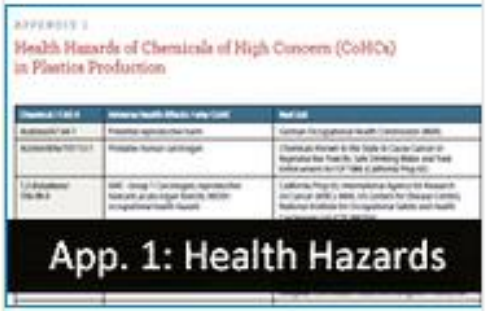
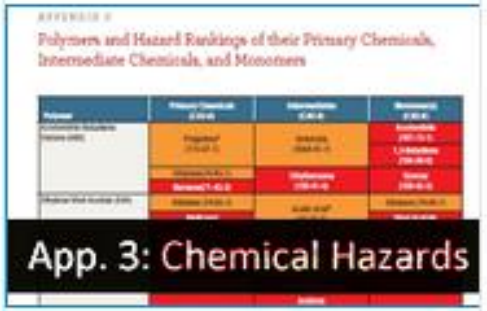
Mark Rossi, Ph.D.

&

Ann Blake, Ph.D.

September 15, 2014

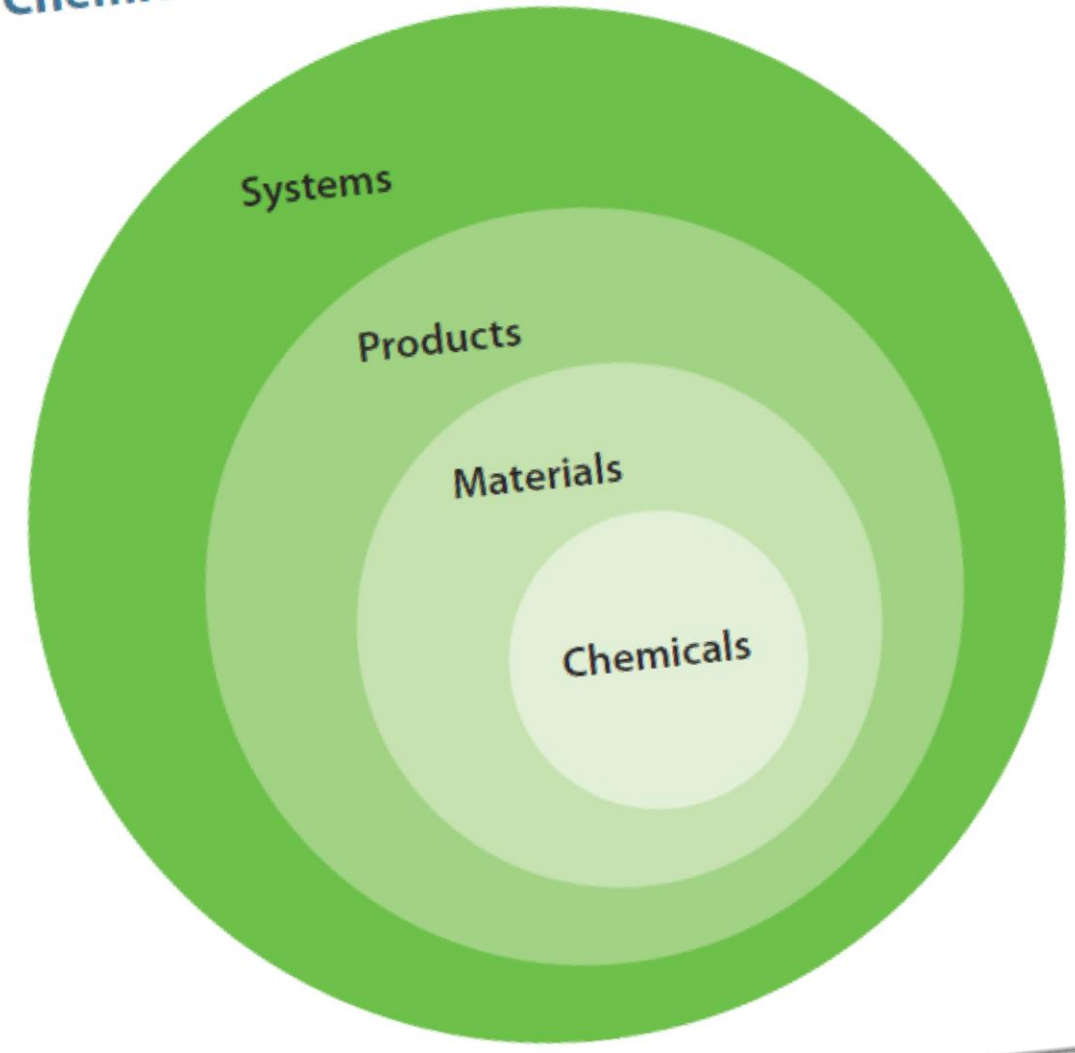




www.bizngo.org/sustainable-materials/plastics-scorecard

FIGURE 1

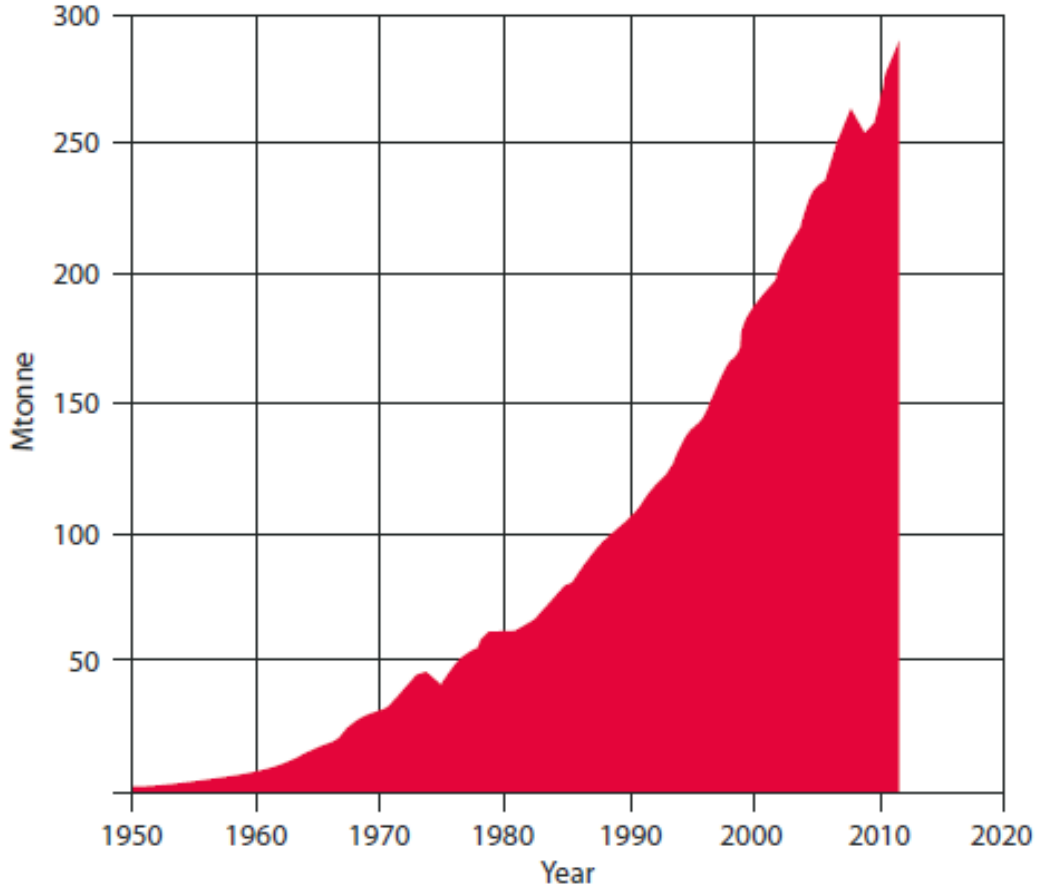
Chemicals at the Core of Systems Change



CLEAN PRODUCTION ACTION

Plastics Scorecard

FIGURE 2 **World Plastics Production 1950–2012**



Includes thermoplastics, polyurethanes, thermosets, elastomers, adhesives, coatings and sealants and PP-fibers. Not included PET-, PA- and polyacryl-fibers.

Source: Plastics Europe, 2013.

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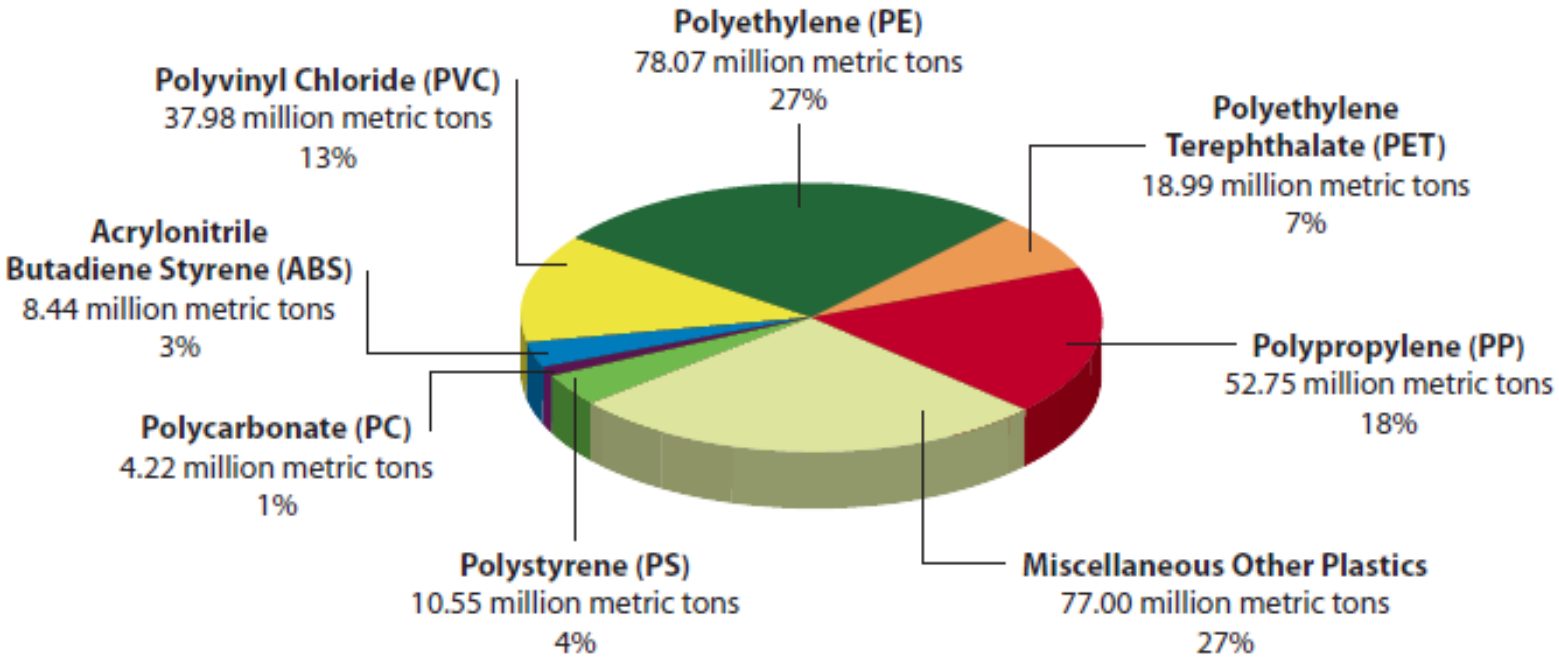
Plastics Scorecard

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



Total = 288 Million Metric Tons

Sources: Plastics Europe, 2013; Sagel, 2012.

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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 / developmental toxicant, persistent, bioaccumulative, toxicant (PBT); endocrine disruptor; or chemical of equivalent concern.

rce: Chemical Economics Handbook articles (c), (d), (e), (f), (g), (l), (m), (n), (o), (p), (q), (s), (t).

vlonitrile Butadiene Styrene
onate
e
erephthalate

PLA = Polylactic Acid
PP = Polypropylene
PS = Polystyrene
PVC = Polyvinyl Chloride

SAN = Styrene Acrylonitrile
SBR = Styrene Butadiene Rubber

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Plastics Scorecard

"workers carry a body burden of plastics-related contaminants that far exceeds those documented in the general public . . . existing epidemiologic and biological evidence indicates that women in the plastics industry are developing breast cancer and experiencing reproductive problems at elevated rates as a result of these workplace exposures" (DeMatteo, et al., 2011).

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Plastics Scorecard

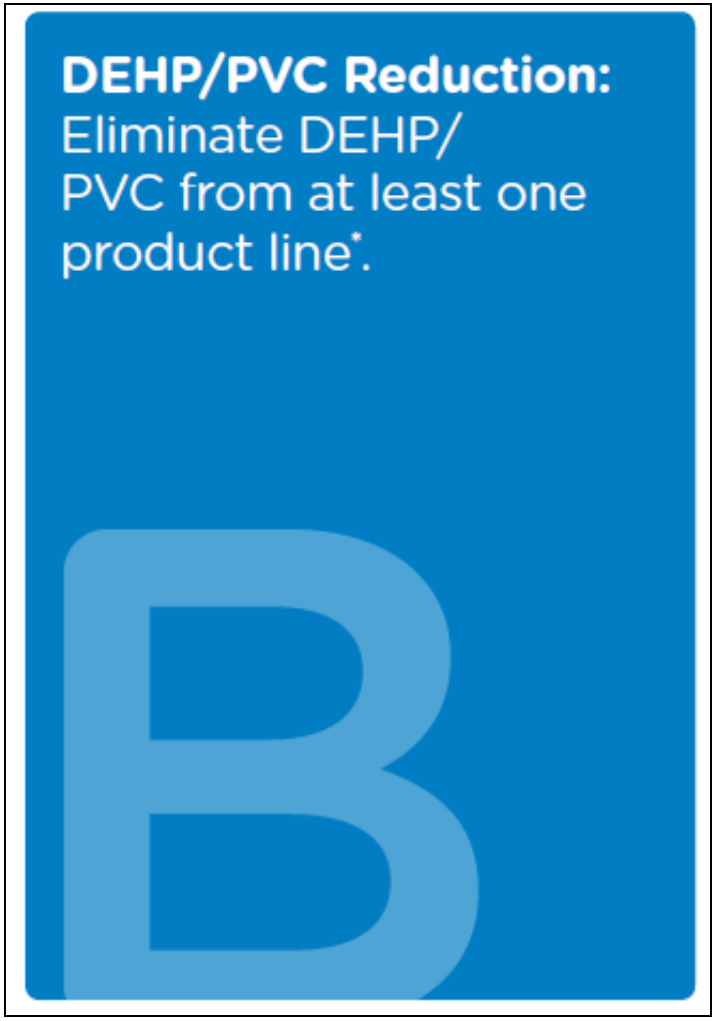
Healthier Hospitals INITIATIVE

PRACTICE Greenhealth™

Standardized Environmental Questions for Medical Products

Chemicals of Concern

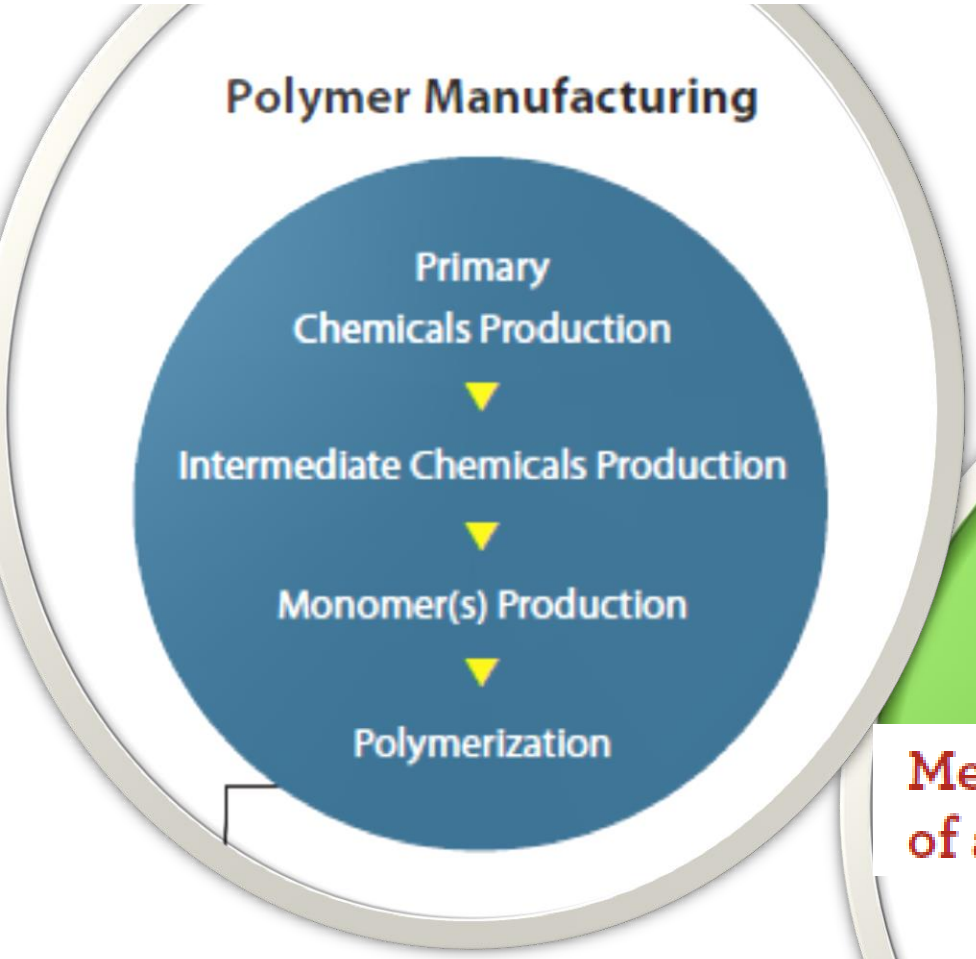
- PVC
- Phthalates
- Halogenated Organic Flame Retardants
- Carcinogens/Reproductive Toxicants

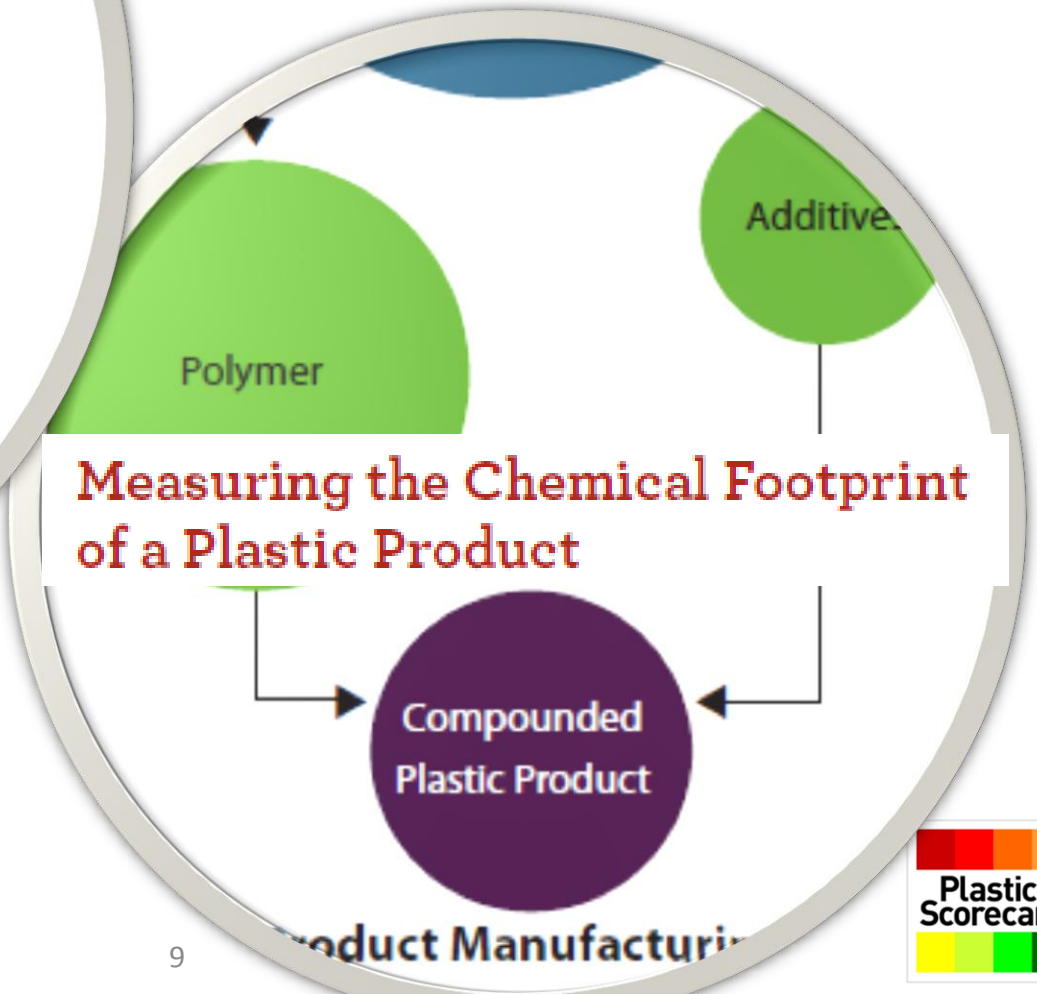


CLEAN PRODUCTION ACTION

Plastics Scorecard

Progress to Safer Chemicals in Polymer Manufacturing





CLEAN PRODUCTION ACTION

Plastics Scorecard

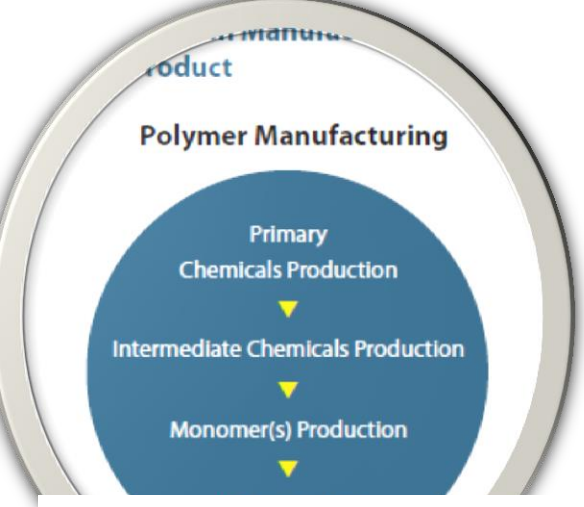


TABLE 5 Plastics Scorecard Progress to Safer Chemicals in Polymer Manufacturing

Polymer	Polymer Manufacturing: Progress to Safer Chemicals Score			
	Primary Chemicals	Intermediate Chemicals	Monomer(s)	Total Manufacturing
Best Case Polymer	33.33	33.33	33.33	100.00

CLEAN PRODUCTION ACTION

Plastics Scorecard

TABLE 5 Plastics Scorecard: Progress to Safer Chemicals in Polymer Manufacturing

Polymer	Polymer Manufacturing: Progress to Safer Chemicals Score			
	Primary Chemicals	Intermediate Chemicals	Monomer(s)	Total Manufacturing
Best Case Polymer	33.33	33.33	33.33	100.00
Polystyrene (PS)	0.00	0.00	0.00	0.00
Polyvinyl Chloride (PVC)	0.00	0.00	0.00	0.00

Polymers and Hazard Rankings of their Primary Chemicals, Intermediate Chemicals, and Monomers

	Chlorine (7782-50-5)	Acetone (67-64-1) / Phenol (108-95-2)	p-tert-buty… (98-54-4)
…thylene (PE)	Ethylene(74-85-1)	Ethylene(74-85-1)	Ethylene(74-85-1)
…yethylene Terephthalate …ET)—Terephthalic Acid …TPA) Route	para-Xylene (106-42-3)	Ethylene Glycol* (107-21-1)	Bis-(2-hydroxyethyl)-terephthalate* (BHET) (959-26-2)
	Methanol (67-56-1)	Acetic Acid* (64-19-7) / Terephthalic Acid* (TPA) (100-21-0)	
Polylactic Acid (PLA)	Glucose* (50-99-7)	Lactic Acid* (50-21-5)	Lactide* (L-lactide - 4511-42-6; DL-lactide - 615-95-2)
…olypropylene (PP)	Propylene* (115-07-1)	Propylene* (115-07-1)	Propylene* (115-07-1)
…olystyrene (PS)	Ethylene (74-85-1) / Benzene(71-43-2)	Ethylbenzene (100-41-4)	Styrene (100-42-5)
…inyl Chloride (PVC)	Ethylene (74-85-1) / Chlorine (7782-50-5)	Ethylene Dichloride (EDC) (107-06-2)	Vinyl Chloride Mono… (75-01-4)
…tadiene Rubber (SBR)	Ethylene (74-85-1) / Benzene (71-43-2)	Ethylbenzene (100-41-4)	1,3-Butadiene (… / Styrene (…

…ark List Translator 1 or GreenScreen®

…data that defines the chemical …slator 1 or GreenScreen®

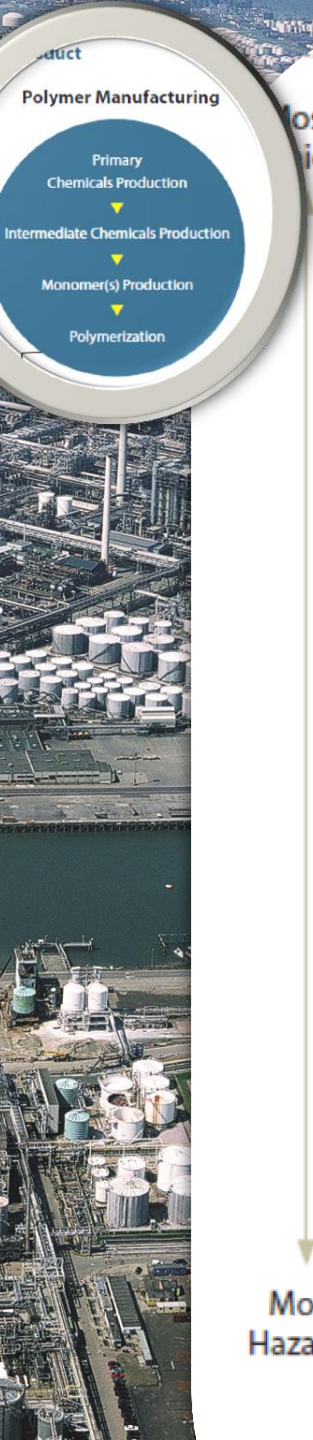
Verified GreenScreen® Benchmark 3

Actual GreenScreen® assessment with determination of … Screen® Benchmark Score of U - unspecified.

* = verified GreenScreen® assessment

CLEAN PRODUCTION ACTION

Plastics Scorecard



RE 6 Progress to Safer Chemicals in Polymer Manufacturing

Measuring the Chemical Footprint of a Plastic Product

CLEAN PRODUCTION ACTION

Plastics Scorecard

Measuring the Chemical Footprint of a Plastic Product

TABLE 6 **Plastic Intravenous (IV) Bag**

Estimated Chemical Footprint of Polyvinyl Chloride (PVC) Phthalate (DEHP)

Functional Use: Chemical Ingredients	Weight (%)
Polymer: PVC[1]	68.80%
Plasticizer: DEHP[2]	30.00%
Antioxidants: including Bisphenol A (BPA)[3]	0.50%
Heat stabilizers[4]	0.50%
Lubricants[5]	0.10%
Slip Agents[6]	0.10%
Monomers and oligomers—residual: vinyl chloride monomer (VCM)[7]	0.0001%
Solvent—residual[8]	unknown
Catalyst—residual	unknown
Total	**100.00%**

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Plastics Scorecard

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

CLEAN PRODUCTION ACTION

Plastics Scorecard

FIGURE 7 **Chemical Footprint of IV Bags Made from PVC/DEHP & Polyolefins**

PROGRESS TO SAFER CHEMICALS IN MANUFACTURING	PRODUCT FOOTPRINT

FIGURE 7 Chemical Footprint of IV Bags Made from PVC/DEHP & Polyolefins

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

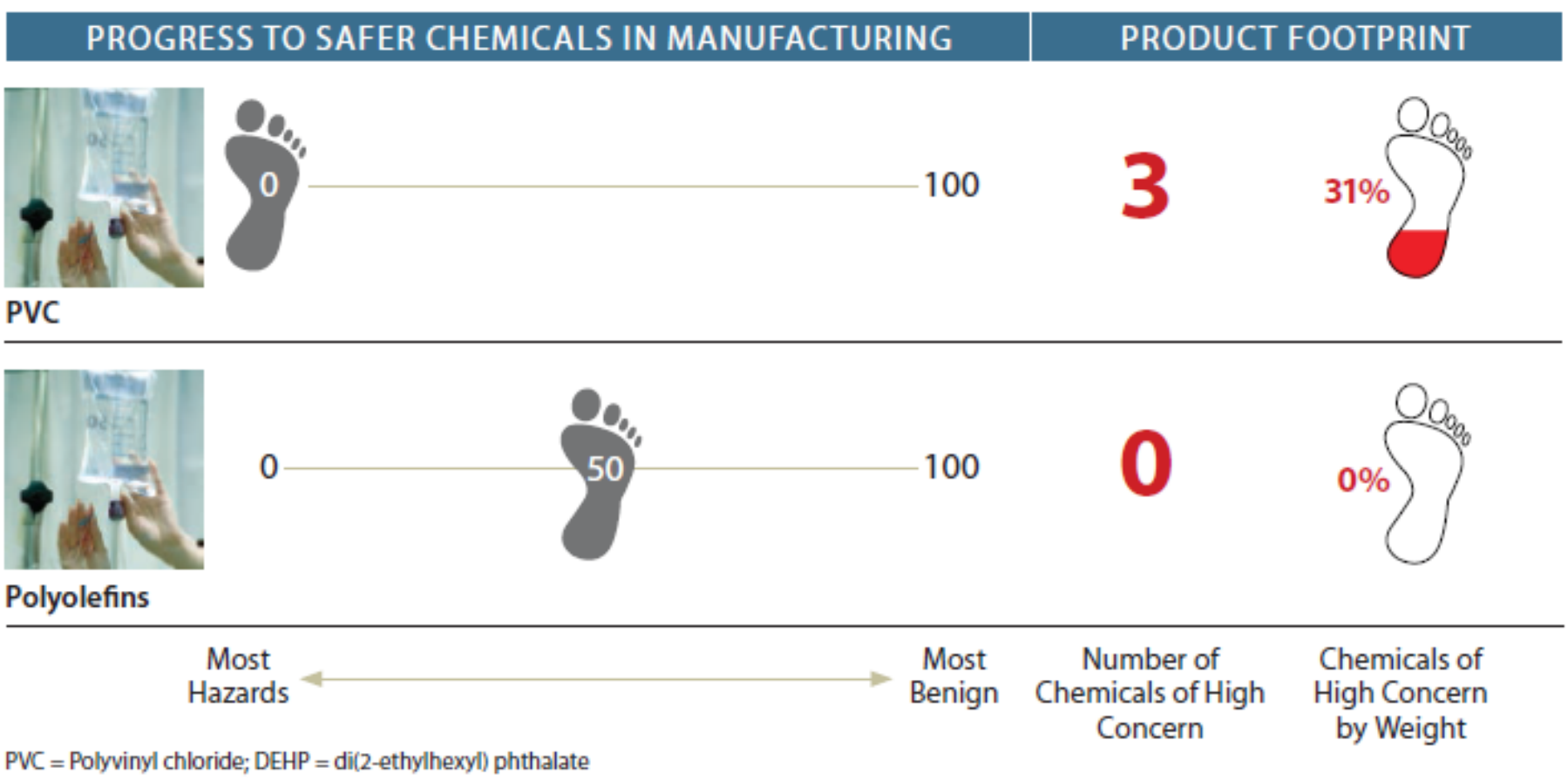
FIGURE 7 **Chemical Footprint of IV Bags Made from PVC/DEHP & Polyolefins**

PROGRESS TO SAFER CHEMICALS IN MANUFACTURING	PRODUCT FOOTPRINT	
	3	 31%
	0	 0%
	Number of Chemicals of High Concern	Chemicals of High Concern by Weight

CLEAN PRODUCTION ACTION

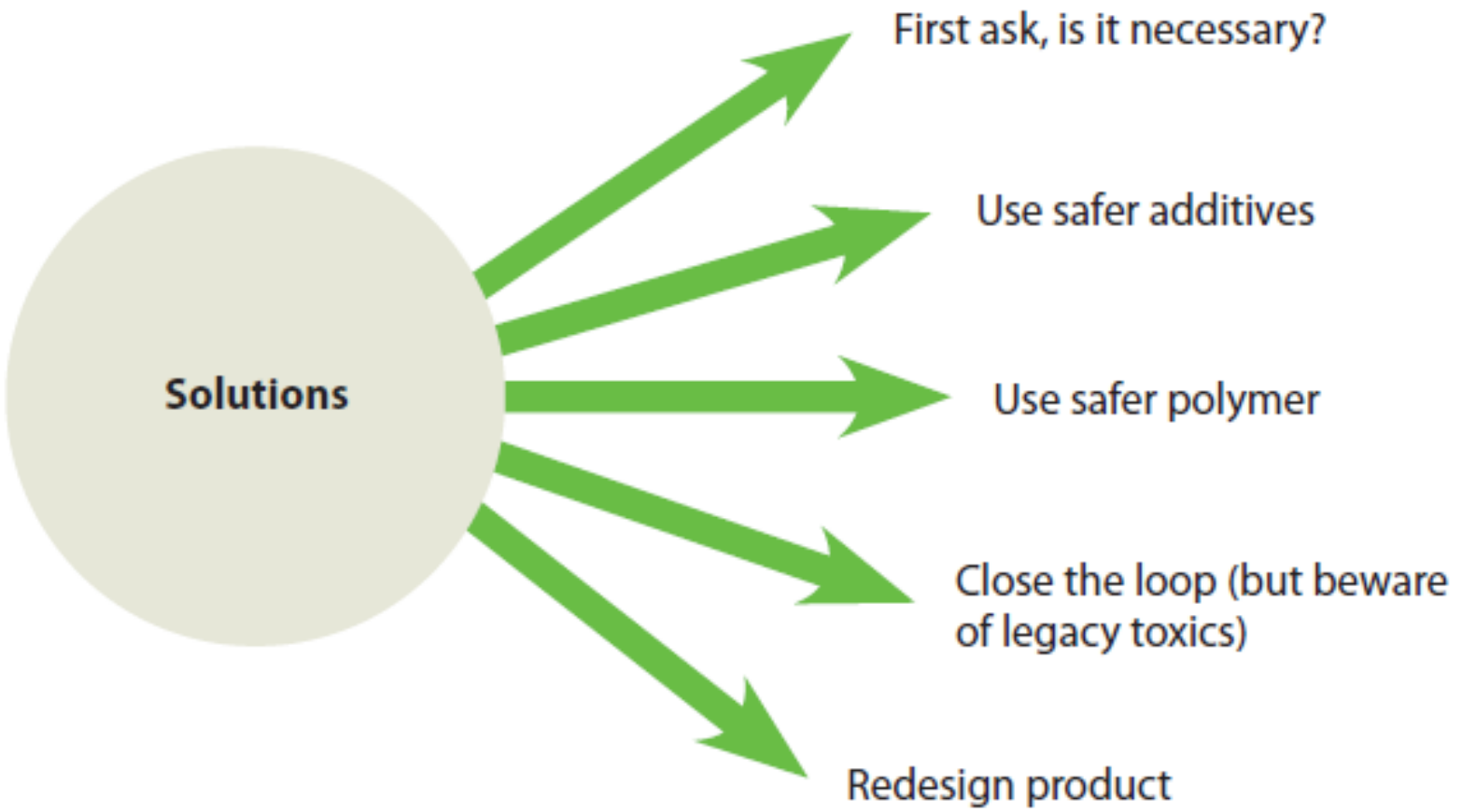
Plastics Scorecard

FIGURE 7 Chemical Footprint of IV Bags Made from PVC/DEHP & Polyolefins



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

FIGURE 9 Solutions to Reducing Chemical Footprint of Plastics



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Plastics Scorecard

Is it Necessary?

Lynne Peeples ♥ Become a fan
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Posted: 06/03/2014 7:50 pm EDT | Updated: 06/03/2014 7:59 pm EDT

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Plastics Scorecard

Use Safer Additives

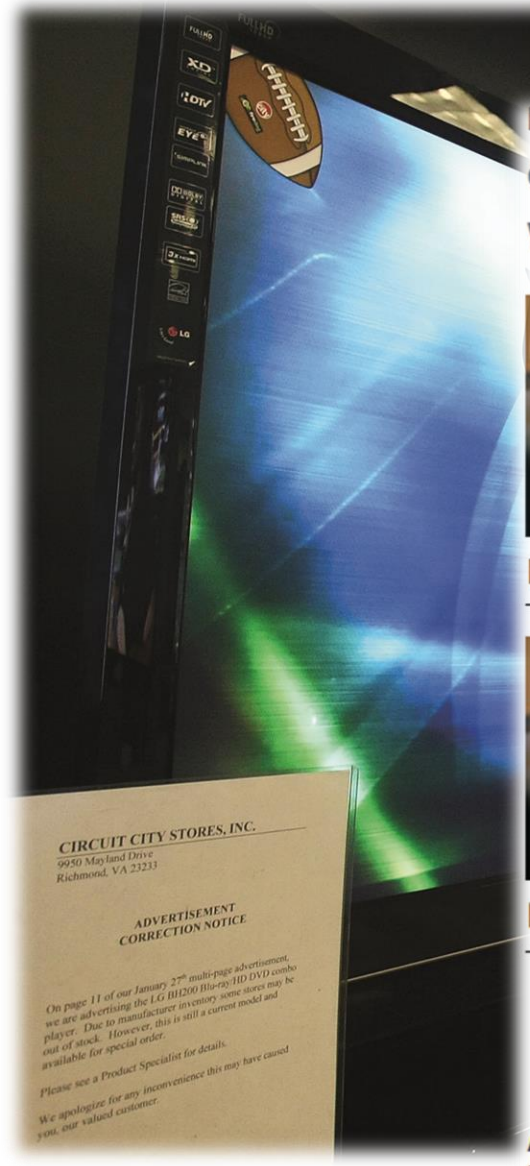

FIGURE ES-3 Estimated Chemical Footprint of Electronic Enclosures Made from HIPS with DecaBDE & PC/ABS with RDP

HIPS with Deca BDE	Number of Chemicals of High Concern	Chemicals of High Concern by Weight
	5	16%

PC/ABS with RDP	Number of Chemicals of High Concern	Chemicals of High Concern by Weight
	5	1%

ABS = Acrylonitrile Butadiene Styrene; DecaBDE = Decabromodiphenyl Ether; PC = Polycarbonate; RDP = Resorcinol Diphenylphosphate

CLEAN PRODUCTION ACTION

Plastics Scorecard

Use Safer Polymer

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

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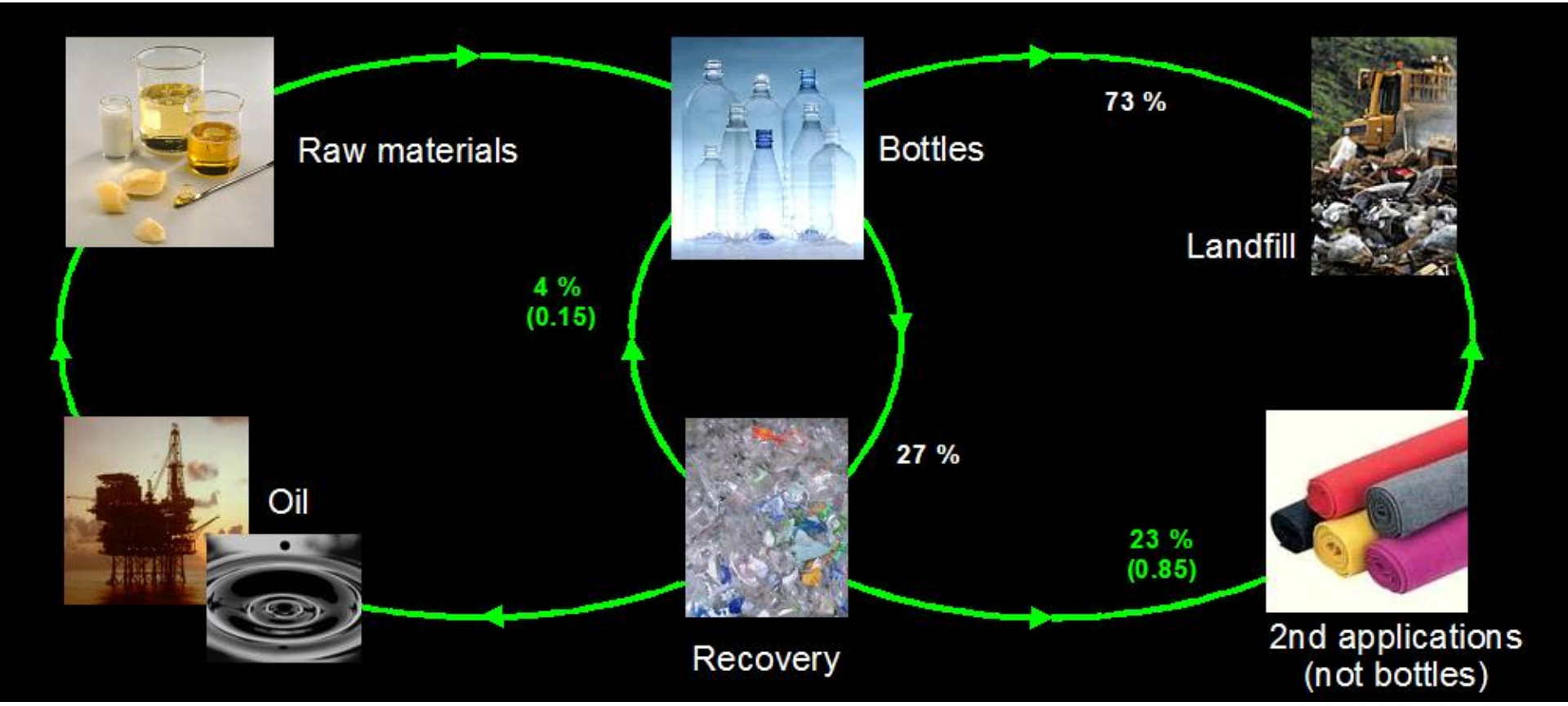
Plastics Scorecard

Close the Loop



Close the Loop (beware of toxics legacy)

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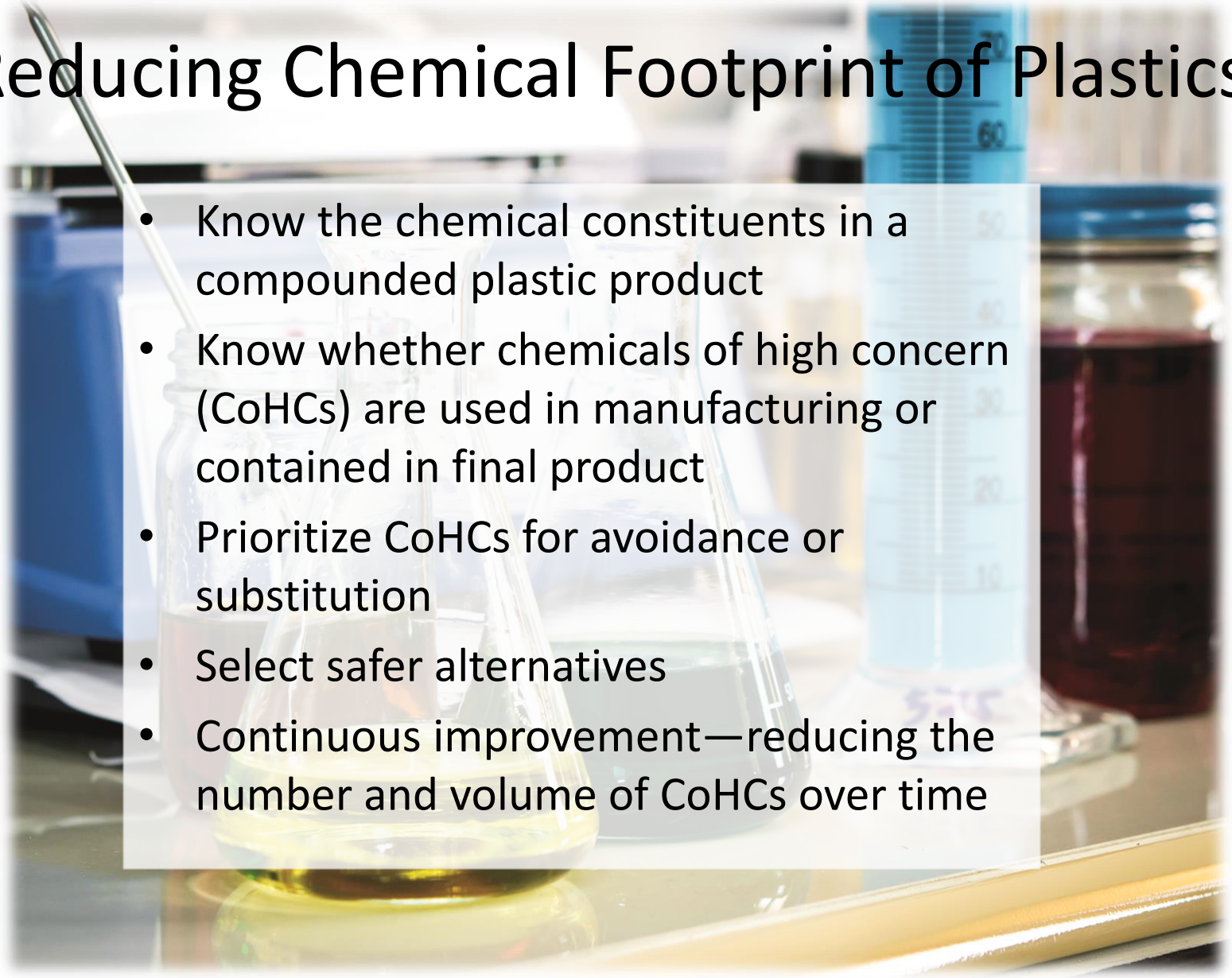
Plastics Scorecard

Re-design Product

Reducing Chemical Footprint of Plastics



- Know the chemical constituents in a compounded plastic product
- Know whether chemicals of high concern (CoHCs) are used in manufacturing or contained in final product
- Prioritize CoHCs for avoidance or substitution
- Select safer alternatives
- Continuous improvement—reducing the number and volume of CoHCs over time

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Plastics Scorecard

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