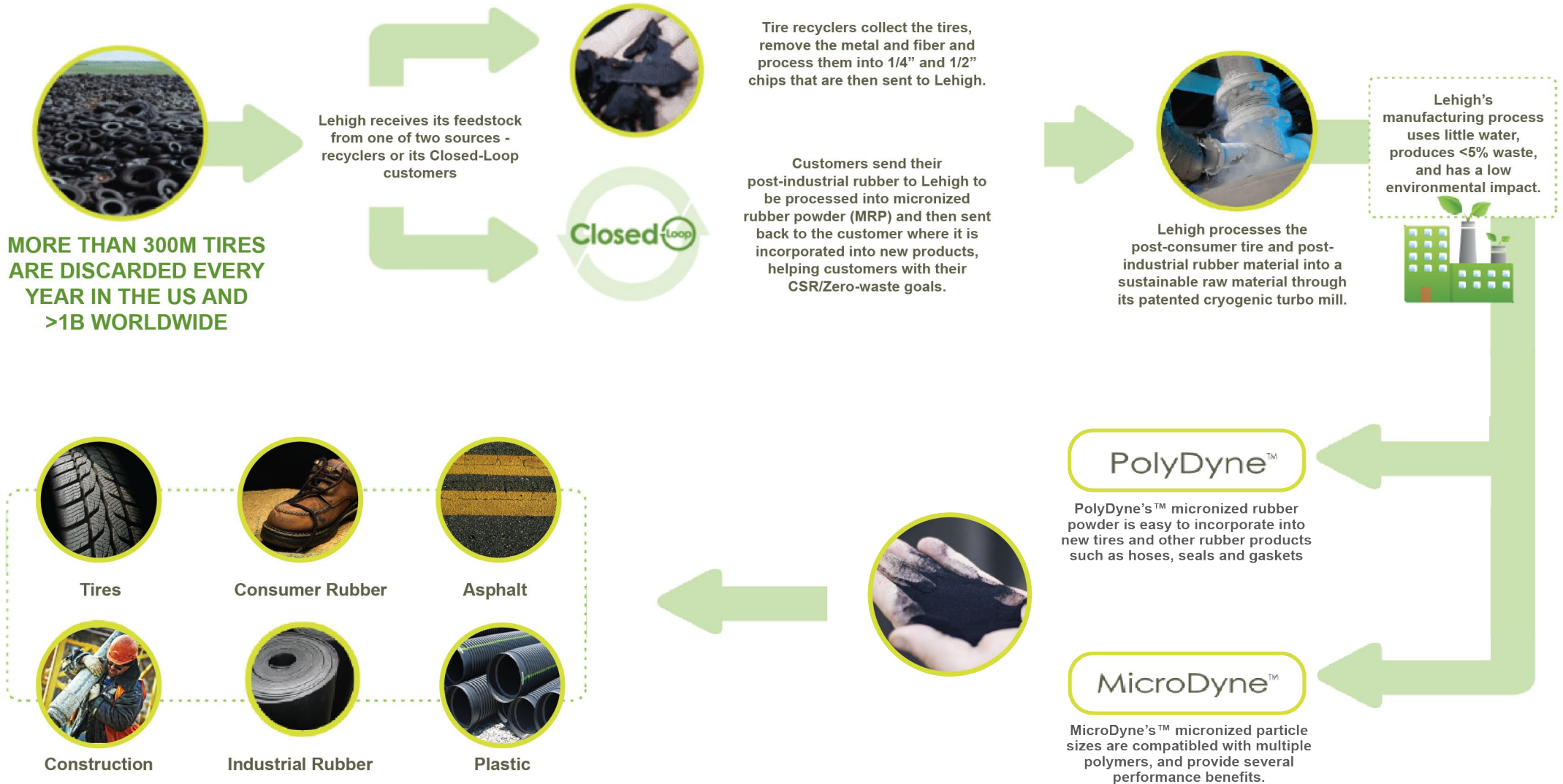




MRP Circular Economy

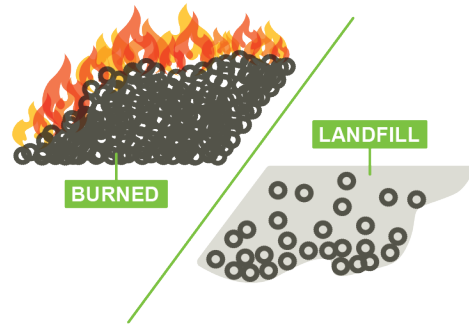
**Scrap Tire Recycling Conference
December, 2019
Greenville, SC**

What We Do

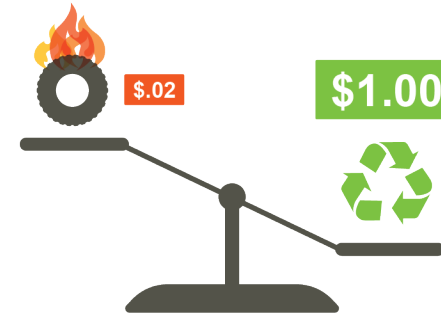


Why It Matters

We waste billions each year by landfilling end-of-life tires



▶ About 50% of tires are burned or landfilled



▶ But reusing tires in new green tires is valuable

Developing new tires with micronized rubber powder (MRP) is challenging

DEVELOPMENT



MULTI-STEP PROCESS



PERFORMANCE + SAFETY REGULATIONS



But now MRP is a standard raw material in green tires



The average set of green tires can save \$200



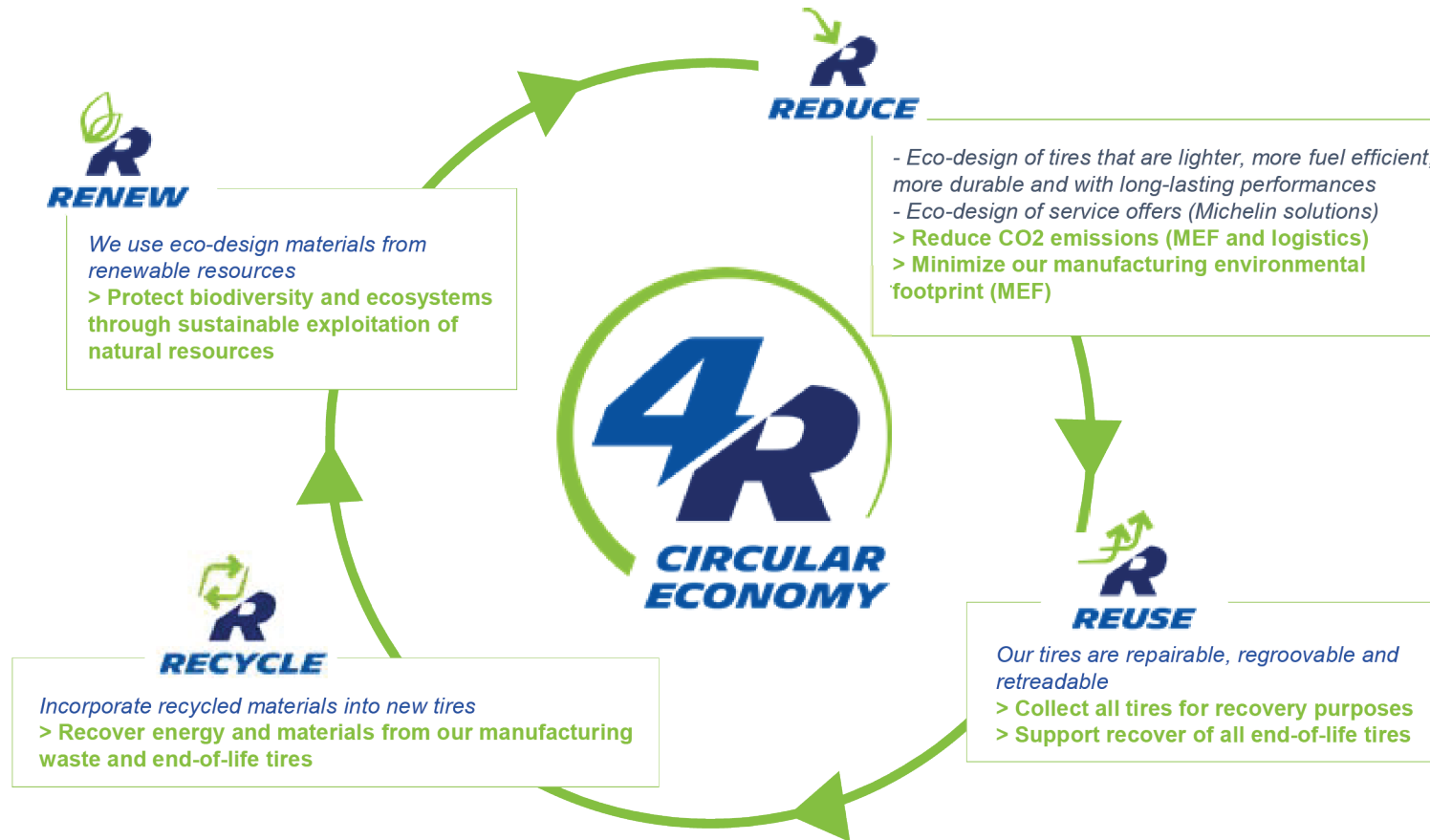
Rapid growth is taking green tires to the mainstream



▶ Over 500 million tires manufactured to date

Lehigh + Michelin

Michelin acquired Lehigh in 2017 as part of its commitment to a sustainable mobility future and the circular economy through its **4R Strategy**.

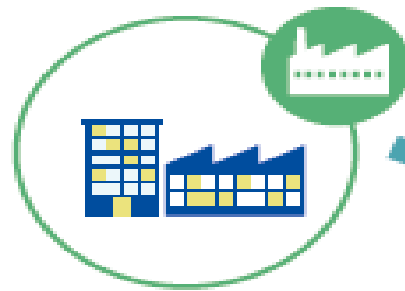


Together Lehigh + Michelin will build on their **collective expertise** in materials to develop and use **innovative technological solutions** within the end-of-life tire and rubber recycling economy.

Committed to Reducing Lifecycle Impact of Tires....

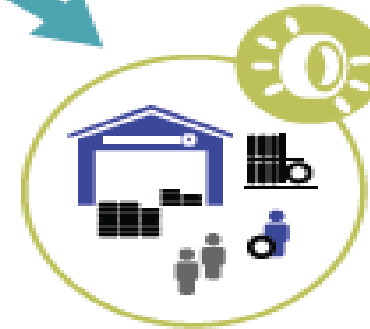
RAW MATERIALS

Michelin is responsibly developing its natural rubber supply and other sustainable materials.



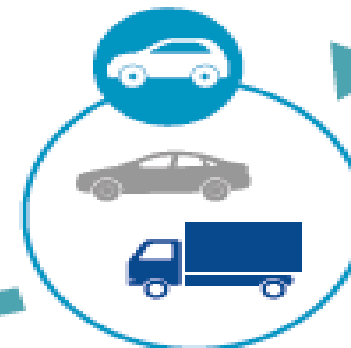
MANUFACTURING

Michelin aims to reduce its environmental footprint by 50% between 2005 & 2020.



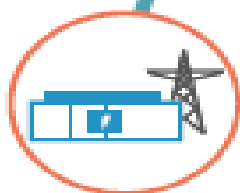
DISTRIBUTION

Michelin applies multiple levers to reduce its carbon footprint for transporting semi-finished and finished products.



USE REPRESENTS 90% OF LIFE CYCLE IMPACTS

Michelin's innovations mean more kilometers and higher performance with fewer materials and a smaller carbon footprint.



Energy recovery



Materials recycling



END OF LIFE

Michelin actively supports resource recovery and recycling systems with its stakeholders and industry partners around the world.

Tire Recycling: Standard Practice



5-10%
MRP
Tire Tread



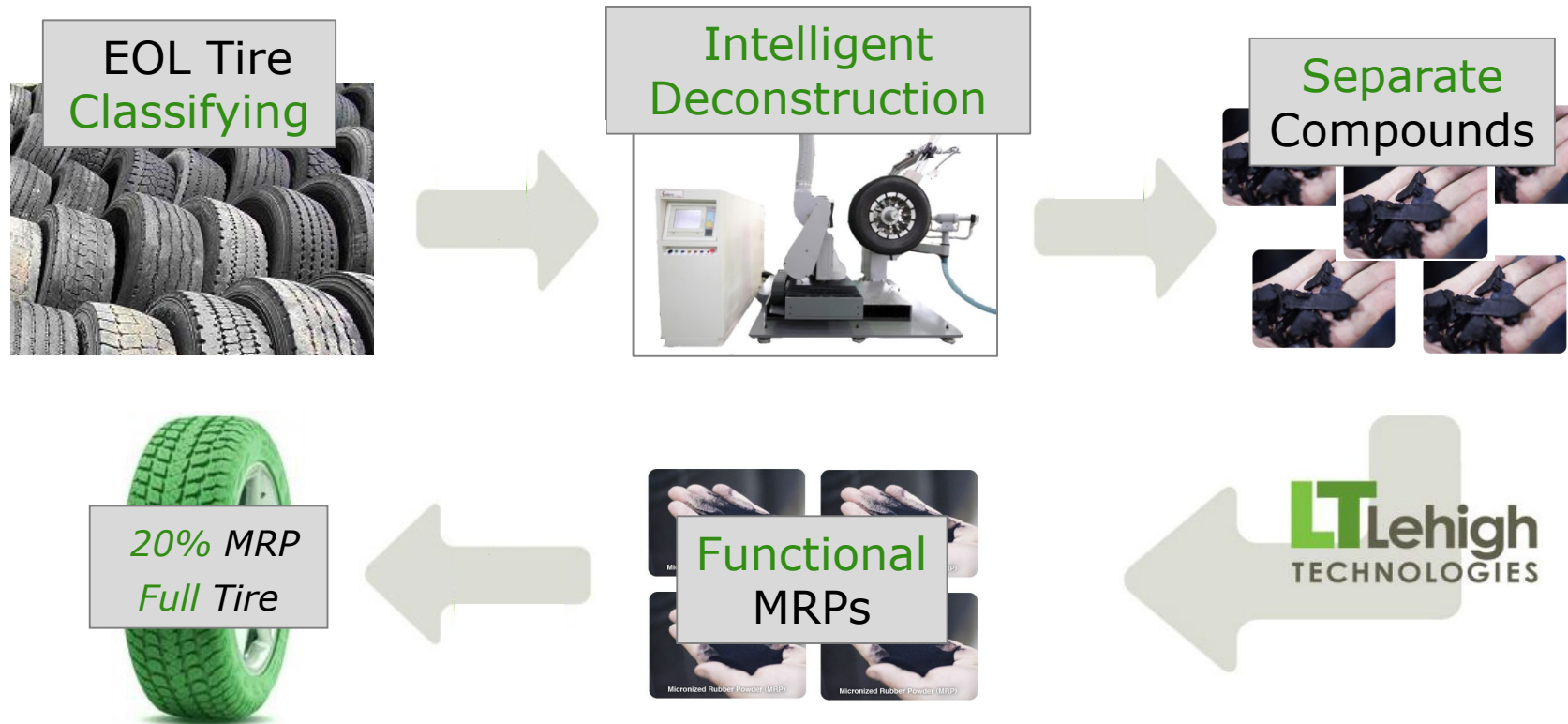
For a 10 Million Unit PC Tire Production Plant using 5-10% PolyDyne MRP....

...The Compound Savings is
\$2.9 - \$7.4 Million Annually

Assumptions		
PC Tire 265/70R16	kg	11.34
total rubber in the tire	kg	10.20
tread rubber per new tire	kg	3.74
liters oil / kg rubber		6.86
Energy to mfg kg SBR	KWh	24.0
Energy to mfg kg MRP	KWh	2.04
CO2 / kg SBR		5.95
CO2/ kg MRP		3.37
Cost of Compound	\$/MT	2977
---Ave cost of SBR Jan 08 - Apr 13	\$/MT	2955
---Ave cost of NR Jan 06 - Apr 13	\$/MT	2448
Price of PD80	\$/MT	992
Price of PD140	\$/MT	1433
PolyDyne loading	%	5%
Landfill Cost	\$/MT	66
Tire Plant Assumptions		METRIC
PC Tires per Year	#	10,000,000
Rubber in Tires	MT	102,041
Tread Compound	MT	37,415
PolyDyne Required in Tread	MT	1,871

Model Calculations @ x % PD80			
		5%	10%
Tread Compound Cost	\$	111,375,000	111,375,000
PolyDyne Cost	\$	1,856,250	3,712,500
Compound Cost Saved	\$	3,712,500	7,425,000
Tires Saved From Landfill	#	183,333	366,667
Oil Saved	liters	12,831,848	25,663,695
Energy Saved	KWh	41,077,891	82,155,782
CO2 Saved	MT	4,826,250	9,652,500
Model Calculations @ x % PD140			
		5%	10%
Tread Compound Cost	\$	111,375,000	111,375,000
PolyDyne Cost	\$	2,681,250	5,362,500
Compound Cost Saved	\$	2,887,500	5,775,000
Tires Saved From Landfill	#	183,333	366,667
Oil Saved	liters	12,831,848	25,663,695
Energy Saved	KWh	41,077,891	82,155,782
CO2 Saved	MT	4,826,250	9,652,500

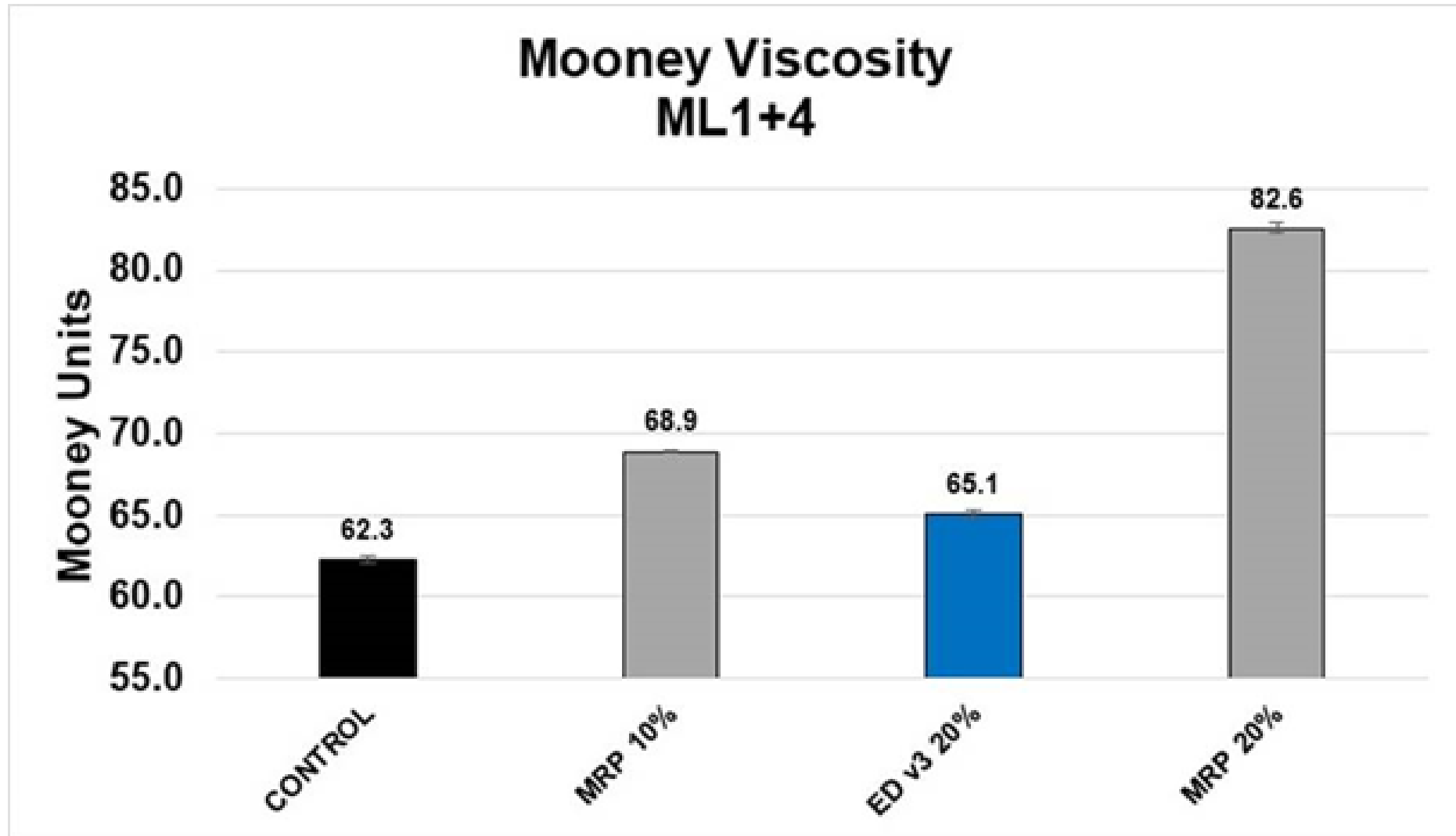
Tire Recycling: Future State



Recycling of Rubber Composites - Challenges

- No design-for-recycling in consumer tires - Separation of metal and fiber in tires, belts, hoses, gaskets, etc.
- Rubbers are thermoset – can't be melted like steel, aluminum, and thermoplastics.
- Devulcanization processes usually damage the polymer.
- Increasing MRP content increases viscosity and reduces green tack.
- Performance depends on particle size.
- The largest market is tire rubber – technically complex and conservative.
- Consumers want to buy products from green companies, but they don't want recycled rubber in their tires.
- Product liability and complexity limits retreading of consumer tires.
- Industry perspective – “burning tires is recycling.”

Example of one Issue...





Thank you