

Science For A Better Life

One-Component UV-Curable Waterborne Polyurethane Coatings A Sustainable Chemistry

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Overview

Waterborne UV-Curable Polyurethane Dispersion Technology

- Chemistry
- Usage

Sustainability

- What is Sustainability ?
- Industry Sustainability Drivers
- Life Cycle Analysis (LCA) Approach

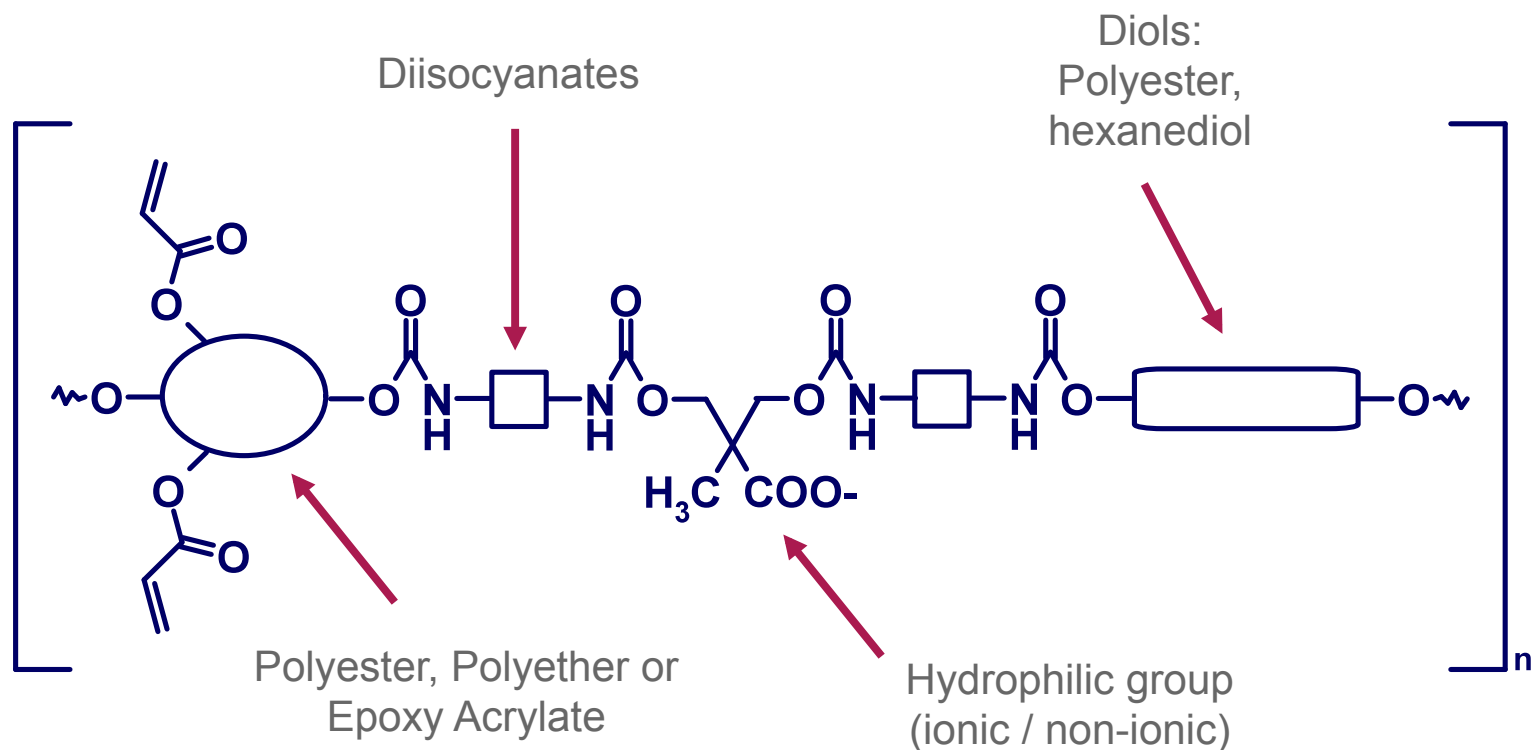


Waterborne UV Polyurethane Dispersions as a Sustainable Chemistry



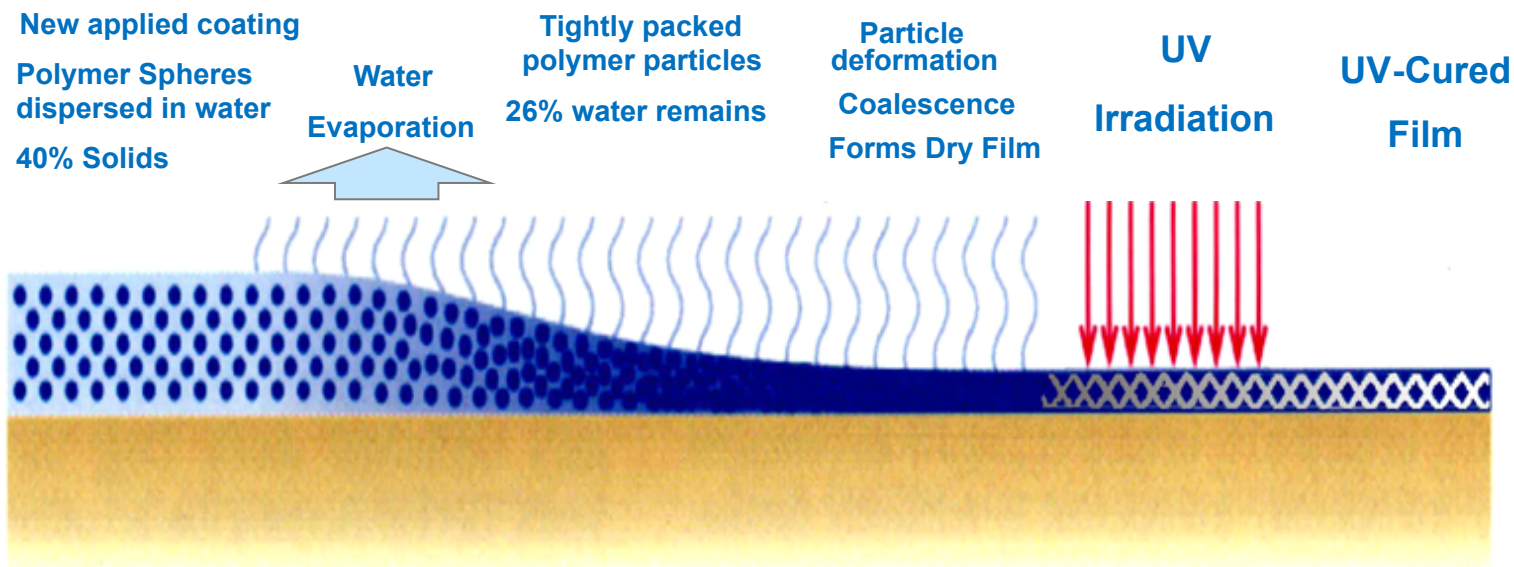
Structure of UV-Curable Polyurethane Dispersions

Incorporation of unsaturated polyols into the Polyurethane backbone creates a Polyurethane Dispersion that can be UV cured after drying





Curing of Waterborne UV PUD Technology



- Polyurethane dispersions that cure by water evaporation and subsequent irradiation with UV light
- Industrial applications by spray coating or also by curtain, roller, knife/blade coating or printing.
- High productivity, excellent quality and low environmental impact!



Waterborne UV-Curable Polyurethane Dispersions

Advantages of Waterborne

- Reduce or Eliminate Solvent
- Reduce or Eliminate HAPs

Advantages of UV

- Quick Cure
- Low Energy Cure vs. Thermal Ovens

Advantages of Polyurethane

- Tailorable Chemistry to design performance





Introduction of Waterborne UV-Curable Polyurethane Dispersion Technology

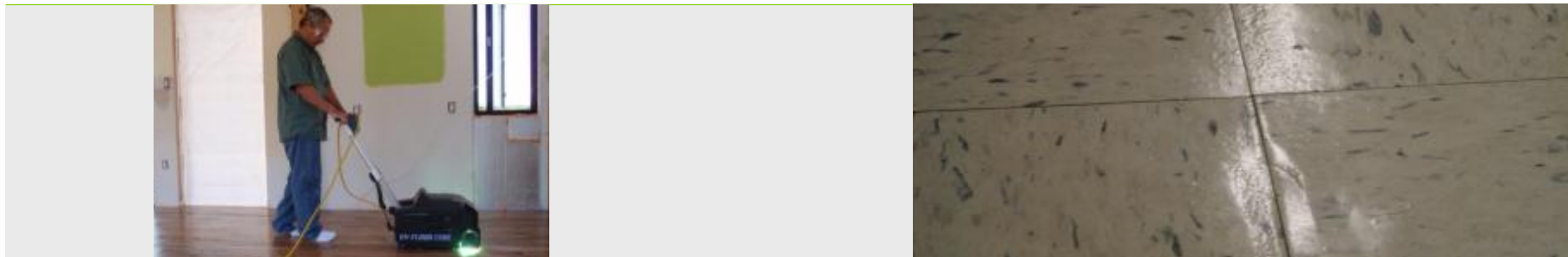


Wood Coatings Market

The wood coatings market was the first to accept 1K UV-Curable Waterborne Polyurethanes as an answer to the market needs of ultra-low VOCs and VHAPs



Introduction of Waterborne UV-Curable Polyurethane Dispersion Technology



Site-Applied Floor Coatings

The key factor for acceptance in site-applied floor coatings is elimination of solvent odor and the rapid return to service.



Introduction of Waterborne UV-Curable Polyurethane Dispersion Technology - Military

1K UV-Curable Waterborne Polyurethane Aerospace (MIL-PRF-85285) Coating

Test	85285 Spec	UV-PUD Coating
GE Impact Test	≥ 60%	60%
Dry / Wet Adhesion	≥ 4B / 4A	4B / 4A
Gloss	60° ≥ 90	80
Initial Pencil Hardness	≥ 2B	HB/F
Mobil Jet Oil	-2 pencils	-1
Hydraulic Fluid	-2 pencils	-1
JP-8 Jet Fuel	-2 pencils	-2
Humidity Resistance after 14 days ambient	30 days	No blisters

Weathering

Number of Hours	60° Gloss	ΔE
0	75	---
500	68	0.66
1000	63	0.70
1500	57	0.76
2000	56	0.70
3000	53	0.72



Military Specification performance and fast return to service

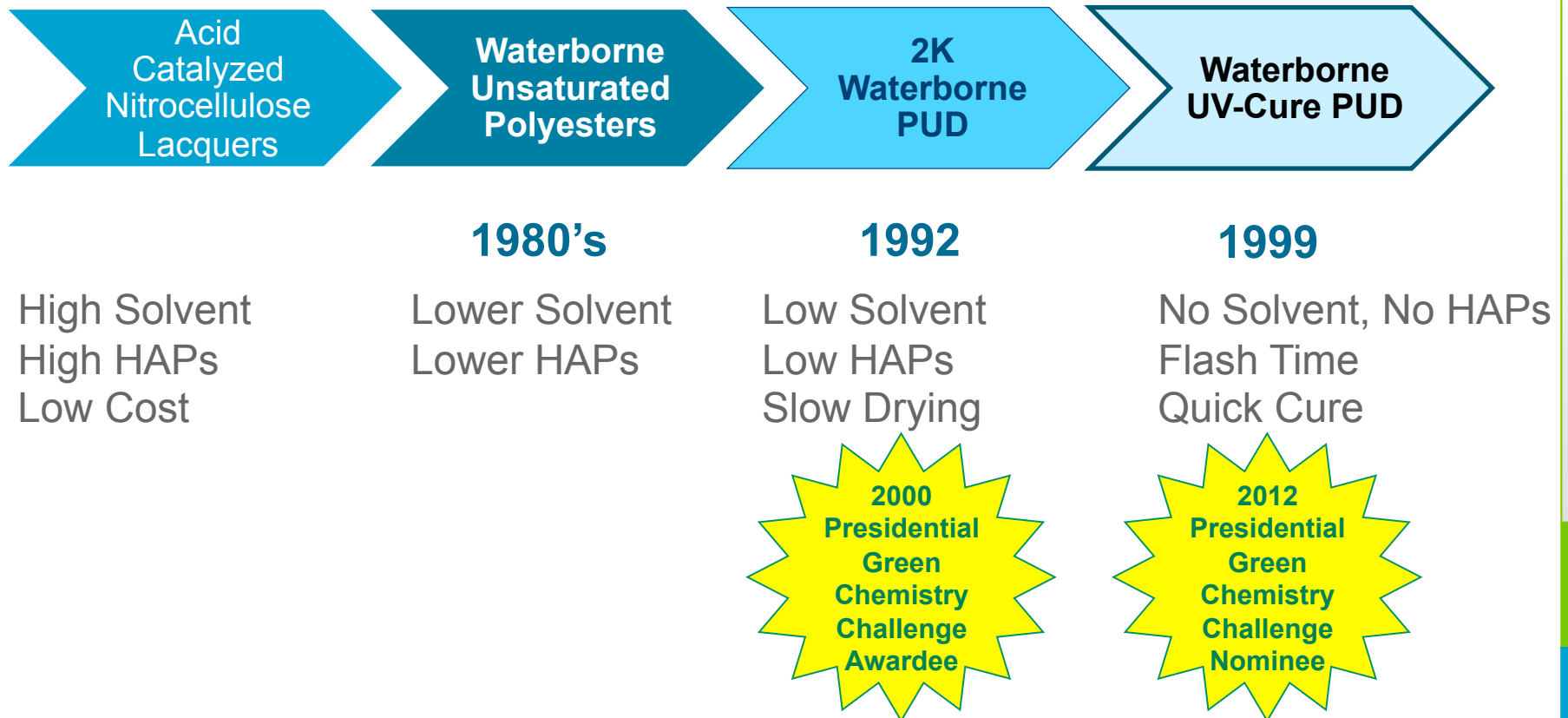
One Component UV-Curable Polyurethane Dispersion Technology – Comparing Film Properties



FILM PROPERTIES	1K PUR WATERBORNE	2K PUR WATERBORNE	1K UV-CURABLE PUR WATERBORNE
Pot Life in minutes	NA	2 hr	NA
Dry Time in minutes	30	45	< 15
MEK Resistance Double Rubs	5	100	100



The Evolution of Waterborne UV-Curable Polyurethane Dispersions



Sales of Waterborne UV-Cure PUDs have grown to approximately 2000t in NAFTA since their introduction with double digit annual growth rate



Sustainability

What is Sustainability?

Coating Industry Sustainability Drivers

Components of Sustainability

Life Cycle Analysis (LCA) Approach





What is Sustainability ?

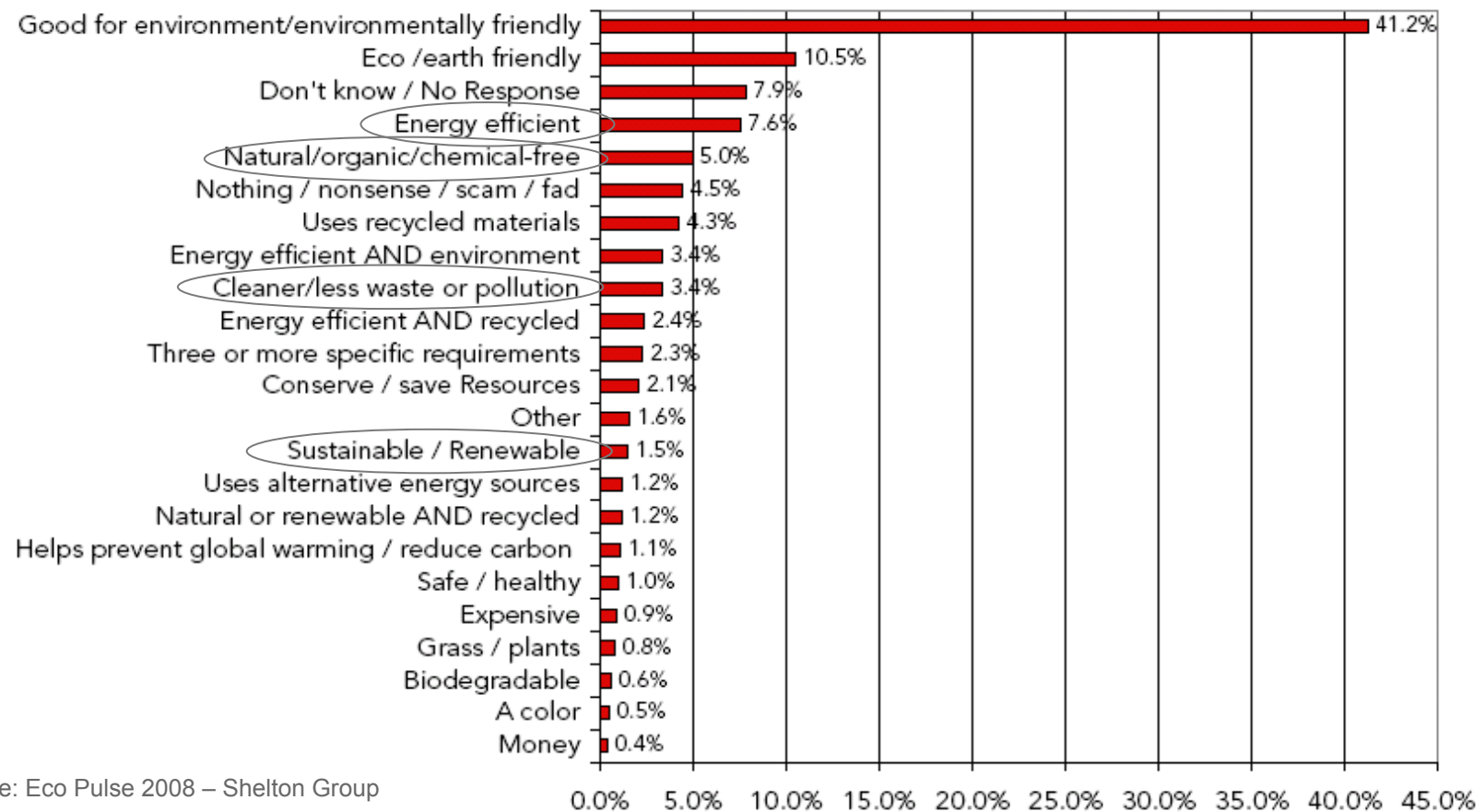
“I know the answer – it’s the question
I’m not sure about...”

- Yogi Berra



Sustainability vs. "Green"

What does the term "Green" mean, as in green homes, green home products?



Source: Eco Pulse 2008 – Shelton Group



Industry Drivers for Sustainability

- Regulatory compliance
 - Ultra low to zero VOC
- Energy efficiency
- Environmentally preferred content
 - Marketability of “green”
- Renewable materials
- End of Life - Recyclable content
 - Used polymer glycolysis, fillers
- Environmental Footprint (LCA)
- Environmental Performance
 - LEED, New standards for indoor air quality





Waterborne – a step toward sustainability

Use of waterborne coatings in the 1990's reduced organic solvent demand by 50 - 99%

Replacing 50% of the solventborne coatings used in the wood furniture coatings market alone with low-VOC waterborne systems would reduce the amount of organic solvent used each year by approximately 18 million pounds

Early "waterborne" coatings had as much as 300 g/l of co-solvent

New commercial systems are now actually waterborne at 0-15 g/l and offer viable replacement products to solventborne systems





UV – “Curing at the Speed of Light”

UV-Curable Coatings: Fast cycle times with superior scratch resistance, gloss and color retention, and adhesion

UV Technology can eliminate the use of thermal ovens which use substantial energy, take up extensive floor space and can produce unwanted emissions

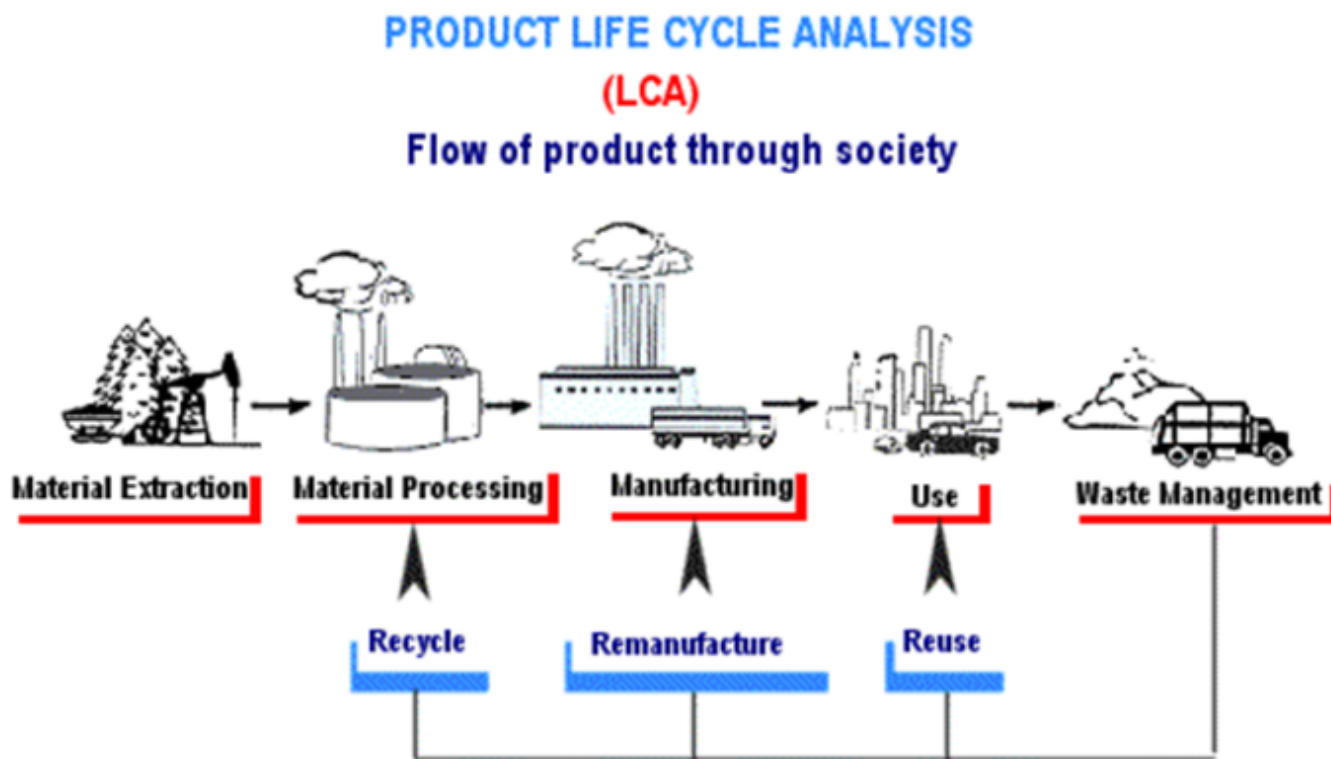
Radiation curable coatings are considered to be green by the U.S. Green Building Council (USGBC)





Life Cycle Approach

A solid approach to measure the overall Sustainability of any Chemistry or Technology is use of a Life Cycle Approach





Basic Life Cycle Analysis Concepts

Life Cycle means ...

Consecutive and interlinked stages of a product, service or system, from raw material acquisition from natural resources to product manufacture, use and maintenance through final disposal (end-of-life). (Cradle-to-Grave)

Life Cycle Assessment is ...

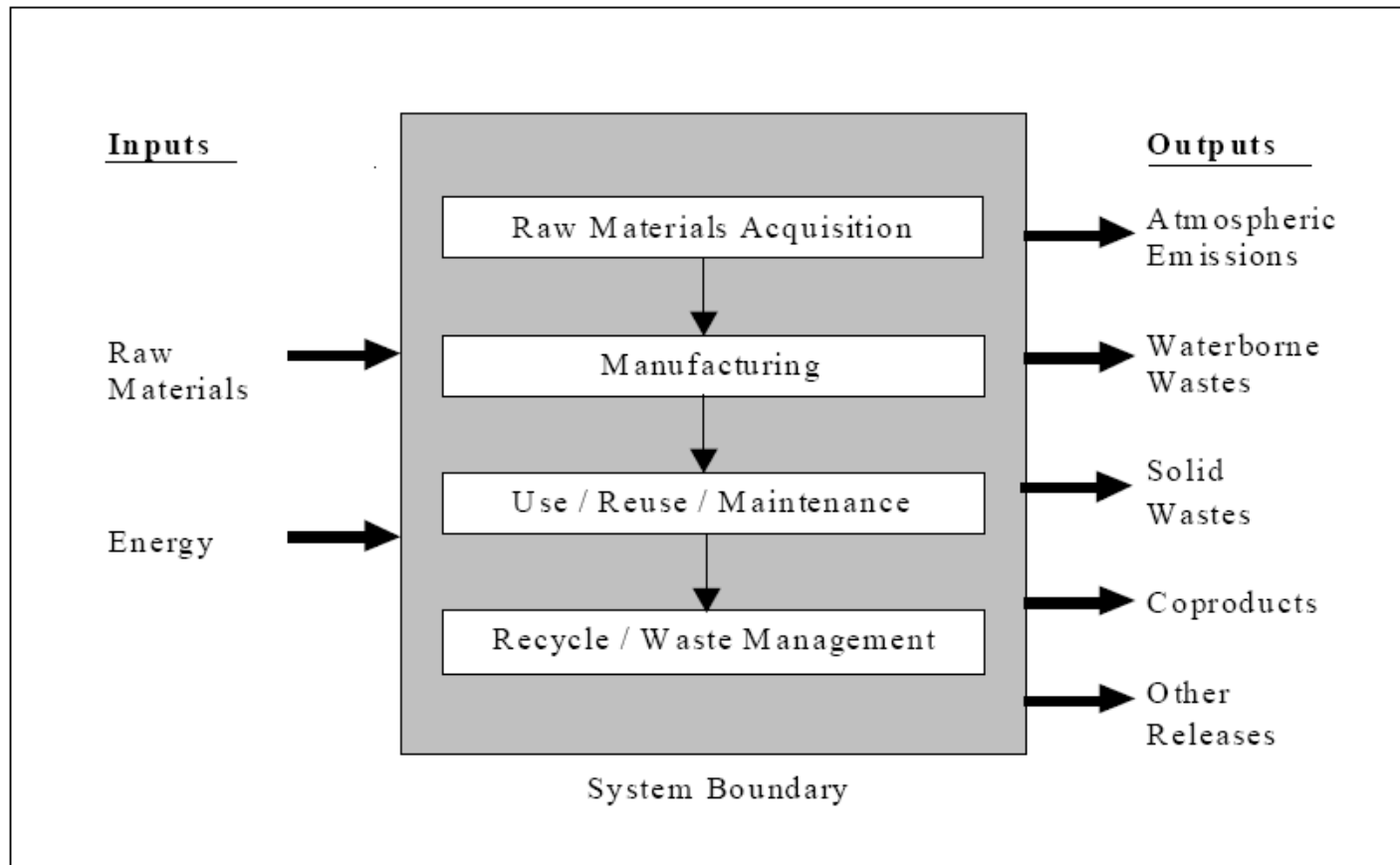
A method for compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

Reference: ISO 14044: 2006(E)



Basic Life Cycle Analysis Concepts

Life Cycle Inputs / Stages / Outputs



Source: *Life Cycle Assessment – Principles & Practice, US EPA, 2006*



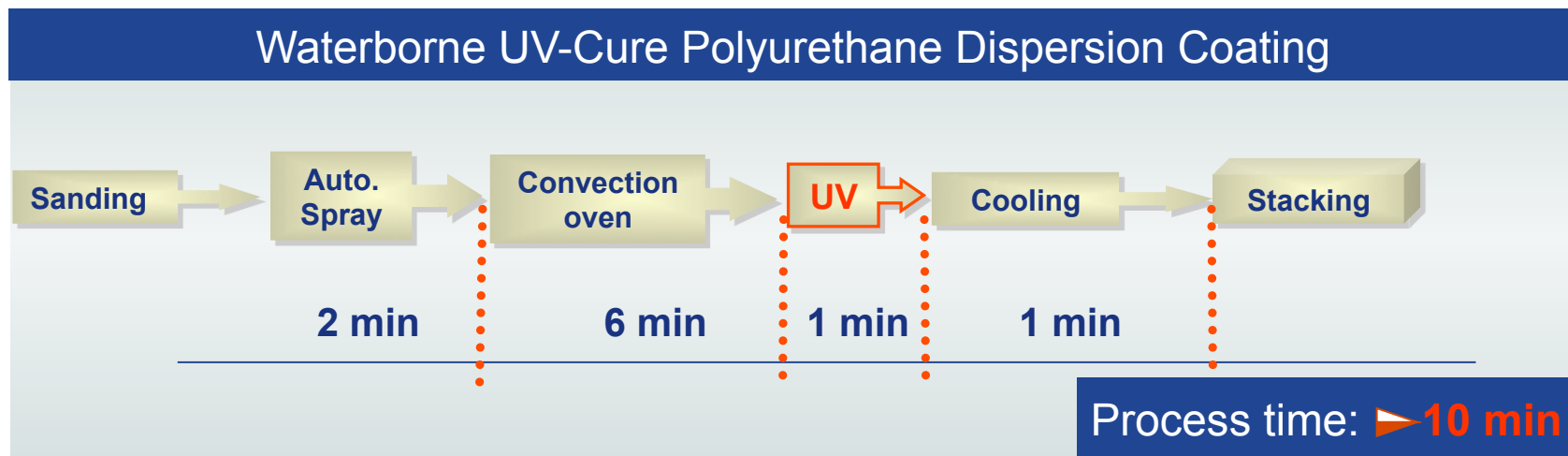
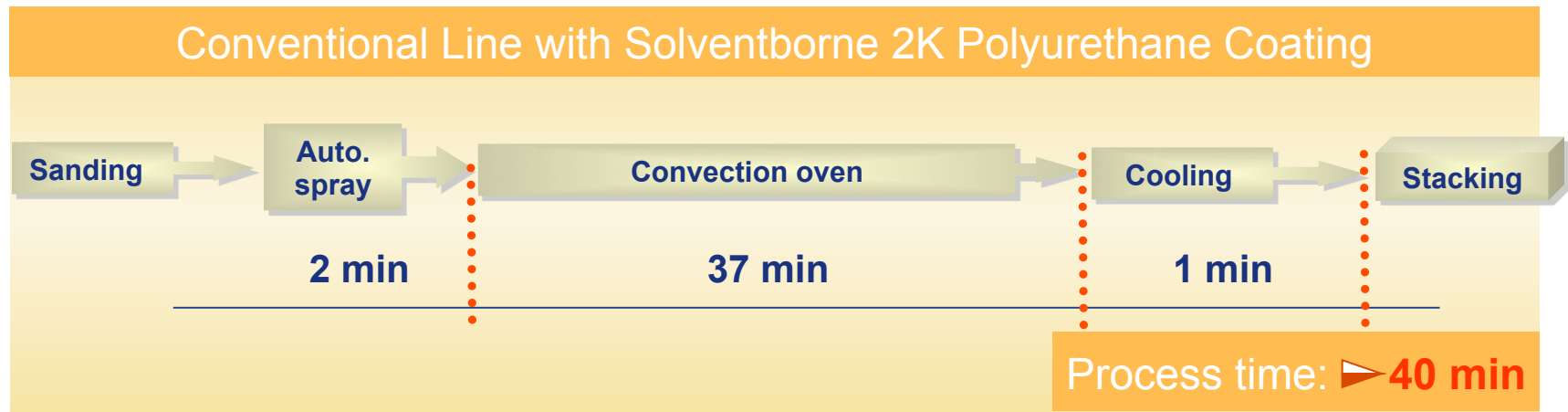
Life Cycle Approach

Comparing use of UV vs. Existing Technology – consider all aspects

- Lower energy costs
- Solvent handling and disposal costs
- Lower quality control costs
- Lower work-in-progress costs
- No VOCs, HAPs or volatile compounds
 - Use of ultra-low VOC systems can contribute to qualification for LEED IEQ points
- Reduction in hazardous material reporting
- Worker Health and Safety
- Freight / Shipment costs
- Production floor “footprint”



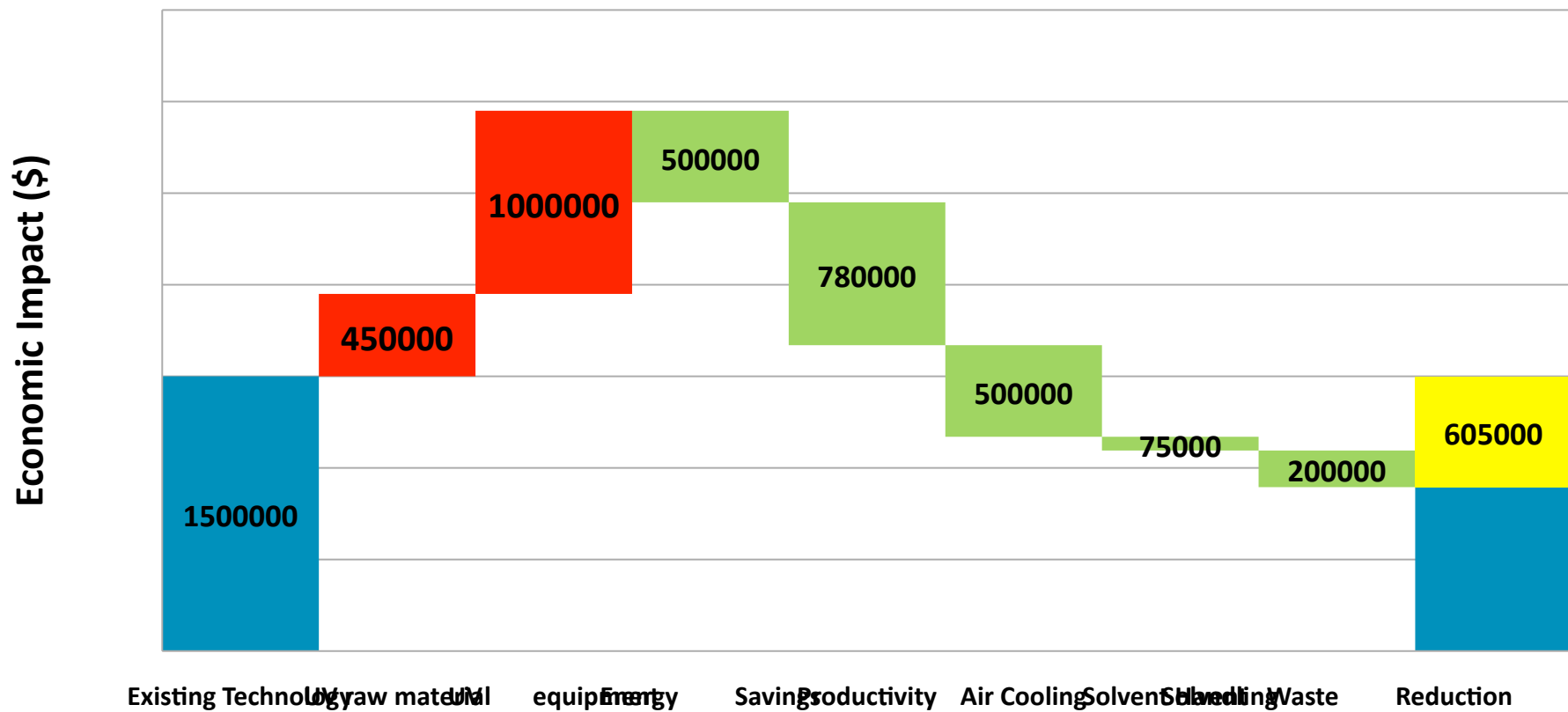
Productivity Improvement with UV-Curing Waterborne Polyurethane-based Furniture Coatings





Cost Using a Life Cycle Approach

When comparing cost of use of Waterborne UV PUD based Coating vs. Existing Technology – consider all aspects (Point of view – Production Line One Year)





Benefits of Waterborne UV Coating Technology

- Source reduction of VOCs of 50-90%
- Source reduction of HAPs of 50-99%
- Reduction of the amount of chemical byproduct evolution from the
- Provide coatings with no solvent odor
- Reduced energy usage
- Increased productivity
- A waterborne coating system that meets all performance requirements for a variety of coatings markets.





Effects of the Introduction of Waterborne UV-curing Polyurethane Dispersion Technology



Wood Coatings Market

The wood coatings market was the first to accept UV-Curable Waterborne Polyurethanes as an answer to the demand for ultra-low VOCs and VHAPs.

The VOC of many coatings used in the wood coatings market is approximately 3.5 lbs/gal. Conversion to an ultra-low 0.2 lbs/gal VOC coating can dramatically impact the total VOC emission for production sites



Effect of the Introduction of Waterborne UV-Curing Polyurethane Dispersion Technology



Source Reduction in VOCs and VHAPs for Wood Coatings OEM

The introduction of the 1K UV-Curable Waterborne Polyurethane technology has competed directly against amino conversion varnishes in the wood coatings market

This technology was able to remove 2.6 million lbs. of organic solvents (VOCs) and 49,000 lbs. of formaldehyde (VHAPs) from the US environment for the period 2007 to 2011.

One-Component Waterborne UV-Curable Polyurethane Dispersion Technology



Nominee for the US EPA
Presidential Green Chemistry
Challenge 2012





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Thank you!

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John Brandt