Plastics Scorecard: Evaluating the Chemical Footprint of Plastics

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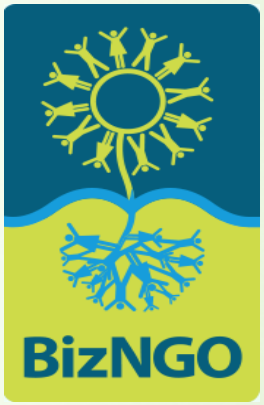
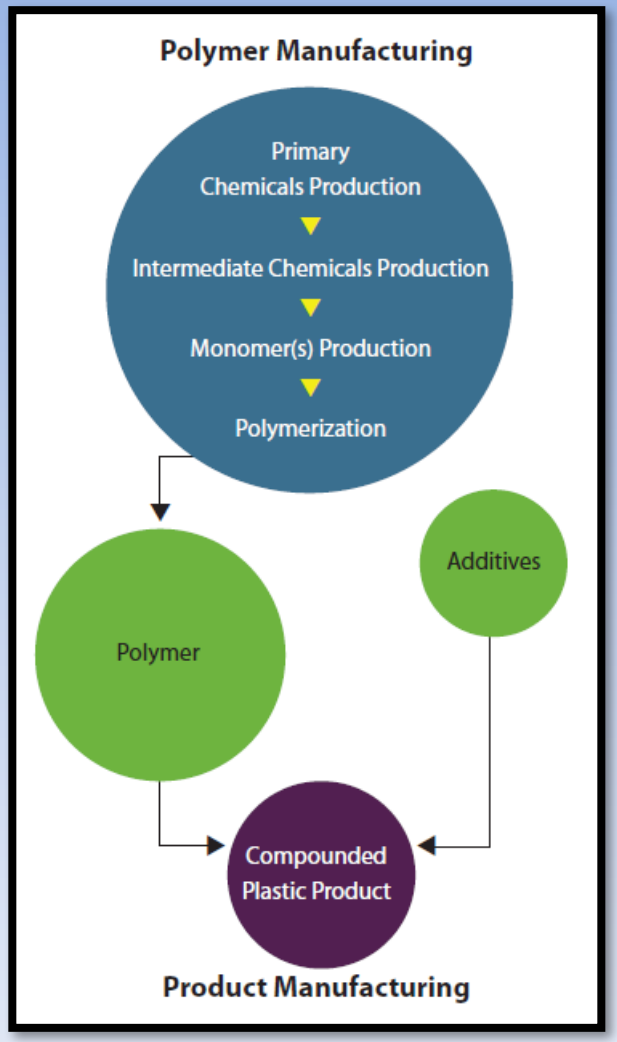
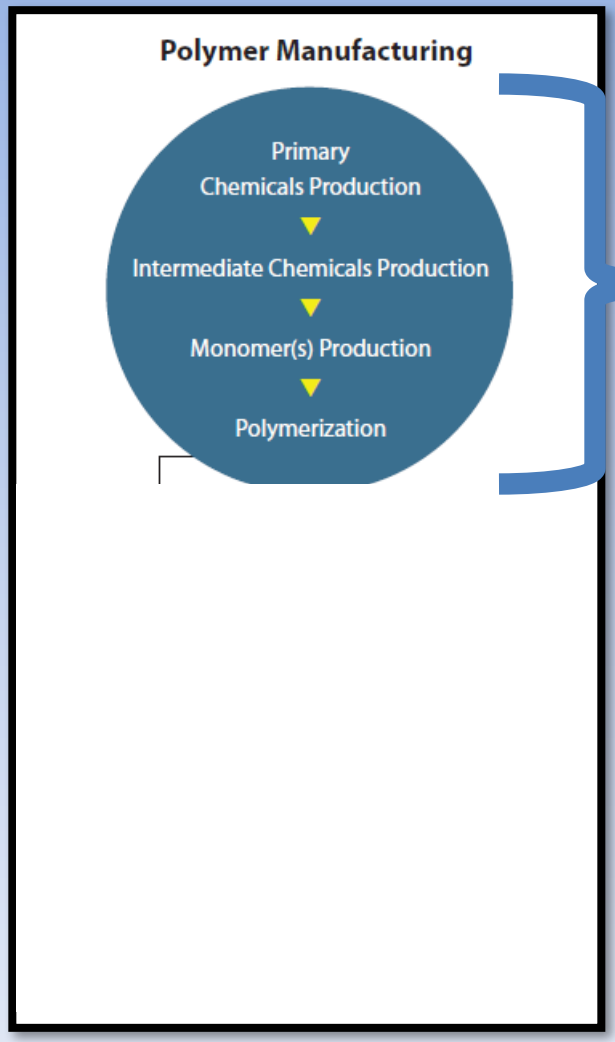


Together, we're creating a safer and healthier future

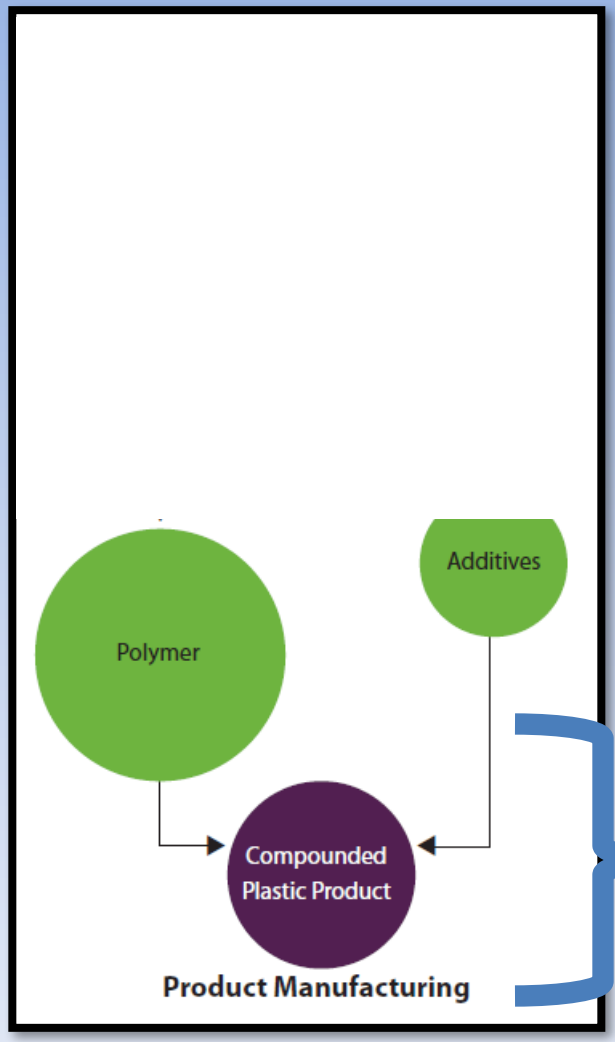
Plastic Scorecard

- **Goal:** define progress to safer chemicals in polymers
- **Polymer manufacturing**: evaluate progress to safer chemicals for each stage in manufacturing a polymer
- **Final plastic product**: evaluate chemical footprint of final product
- **Published in 2014** – authors: Mark Rossi & Ann Blake https://www.biznGO.org/sustainable-materials/plastics-scorecard


Polymer Manufacturing
Primary
Chemicals Production
Intermediate Chemicals Production
Monomer(s) Production
Polymerization
Polymer
Additives
Compounded
Plastic Product
Product Manufacturing



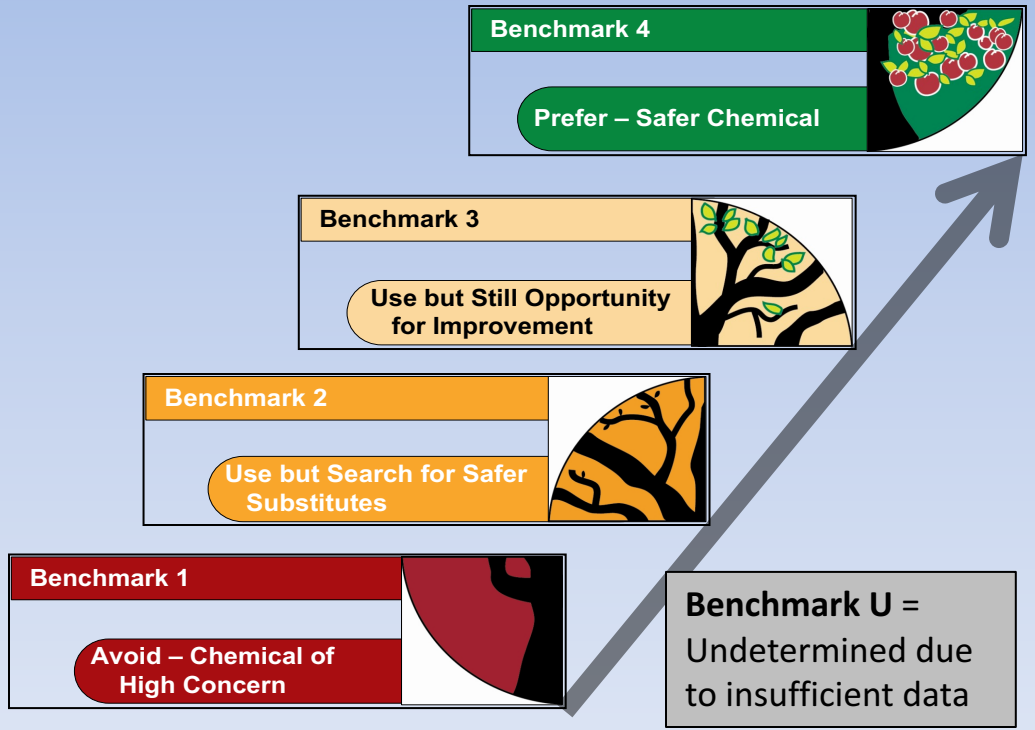
Evaluated progress to safer chemicals (using GreenScreen)



Evaluated presence of chemicals of high concern, ie, chemical footprint (GreenScreen Benchmark 1)

GreenScreen® for Safer Chemicals

- **Comprehensive & vetted:**
  - 18 hazard endpoints
  - publicly available, current v 1.4
  - vetted by scientists, businesses, NGOs, & governments
- **Translated to easy to communicate Benchmarks:** 1 to 4 plus "U"
- **Identify chemicals of high concern**: Benchmark 1 – "chemical footprint"
- **Identify safer chemicals**: ≥Benchmark 2
- **Used by**: Apple, HP, Levi's, etc.
- Method document: https://www.greenscreenchemicals.org/method/method-documents



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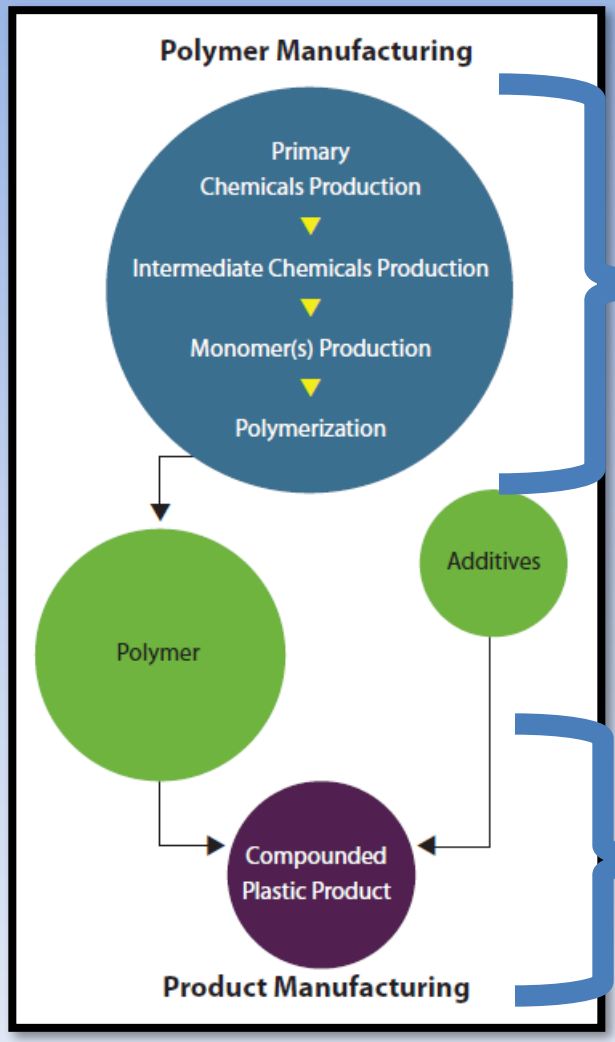
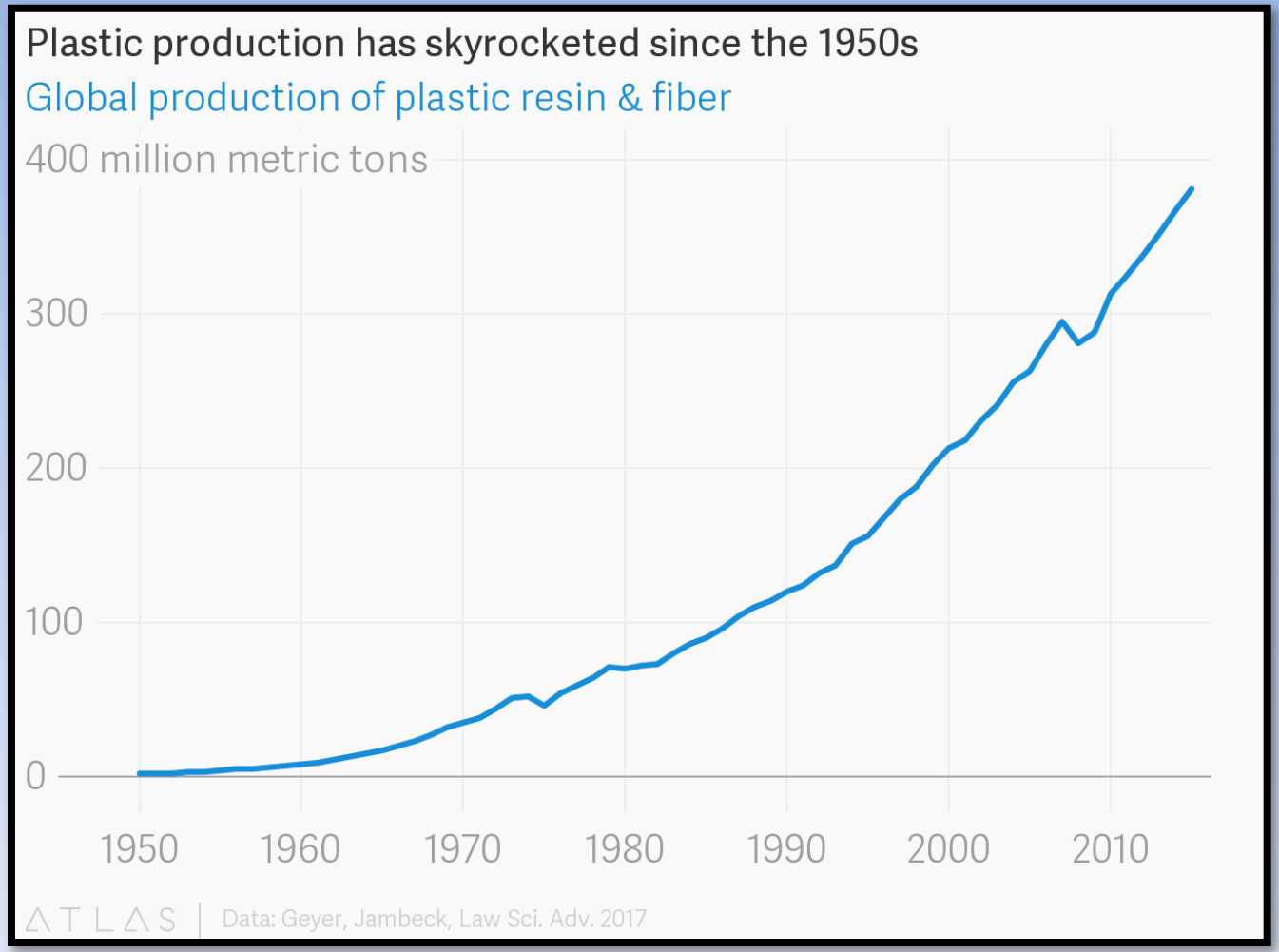


Evaluated progress to safer chemicals (using GreenScreen)

Evaluated presence of chemicals of high concern, ie, chemical footprint (GreenScreen Benchmark 1)

Progress to safer chemicals in polymer manufacturing



Source: https://www.theatlas.com/charts/BkAVFsjrb

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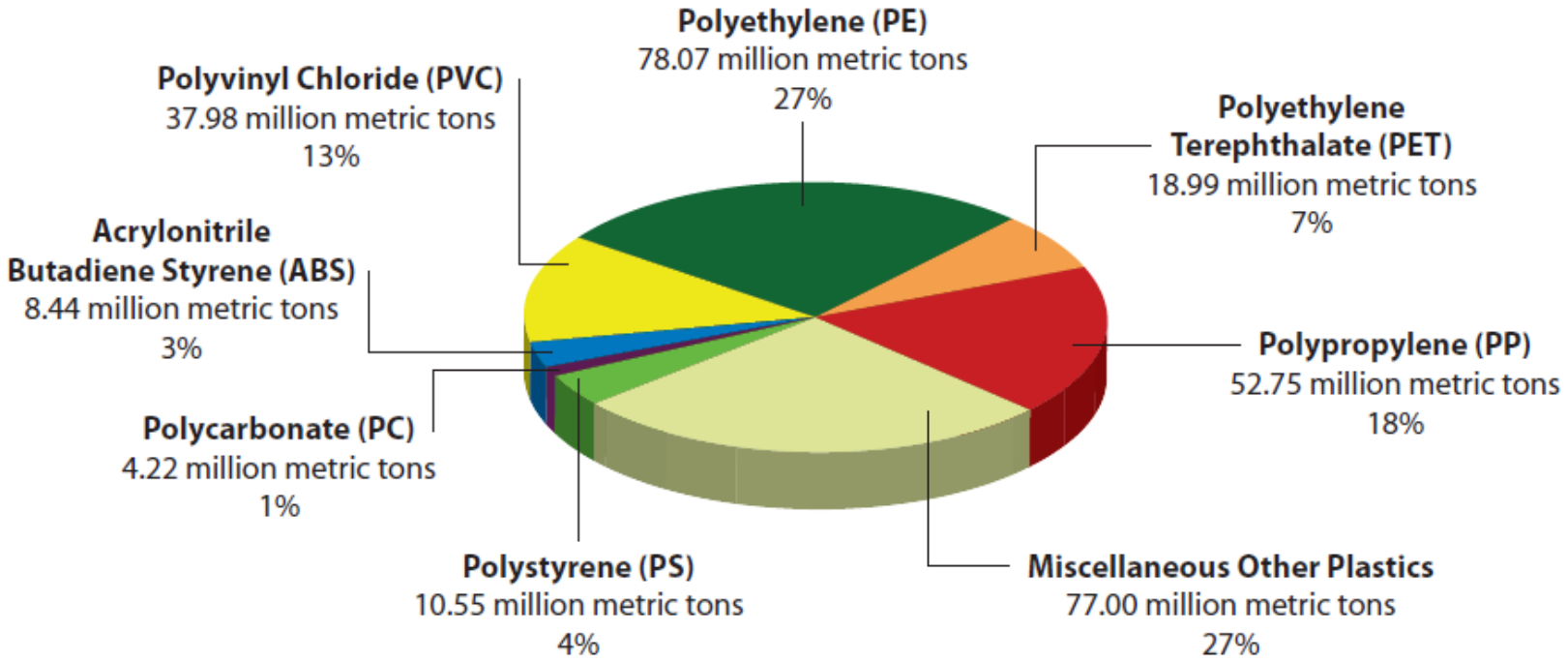
FIGURE 3 **Global Production of Plastics (2012)**



Total = 288 Million Metric Tons

Sources: Plastics Europe, 2013; Sagel, 2012.

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TABLE 1 Primary Chemicals Consumed by Plastics

Primary Chemicals				
Ethylene[a]				
Propylene[a]				
Xylenes[b]				
Benzene[a]				
Chlorine[c]				
Butadiene[a]				
Methanol[a]				
Total				

"Primary chemicals" are the building block chemicals used to manufacture plastics and other chemicals.

a. 2008 data, b. 2009 data, c. 2010 data

Source: Chemical Economics Handbook, articles (a), (d), (e), (i), (j), (r), (s).

Plastics Scorecard

TABLE 1 Primary Chemicals Consumed by Plastics

Primary Chemicals	Total Global Consumption — All End Uses (million metric tons)	Consumed by Plastics (%)	Consumed by Plastics (million metric tons)
Ethylene[a]	113.18	84%	95.13
Propylene[a]	74.90	82%	61.66
Xylenes[b]	42.89	88%	37.62
Benzene[a]	39.67	85%	33.52
Chlorine[c]	56.21	42%	23.55
Butadiene[a]	9.28	94%	8.75
Methanol[a]	41.86	10%	4.19
Total	**377.99**	**70%**	**264.41**

"Primary chemicals" are the building block chemicals used to manufacture plastics and other chemicals.

a. 2008 data, b. 2009 data, c. 2010 data

Source: Chemical Economics Handbook, articles (a), (d), (e), (i), (j), (r), (s).

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TABLE 2 Plastics and the Chemicals they Consume

Steps in Polymer Manufacturing	Plastic Polymers							
Core Chemical Inputs	ABS	PC	PE	PET	PLA	PP	PS	PVC
Primary Chemical Inputs								
1,3-Butadiene	●							
Benzene	●	●					●	
Chlorine		●						●
Ethylene	●		●				●	●
Glucose					●			
Methanol				●				
Propylene	●	●				●		
Xylenes (p-Xylene)				●				

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TABLE 2 **Plastics and the Chemicals they Consume**

Steps in Polymer Manufacturing	Plastic Polymers							
Core Chemical Inputs	ABS	PC	PE	PET	PLA	PP	PS	PVC
Intermediate Chemical Inputs								
Acetic acid				●				
Acetone		●						
Ammonia	●							
Cumene		●						
Dimethyl terephthalate / Terephthalic acid				●				
Ethylbenzene	●						●	
Ethylene dichloride								●
Ethylene glycol				●				
Lactic Acid					●			
Phenol		●						

TABLE 2 **Plastics and the Chemicals they Consume**

Steps in Polymer Manufacturing	Plastic Polymers							
Core Chemical Inputs	ABS	PC	PE	PET	PLA	PP	PS	PVC
Monomer Inputs								
1,3-Butadiene	●							
Acrylonitrile	●							
bis(2-hydroxyethyl) terephthalate				●				
Bisphenol A (BPA)		●						
Ethylene			●					
Lactide					●			
p-tert-Butylphenol		●						
Propylene						●		
Styrene	●						●	
Vinyl chloride monomer								●

Plastics Scorecard

TABLE 3 Plastics and the Chemicals of High Concern they Consume

Chemicals of High Concern (plastics)	
Ethylene dichloride (PVC)[b]	
para-Xylene (PET)[b]	
Benzene (PS)[b]	
Vinyl chloride monomer (PVC)[b]	
Ethylbenzene (ABS, PS)[b]	
Styrene (ABS, PS, SAN, SBR)[b]	
Ethylene glycol (PET, Nylon)[a]	
Cumene (PC)[b]	
Butadiene (ABS, SBR)[b]	
Acrylonitrile (ABS)[a]	
Phenol (PC)[c]	
Bisphenol A (PC, epoxy resins)[c]	
Acetone (PC)[d]	
Total	

"Chemicals of High Concern" to human health or the environment = carcinogen, mutagen, reproductive / developmental toxicant; persistent, bioaccumulative, toxicant (PBT); endocrine disruptor; or chemical of equivalent concern.

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Plastics Scorecard

TABLE 3 Plastics and the Chemicals of High Concern they consume

Chemicals of High Concern (plastics)	Total Global Consumption (million metric tons)	Consumed by Plastics (%)	Consumed by Plastics (million metric tons)
Ethylene dichloride (PVC)[b]	43.45	97%	42.14
para-Xylene (PET)[b]	42.89	88%	37.62
Benzene (PS)[b]	39.67	85%	33.52
Vinyl chloride monomer (PVC)[b]	32.79	97%	31.80
Ethylbenzene (ABS, PS)[b]	27.57	99%	27.29
Styrene (ABS, PS, SAN, SBR)[b]	23.63	91%	21.38
Ethylene glycol (PET, Nylon)[a]	21.00	80%	16.80
Cumene (PC)[b]	12.23	84%	10.27
Butadiene (ABS, SBR)[b]	9.28	94%	8.75
Acrylonitrile (ABS)[a]	5.35	96%	5.16
Phenol (PC)[c]	8.90	55%	4.88
Bisphenol A (PC, epoxy resins)[c]	4.04	96%	3.86
Acetone (PC)[d]	5.67	45%	2.53
Total	**270.79**	**90%**	**243.48**

"Chemicals of High Concern" to human health or the environment = carcinogen, mutagen, reproductive [illegible] persistent, bioaccumulative, toxicant (PBT); endocrine disruptor; or chemical of equivalent concern.

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FIGURE 6 **Progress to Safer Chemicals in Polymer Manufacturing**

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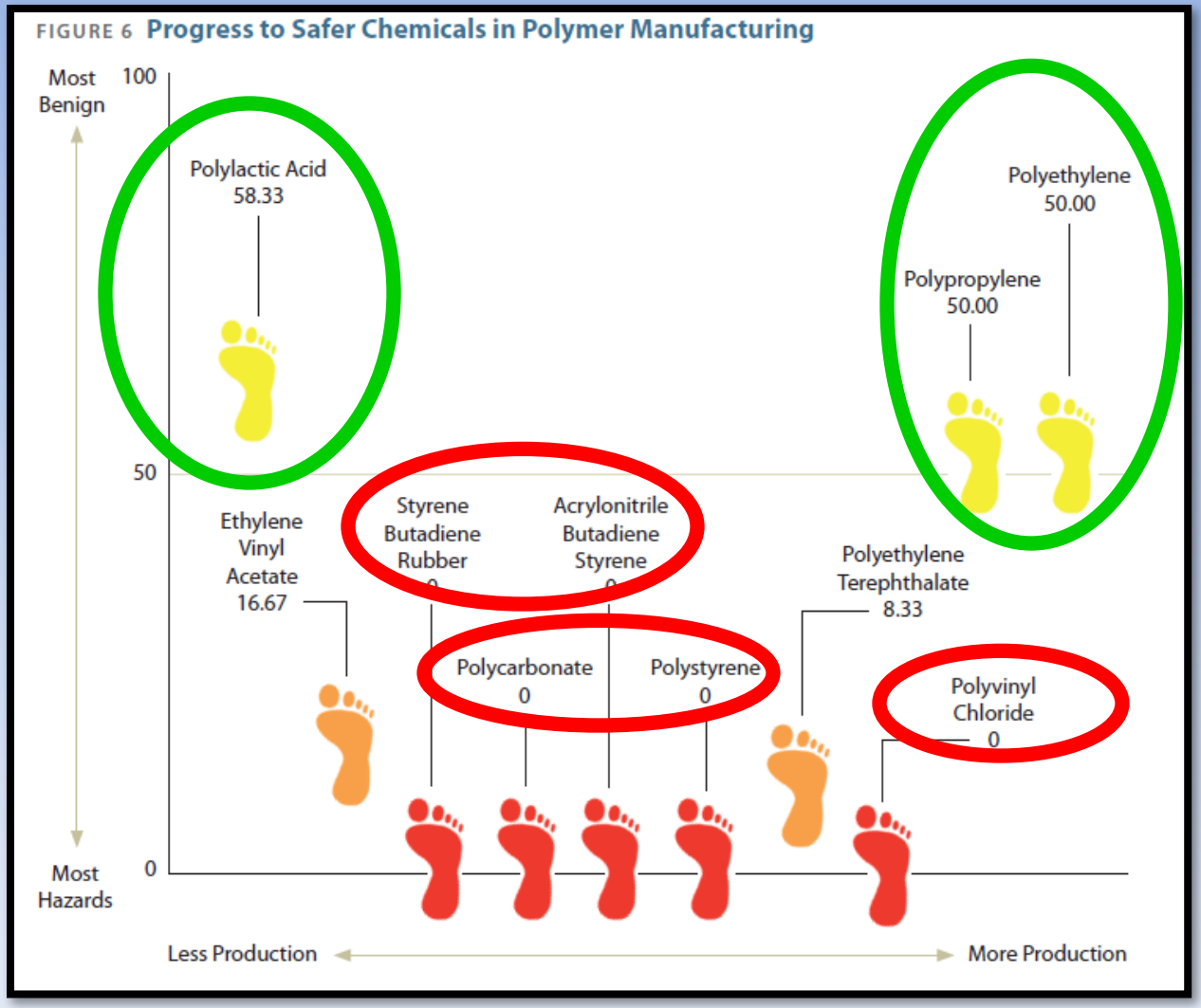
FIGURE 6 **Progress to Safer Chemicals in Polymer Manufacturing**



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Chemical footprint of plastic products

Chemical Footprint of IV Bags

FIGURE ES-2 **Estimated Chemical Footprint of IV Bags Made from PVC/DEHP and Polyolefins**

PVC = Polyvinyl chloride; DEHP = di(2-ethylhexyl) phthalate

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Chemical Footprint of IV Bags

FIGURE ES-2 **Estimated Chemical Footprint of IV Bags Made from PVC/DEHP and Polyolefins**

3

31%

PVC

PVC = Polyvinyl chloride; DEHP = di(2-ethylhexyl) phthalate

Chemical Footprint of IV Bags

FIGURE ES-2 **Estimated Chemical Footprint of IV Bags Made from PVC/DEHP and Polyolefins**

PVC

3

31%

Polyolefins

0

0%

	Number of Chemicals of High Concern	Chemicals of High Concern by Weight

PVC = Polyvinyl chloride; DEHP = di(2-ethylhexyl) phthalate

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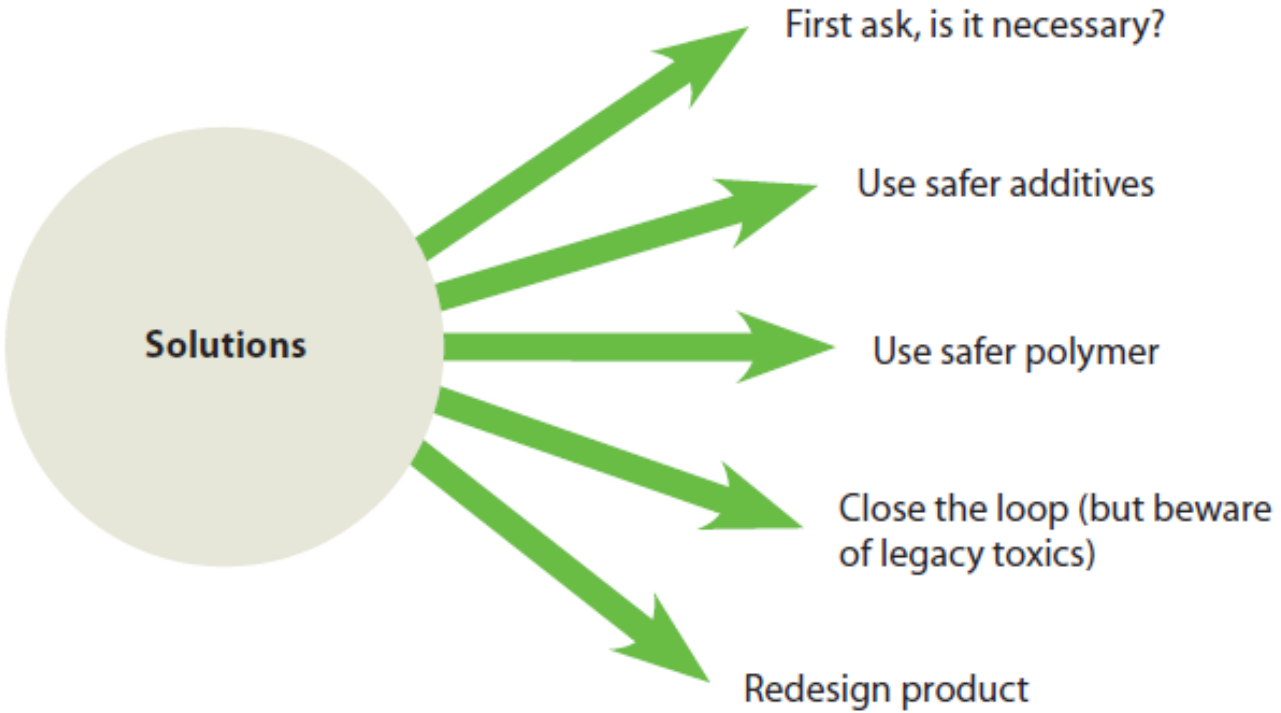
FIGURE 9 **Solutions to Reducing Chemical Footprint of Plastics**



Thank you!

Questions?

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