEV passenger cars (2019)



3 workshops organized in the past 3 years - Pinfa had online webinar in 2020



China – pinfa Emobility & Fire Safety Challenges
Shanghai, 22 November 2018

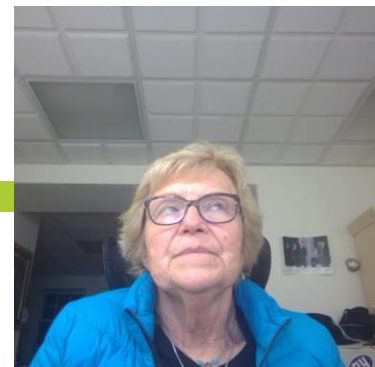


Japan – pinfa Emobility & Fire Safety Challenges
Tokyo, 01 July 2019



Germany – Joint pinfa/Fraunhofer LBF/FGK Emobility & Fire safety challenges
Darmstadt, November 12 2019

Pinfa NA participated in Battery and Hybrid Vehicle symposium in 2020



Batteries

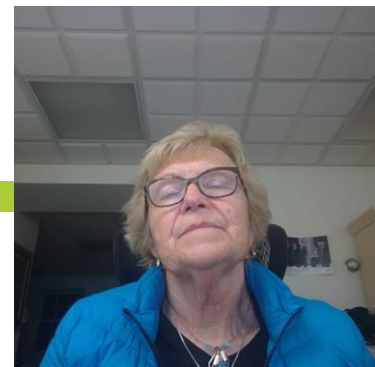
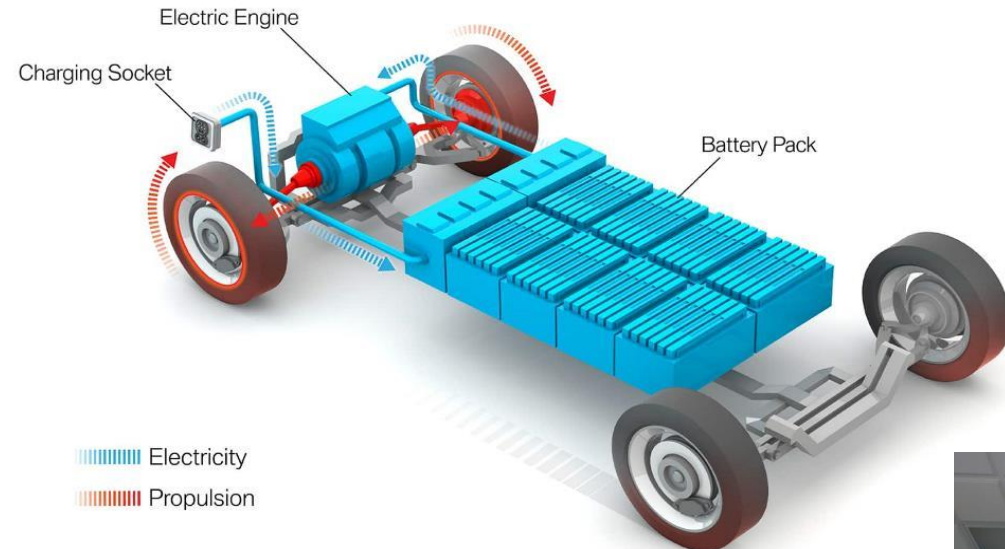
- Longer range (>350km)
- Heavier >400kg
- Higher energy density & 800V
 Today: 145% of 2005
 Li Solid-State: 230% of 2005
- Fast charging time
- Long-term durability



High Safety Standards

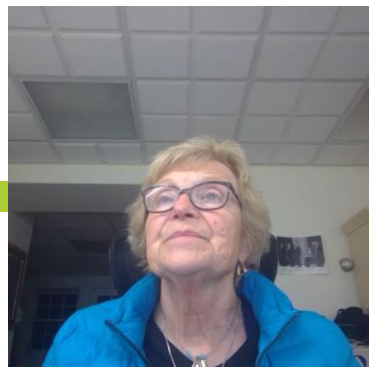
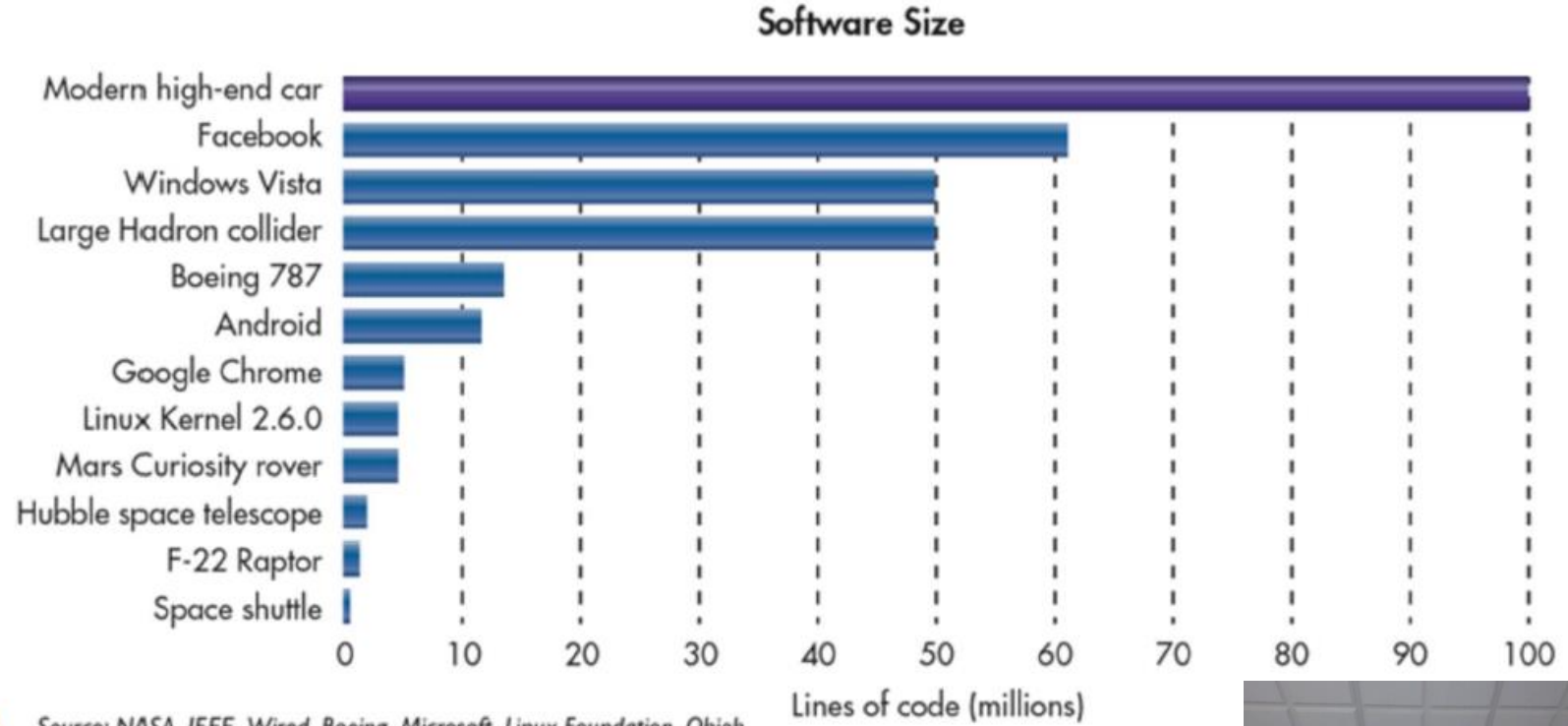
Needs for Mass Market Acceptance

- Reduced Cost (1st criterion)
- Increased Range (2nd criterion)
- Increased safety



Sensors and Entertainment systems

Several miles of wires in an EV
Loads of data produced by EV

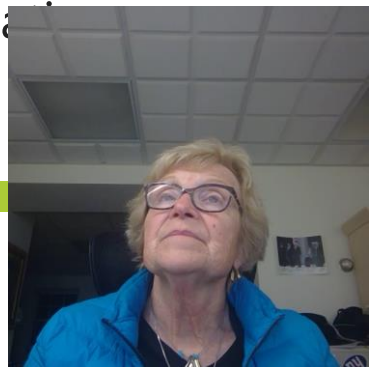


Existing Road Vehicles already represent a fire risk:

- Over 202,000 vehicle fires, causing 560 deaths, 1500 injuries and nearly 2 Billion US\$ property damage in the US alone in 2018.

Electric and Hybrid vehicles bring new and increased safety risks:

- Specific fire risks of batteries, related to energy concentration when fully charged ("Stranded energy") to possible mechanical faults and risk of runaway
- High amperage drive cables and connectors charging connection, move from 12V to 24 V, with risks of overheating and arcing
- Proximity and interconnection of electronics battery management, power and communication
- More cables and connectors than in traditional vehicles

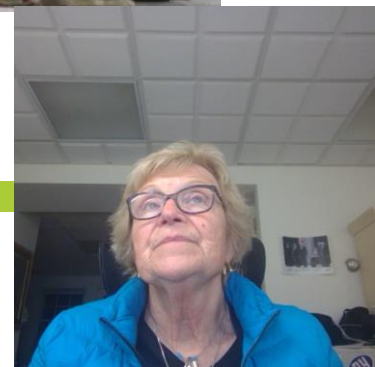


Fire Causes

- Vehicle fault
- Vehicle Crash (drop)
- Charger fault
- Internal Cell fault

Risks can be classified in 4 categories

- Release of thermal energy
- High voltage or loss of function
- Release of kinetic energy
- Release of chemicals (electrolyte and gases)



Faster charging
up to 7min (350kW)

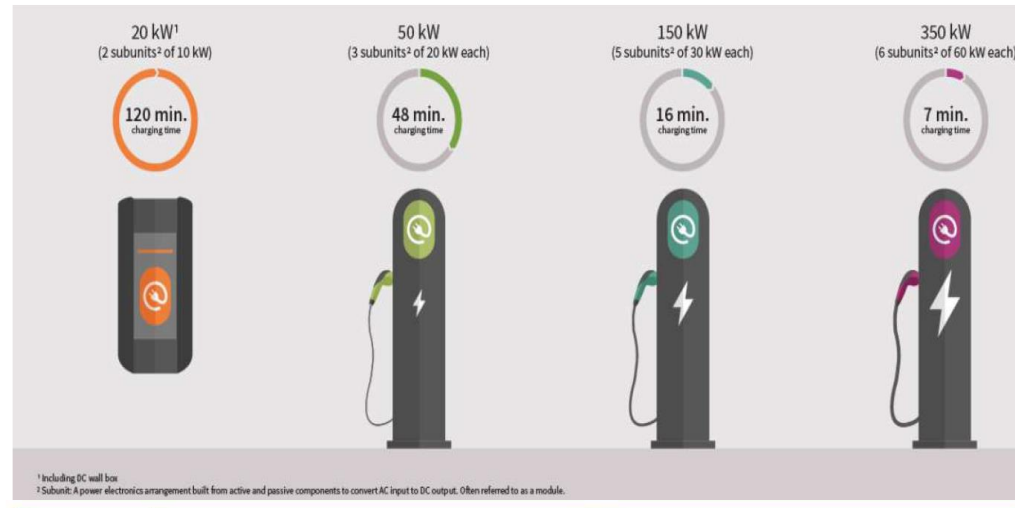
Outgrowing gas stations
150,000 eV C.P. VS 92,000 gas stations
in EU+NA

Challenge: Standardization

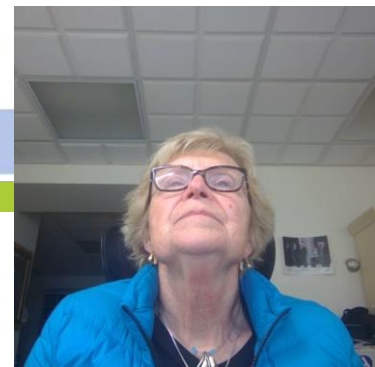
Up to 4 different connectors per charger
3 cables groups (EU standard, EU HPC, US-no HPC)

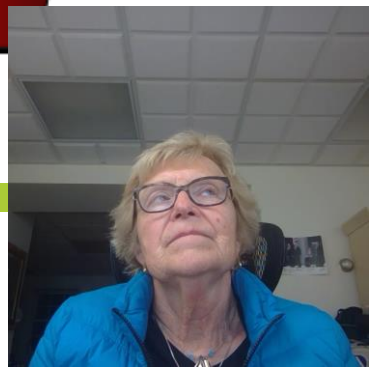
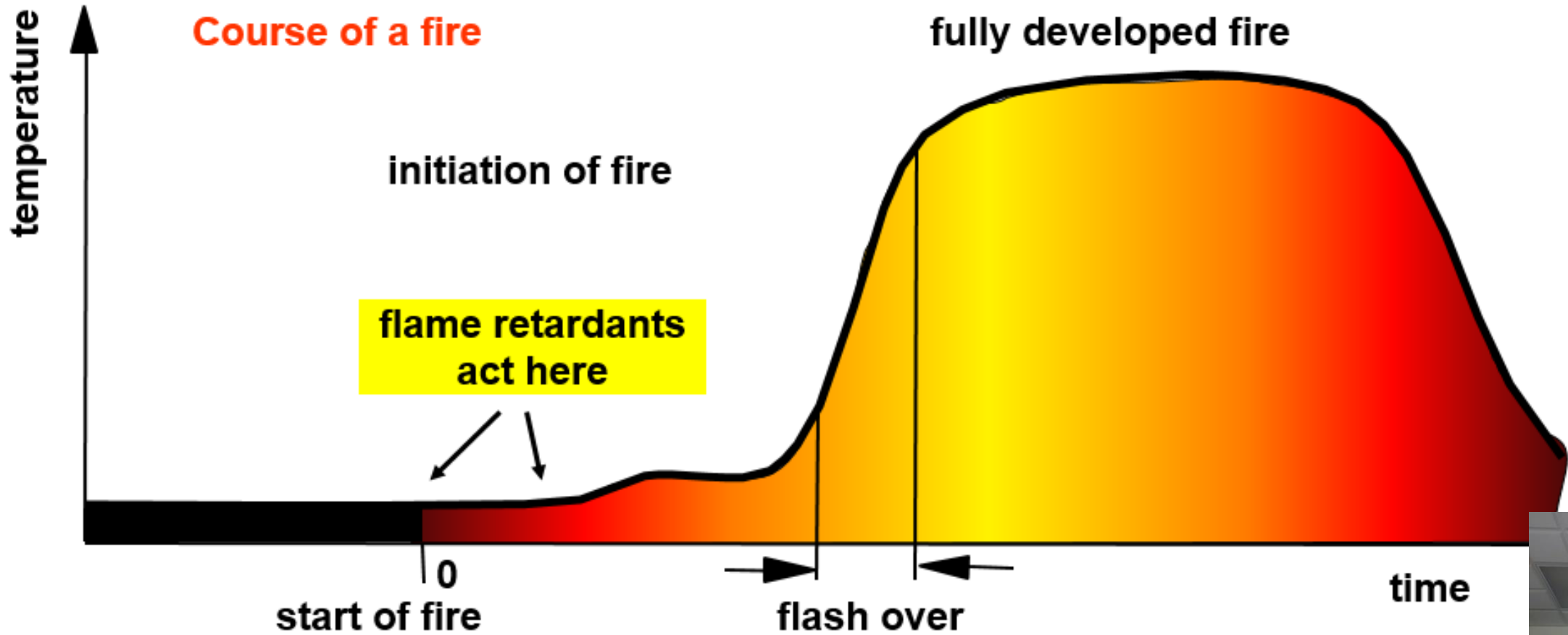
Challenge: Fire Safety

Cables: Halogen Free materials (EN50620)
Connectors



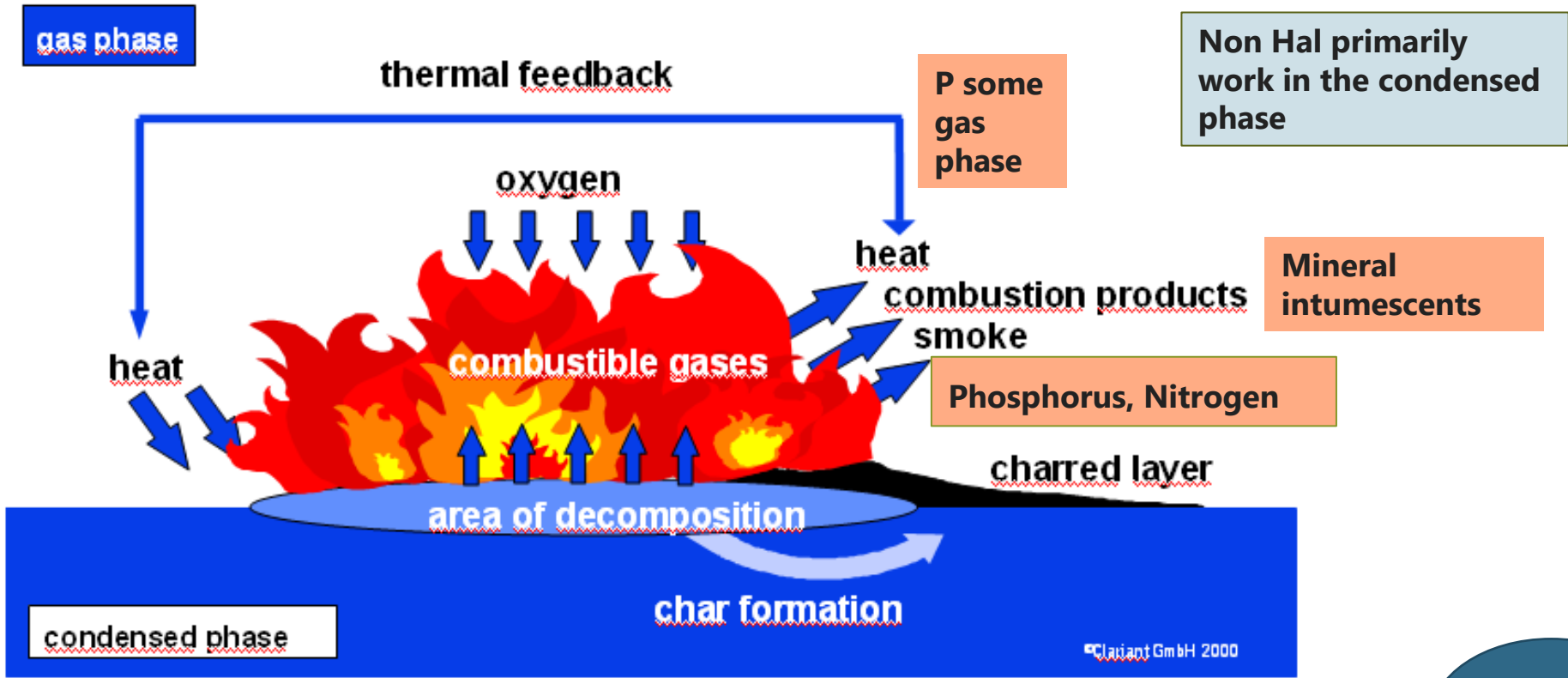
Current type	Region			
	Japan	America	Europe, rest of world	China
AC				
Plug name:	J1772 (or Type 1)	J1772 (or Type 1)	Mennekes (or Type 2)	GB/T
DC				
Plug name:	CHAdeMO	CCS1	CCS2	GB/T





COMBUSTION OF PLASTICS

Halogenated systems primarily work in the gas phase



Binary

Flame Retardants can inhibit or suppress combustion mechanism by:
Physical Action: cooling, formation of protective layer (coating), dilution
Chemical Action: rxn in gas phase, rxn in solid phase

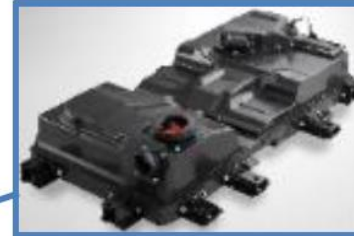
Multi-



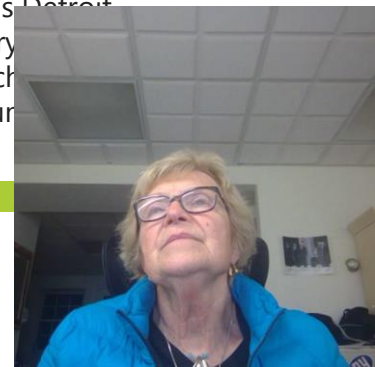
More & More Plastic

Example: increased composite adoption for battery upper case

OEM	Vehicle	EV/PHEV	LWR CASE	UPR CASE
Nissan	リーフ	EV	Steel	Steel
BMW	i3	EV	Aluminum	Steel
TESLA	S	EV	Aluminum	Steel
Mitsubishi	i-Miev	EV	Steel	Plastic (PP)
Renault	ZOE ZE	EV	Aluminum	Steel
FIAT	500e	EV	Steel	Composite
VW	e-up	EV	Steel	Composite (GF-SMC)
	e-Golf	EV	Steel	Composite (GF-SMC)
BYD	E6	EV	Steel	Composite
	Denza EV	EV	Aluminum	Steel
Chevrolet	Spark	EV	Steel	Composite
Toyota	RAV4	EV	Aluminum	Steel
Chevrolet	BOLT	EV	Steel	Composite (GF-SMC)
FORD	Focus EV	EV	Steel	Steel
SMART	SMART	EV	Steel	Steel



April 6, 2021-the fully electric Chevrolet Silverado has been greenlit for production at GM's Detroit Hamtramck "Factory" vehicle plant in Michigan. The upcoming GMC Hummer and SUV models.



More plastics, less metal

- Epoxy & Polyurethane
- Engineering polymers are commonly used.

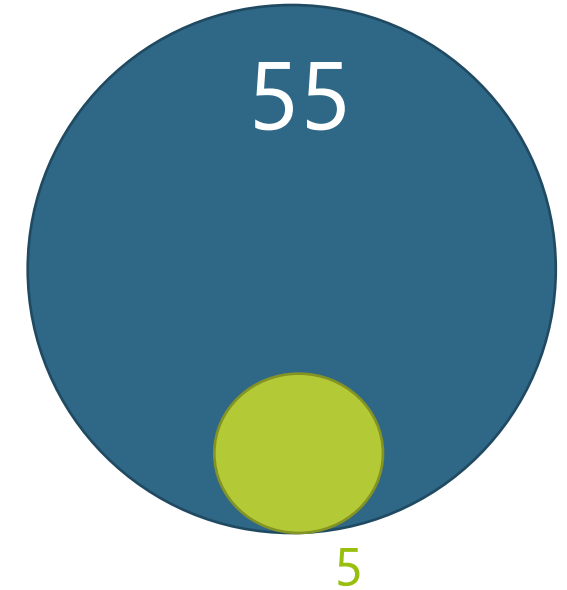
Thinner & lighter casings

- Weight reduction

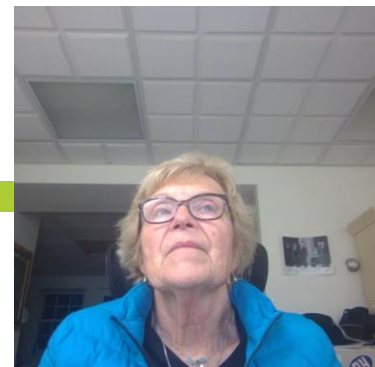
Concentration Parking & Charging

Very safe: Low occurrence of fire events

- 300.000 Tesla driving 7.5 billion mi suffered 40 fires
- BEV: 5 fires per billion mi travelled
- ICE: 55 fires per billion mi travelled

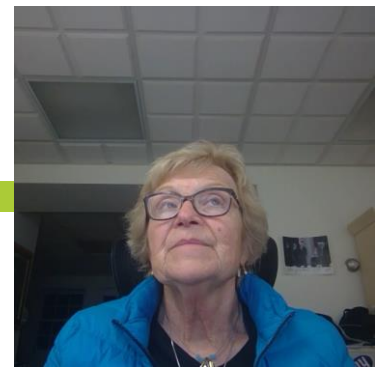


Fires per billion mi travelled



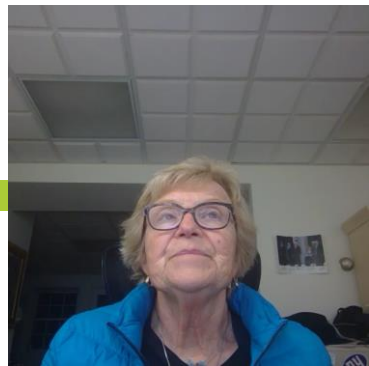
Fire retardant additives are used to help delay the combustability of materials

- It is not the only criteria for material choice
 - Maximum continuous utilization temperature in dry or humid conditions
 - For high Voltage components dielectric strength is key, so some traditional polymers like Nylon 6 may be problematic
 - Retention of mechanicals and HDT
 - Selection of additives in Plastics is critical
 - Some halogenated FR additives can cause electrochemical corrosion
 - High pH leads to dissolution of the passive surface layer of oxides and aluminum
 - Non Hal is better here
 - Processing cost
 - Lower density is preferred



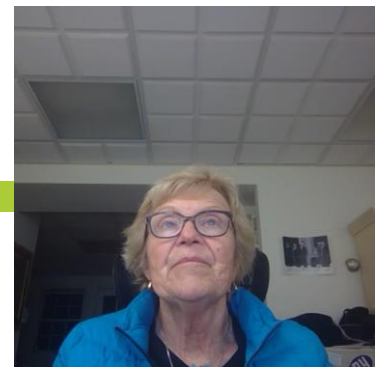
Becoming mandatory in many parts of the world

- CTI 600V and above
- UL 94 V-0 for electrical/electronic components down to 0.4mm and after aging
- Hydrolysis resistance of PBT GF FR
- Laser marking and laser welding
- Avoid Blooming and Mold deposits.
- EN62368 Communication systems for all vehicles



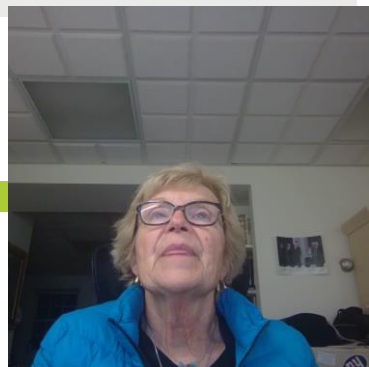
Batteries facing more severe endurance tests:
Example: Japan

Standard No.			
	Current standard		In future ?
Standard No.	UN R100-03	GB/T 31467.3	GTR(Global Technical Regulations) 5.4.12
Flame retardancy to external flame	Y	Y	Y
Flame retardancy for internal hot gas	N	N	Y



FR parts in an EV

Seat, seat belt, ceiling cloth, convertible top, arm rest, door trim, front trim, rear trim, side trim, rear package tray, head back tilt control device, carpet, mat, sun visor, sunshade, wheel house cover etc.



APPLICATION REQUIREMENTS

**Without
Flame retardant**

**Color
RAL 2003**

CTI \geq 400 V

**High
Ductility**



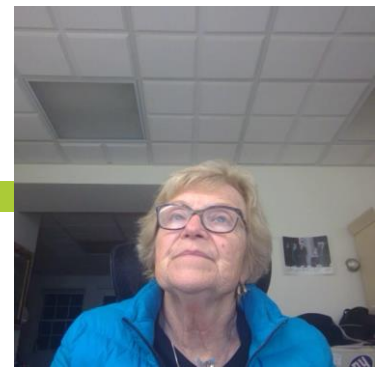
**With
Flame retardant**

**Color
RAL 2008**

CTI \geq 600 V

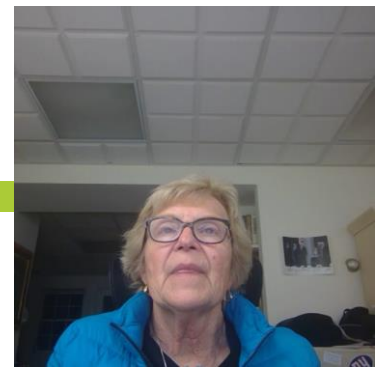
**High
Stiffness**

Orange color in the presence of high voltages and after aging must remain visible



APPLICATION REQUIREMENTS

EMI Shielding		Temperature Resistance
Electrical Insulation		High Stiffness
Leakage Proof		Dimensional Stability
UL 94 V0 at 2/3 mm		Space Constraints



APPLICATION REQUIREMENTS

Vibration ageing
Performance

UL 94 V0 at 2 mm

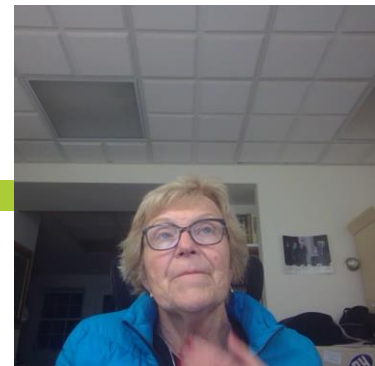
High Stiffness

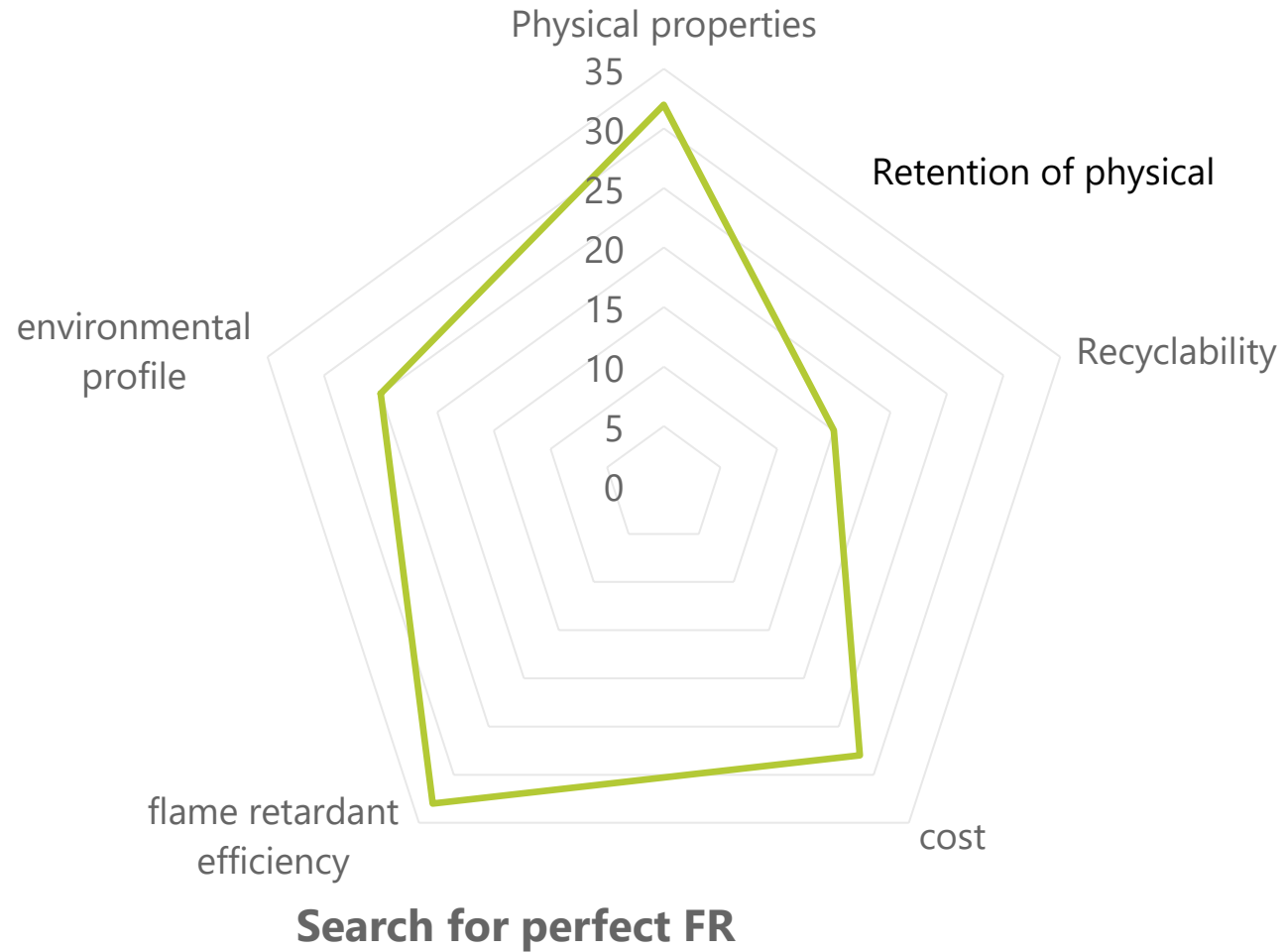


Impact
resistance

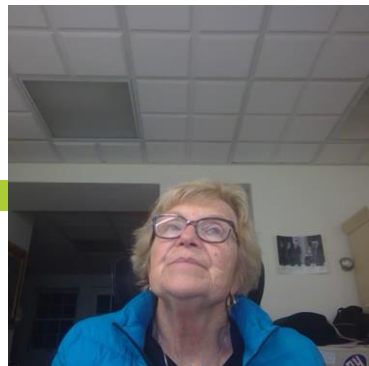
Leakage
Proof

EMI Shielding





Need for continuous Improvement...



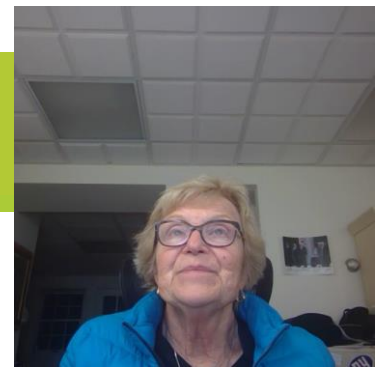
Compliance with more and more stringent regulations

- REACH
- RoHs
- WEEE
- POP / Stockholm convention
- Ecodesign Regulation for screens & displays

Recycling challenges

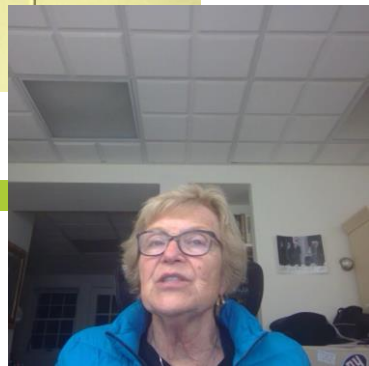
- Migration/Leakage of flame retardants
- Physical alterations of recycled polymer
- Ensuring feedstock for the recycler: durable supply of recyclable material
- Sorting of FR formulation : marker the future of sorting

Goal of pinfa- bring stakeholders and supply chain together to meet material fire safety needs and challenges



Mobility as a Service

Connected
Autonomous
Shared
Electric





THANK YOU FOR YOUR ATTENTION!

Thanks to Pinfa EU Executive Committee

Thanks to Pinfa NA Executive Committee

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