

Mainstreaming Green Chemistry – the role of bio-based materials.

GC3 Innovators Roundtable

Beaverton, OR

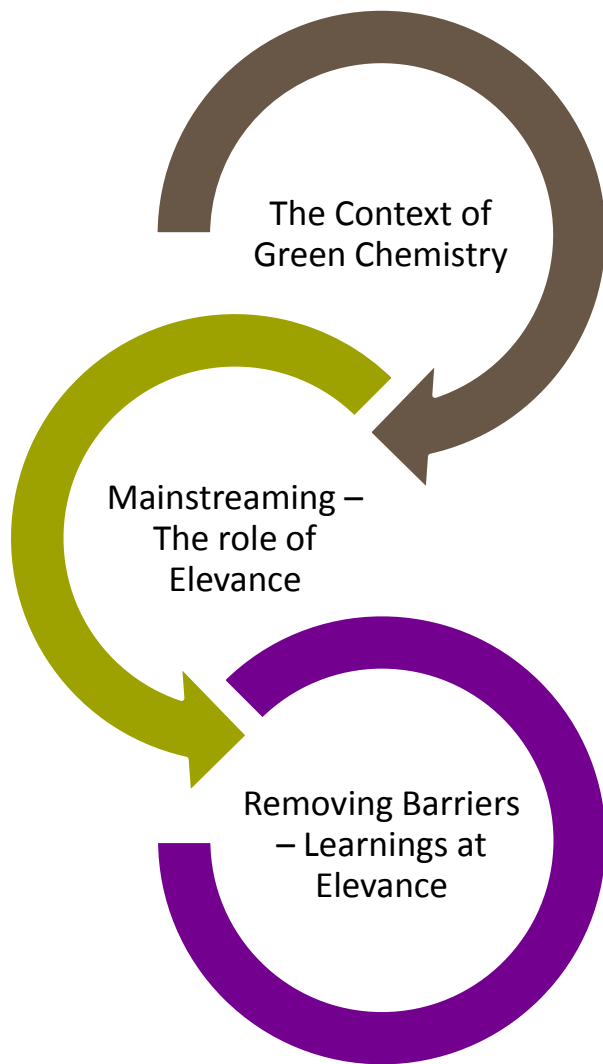
April 28, 2015



Bob Kumpf

CTO, Elevance Renewable Sciences

Outline of Presentation



The Summary

Contextual Intelligence

Through the last 100 years of business history the only factor that has correlated with financial success is contextual intelligence. It is important to understand the business context within which we are advancing green chemistry.

Mainstreaming

To advance any technology, and green chemistry specifically, four verbs are important: demonstrate, build, apply, and embrace.

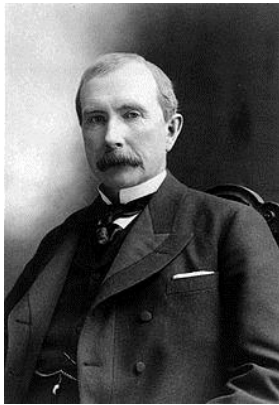
Removing Barriers

Green chemistry must move beyond the caveats of “but” to the power of “and”. At Elevance we call that idea Renewicals™.

Contextual Intelligence

Through the last 100 years of business history the only factor that has correlated with financial success is “contextual intelligence”.

A business leader’s ability to make sense of his or her contextual framework and harness its power often made the difference between success and failure.



Context of late 19'th Century



Context of early 21'st Century

Database of 860 business leaders (Founder or Chief Executive Officer) of a U.S.-based company for at least five years between 1900 and 2000. www.hbs.edu/leadership



We live in a world dependent on petroleum



The petroleum era led to breakthroughs in materials



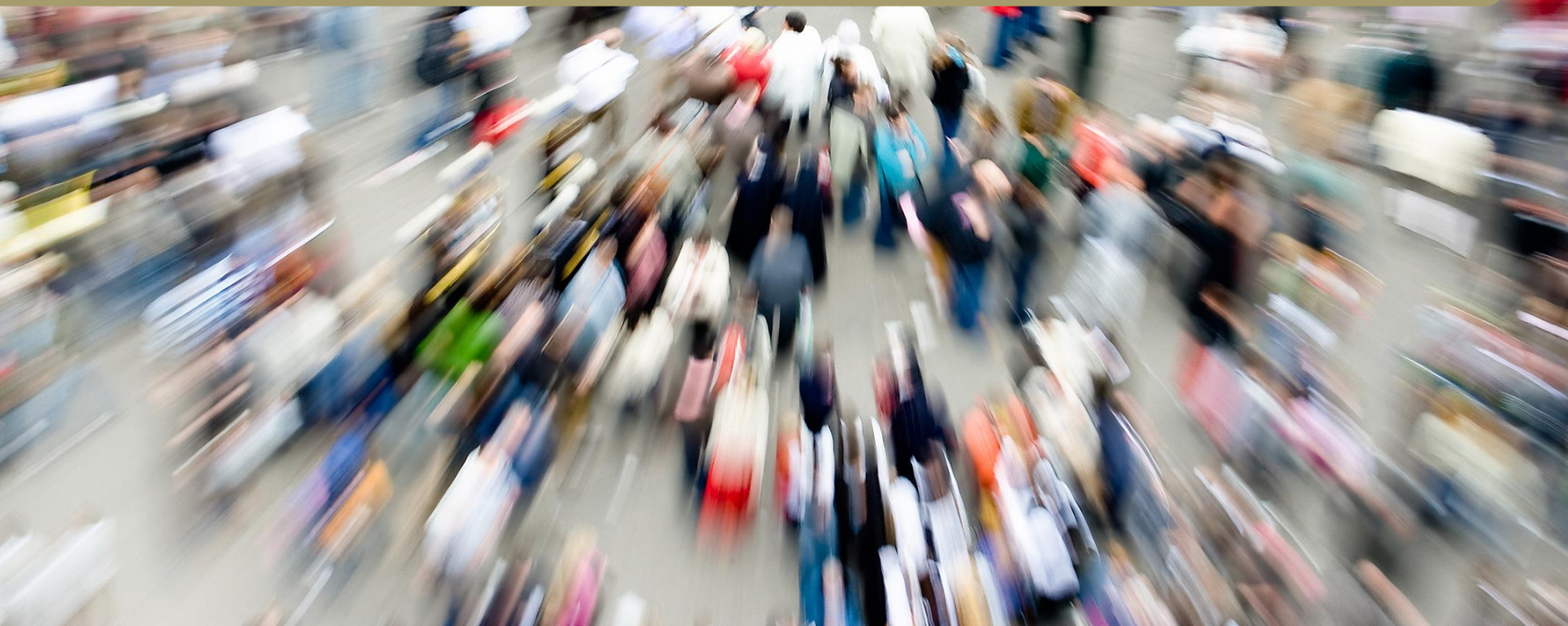
Improving the way products performed



But at a price to the environment

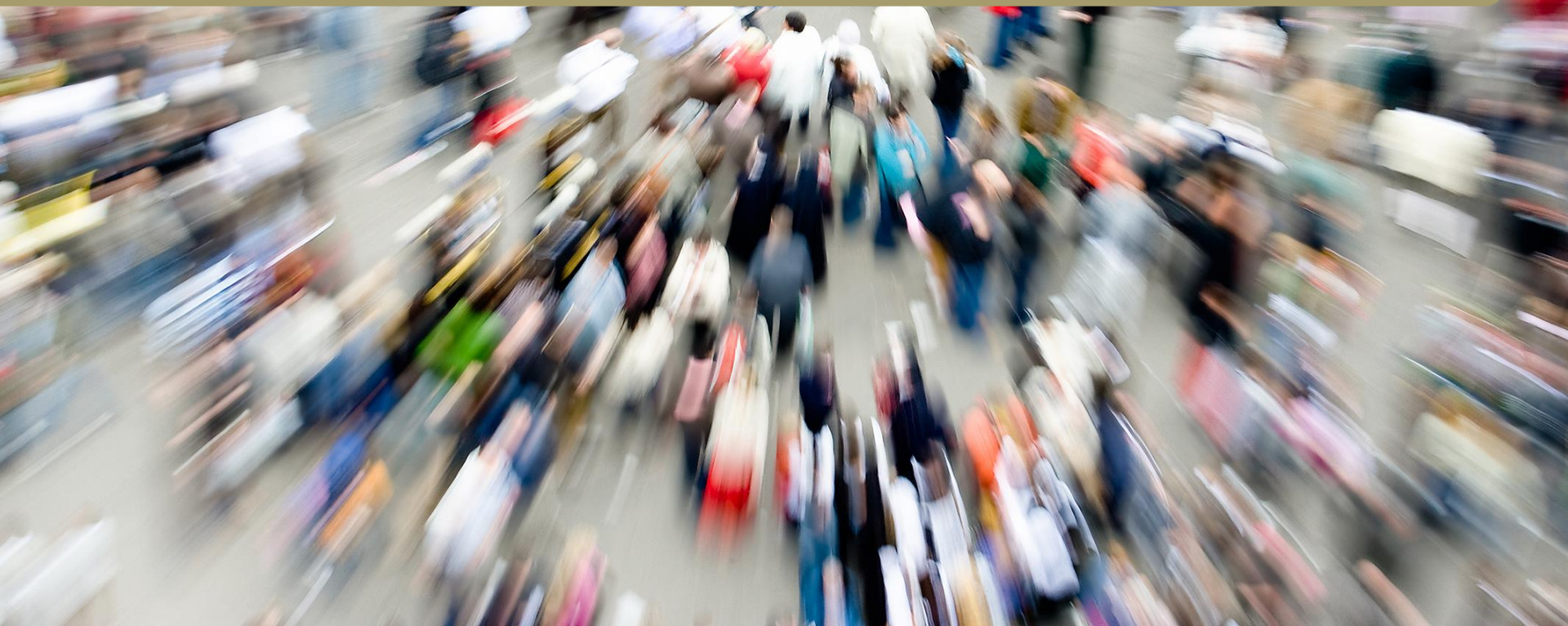


Lifestyles and living standards vary widely





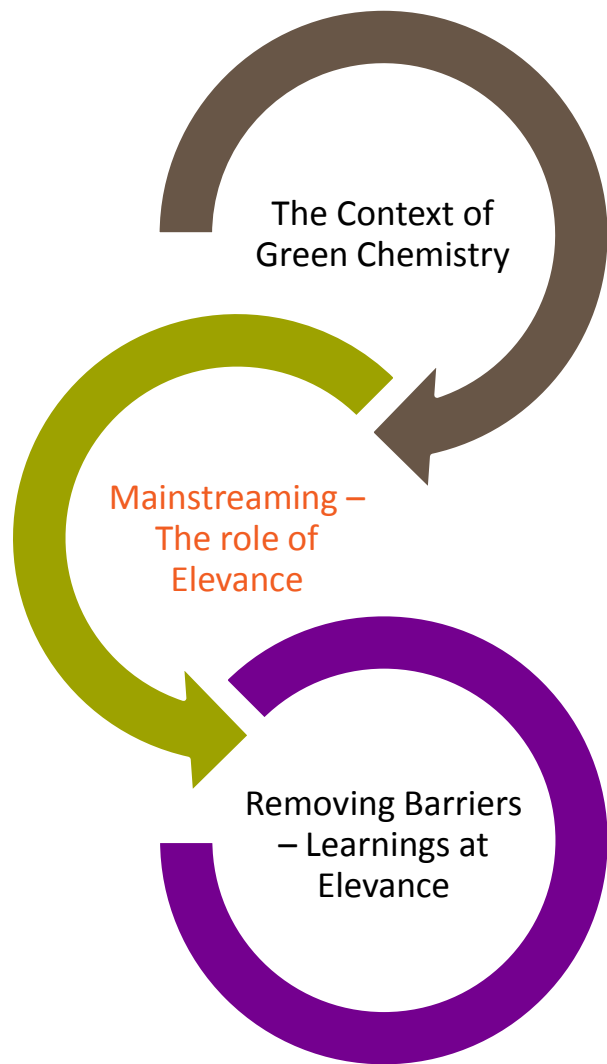
And with the population growing exponentially



A high-angle, blurred photograph of a large crowd of people walking. The image is heavily motion-blurred, creating a sense of a busy, crowded environment. The people are seen from above, and their colors are streaked and distorted. A semi-transparent, olive-green rectangular box is centered horizontally across the middle of the image, containing white text.

We have to find a better way...

Outline of Presentation



Mainstreaming Green Chemistry

The key elements needed to mainstream green chemistry:

1. Demonstrate new technology (read green chemistry) - in the lab
2. Build new green chemistry (read technology) - in a plant
3. Apply green chemistry - in the field
4. Embrace green chemistry - by the marketplace

What are we doing at Elevance to advance the mainstreaming of Green Chemistry?

Elevance is

A High Performance Specialty Chemical Company Transforming Renewable into Remarkable

Enabling new possibilities for
manufacturers utilizing Inherent™
renewable building blocks

Empowering formulators with a broad
line of Elevance Ingredients

Delivering improved performance with a
smaller environmental footprint



Elevance Renewable Sciences

Who We Are

Elevance Renewable Sciences is a leader in the chemical conversion of renewable feedstock into a wide range of both 'drop in' and novel specialty chemicals

What We Do

Elevance produces specialty chemicals with performance benefits for a wide range of markets using proprietary, Nobel Prize winning, olefin metathesis technology

Key Stats

Employees: ~150

Founded: 2007

Headquarters: Woodridge, IL

Facilities:

Gresik, Indonesia (operating)

Natchez, MS (biodiesel operations)

Raised over \$300M in private equity capital

Woodridge, Illinois



Gresik, Indonesia



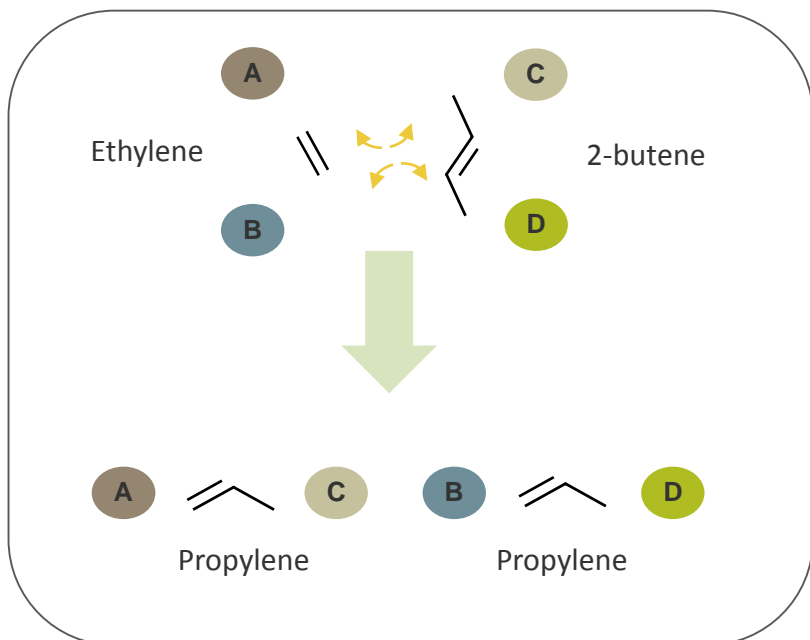
Natchez, Mississippi



Green Chemistry was demonstrated in the lab...

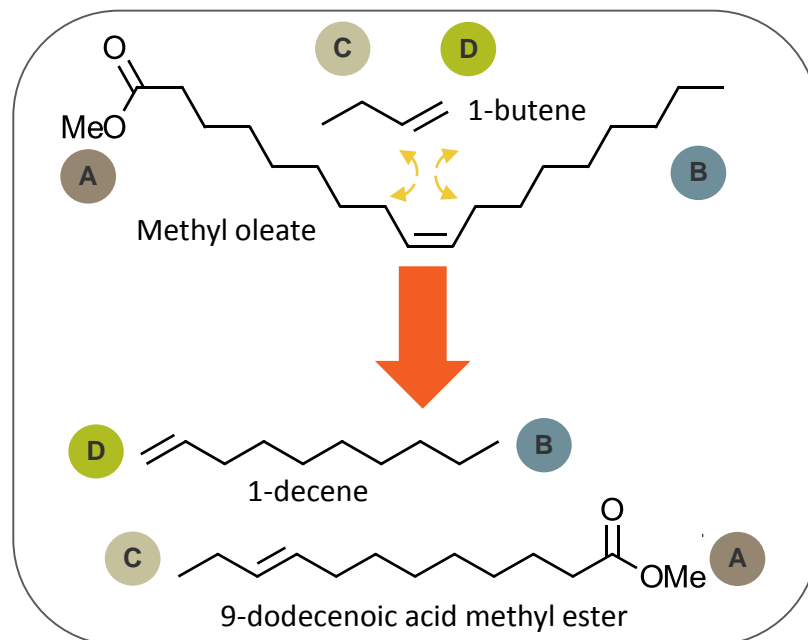
The ability to exchange groups on either side of an oxygen-, nitrogen- or hetero atom-functional olefin allows for the production of bio-based hydrocarbons from renewable oils.

Traditional Metathesis Catalyst



- ✓ Achieved with **hydrocarbon** feedstocks ONLY
- ✓ Limited conversion options
- ✓ High pressure and temperatures

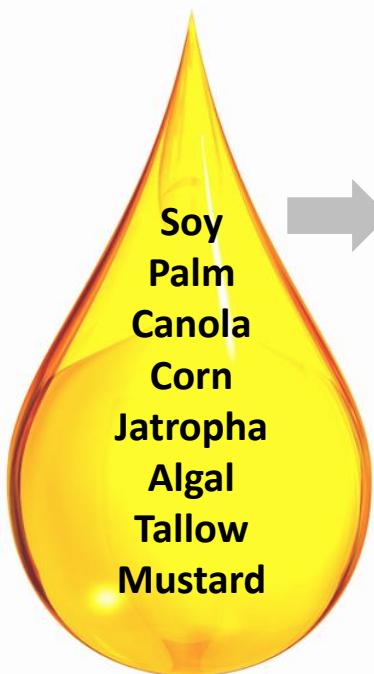
Proprietary Metathesis Catalyst



- ✓ Achieved with **renewable oils** (lipids, fats)
- ✓ Creates bio-based hydrocarbons
- ✓ Creates novel, high-performance specialty esters
- ✓ Low pressure and temperatures

...Green Chemistry has been scaled-up in manufacturing...

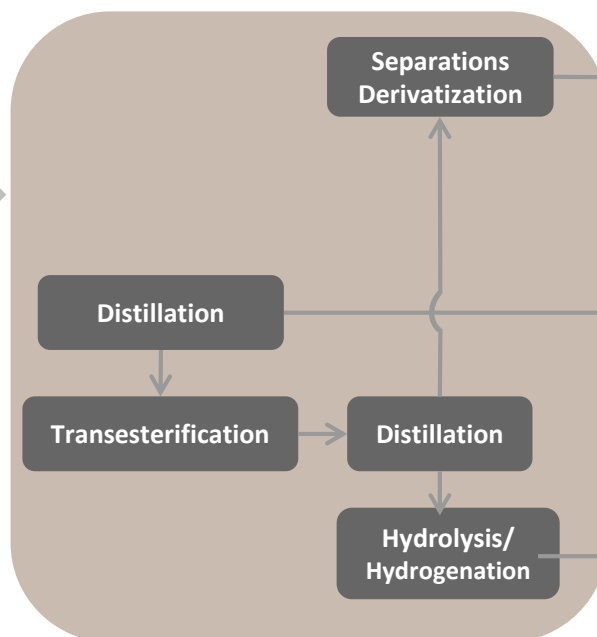
Natural Oil
Feedstock
Options



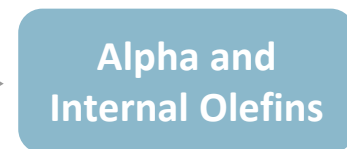
Nobel Prize-
Winning
Technology



Standard
Chemical
Unit Operations



Novel,
Advantaged
Products



... Which is operating today in Indonesia...



A joint venture between



... and expanding in North America...



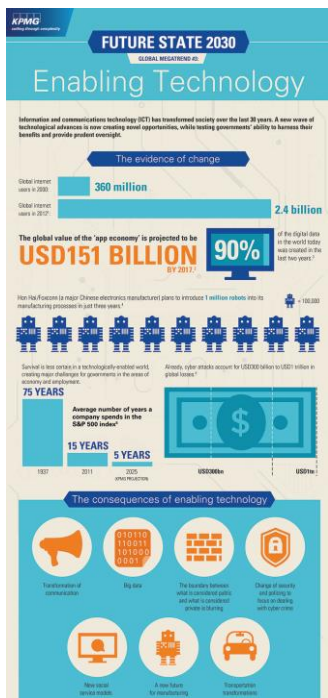
Mainstreaming Green Chemistry

The key elements needed to mainstream green chemistry:

1. Demonstrated new technology (read green chemistry) - in the lab
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3. **Applied green chemistry - in the field**
4. **Embraced green chemistry - by the marketplace**

What are we doing at Elevance to advance the mainstreaming of Green Chemistry?

Context is Important – Global Megatrends



KPMG Future States 2030

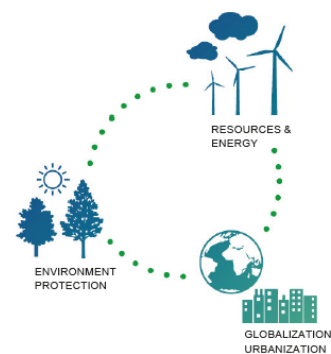
McKinsey Global Institute

Twelve potentially economically disruptive technologies

	Mobile Internet	Increasingly inexpensive and capable mobile computing devices and Internet connectivity
	Automation of knowledge work	Intelligent software systems that can perform knowledge work tasks involving unstructured commands and subtle judgments
	The Internet of Things	Networks of low-cost sensors and actuators for data collection, monitoring, decision making, and process optimization
	Cloud technology	Use of computer hardware and software resources delivered over a network or the Internet, often as a service
	Advanced robotics	Increasingly capable robots with enhanced senses, dexterity, and intelligence used to automate tasks or augment humans
	Autonomous and near-autonomous vehicles	Vehicles that can navigate and operate with reduced or no human intervention
	Next-generation genomics	Fast, low-cost gene sequencing, advanced big data analytics, and synthetic biology ("writing" DNA)
	Energy storage	Devices or systems that store energy for later use, including batteries
	3D printing	Additive manufacturing techniques to create objects by printing layers of material based on digital models
	Advanced materials	Materials designed to have superior characteristics (e.g., strength, weight, conductivity) or functionality
	Advanced oil and gas exploration and recovery	Exploration and recovery techniques that make extraction of unconventional oil and gas economical
	Renewable energy	Generation of electricity from renewable sources with reduced harmful climate impact

Innovation – driven by global trends and challenges

MEGATRENDS DRIVING INNOVATION



Environment Protection

- Clean technologies
- Resource efficiency
- Climate change
- Avoiding waste

Globalization & Urbanization

- Mobility
- Construction
- Nutrition & health
- Life style

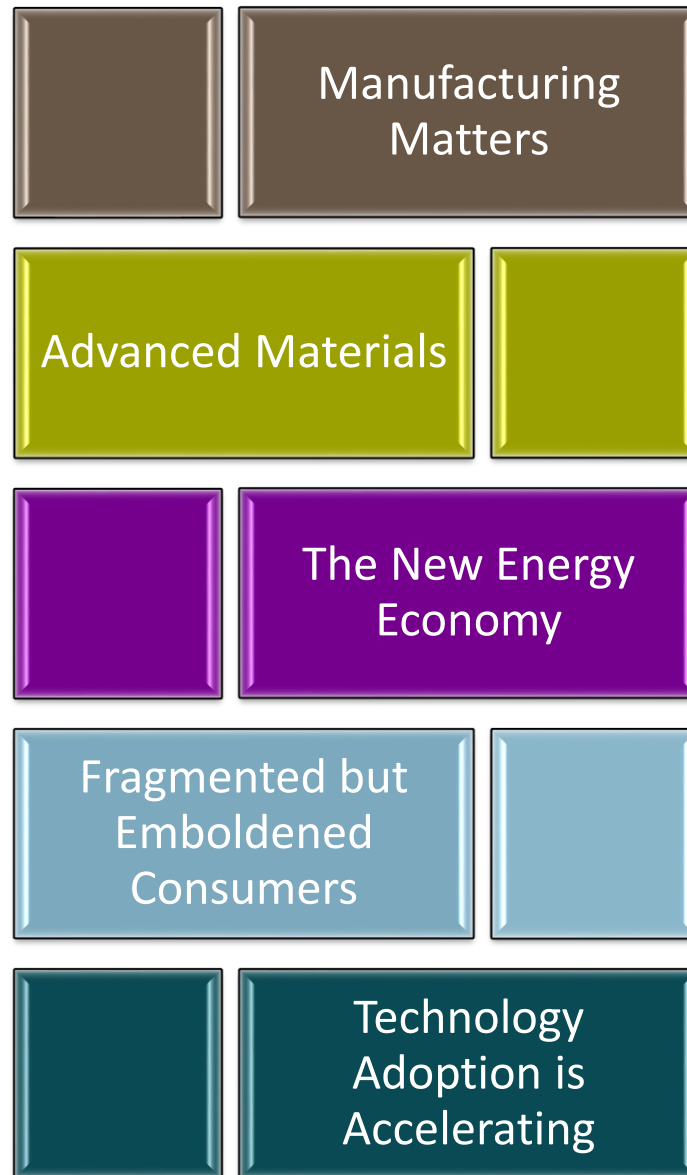
Resources & Energy

- Alternative energy sources
- Energy storage
- Renewable Raw Materials

Clariant Capital Markets and Media Day, June 2014

Which global megatrends align with mainstreaming Green Chemistry?

“Consensus” Megatrends important for Elevance



Megatrends relevant to Elevance Renewable Sciences

Advanced Materials

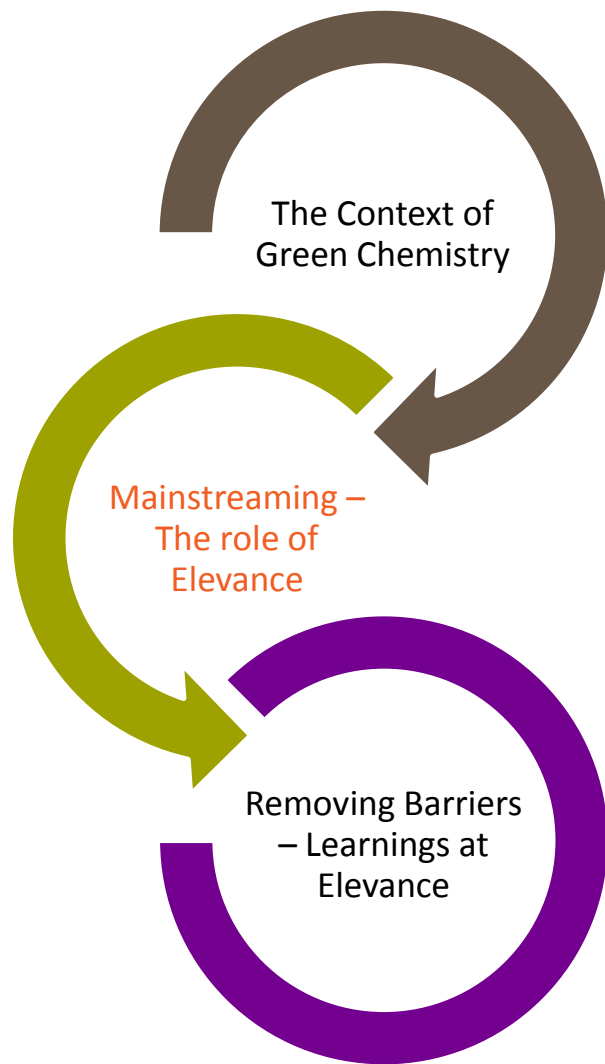
The New Energy
Economy

Fragmented but
Emboldened
Consumer

Let's look at cases studies from three of these Megatrends.

We will be bringing a certain perspective....

Outline of Presentation



A breakthrough category
of novel products

A paradigm shift in addressing
industry and consumer demand,
delivering improved performance

All while leaving a smaller footprint



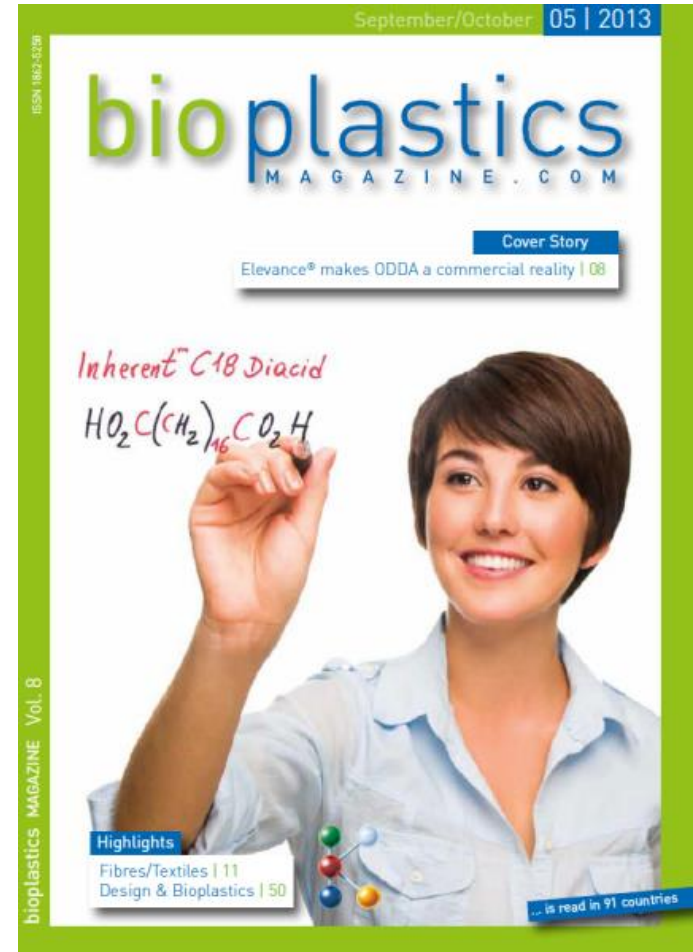
Renewicals™

Megatrends relevant to Elevance Renewable Sciences

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Megatrend: Advanced Materials

- “Advances” in many complex manufactured goods are **enabled** by advances in materials science
- Materials matter: by 2020 the average car will incorporate 350kg of plastics up from 200kg in 2014.
- Will these advanced materials be 100% petroleum or will **bio-based materials** play a role?



Science **347**, 1349 (2015);

John R. Tumbleston *et al.*

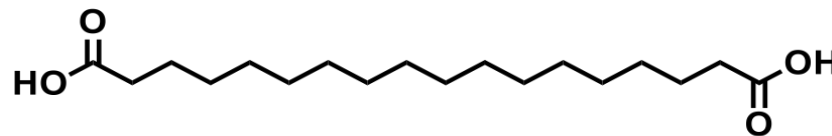
Continuous liquid interface production of 3D objects

Inherent™ C18 Diacid



Performance and Sustainability

- Elevance's proprietary technology and novel specialty chemicals are enabling a wide range of new market solutions
- Bio-based Inherent™ C18 Diacid available commercially



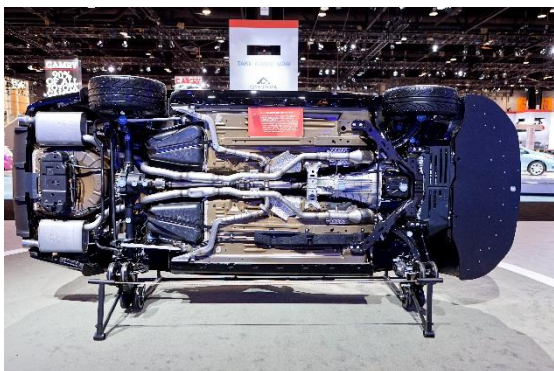
An application of C18 Diacid: Thermoplastic Polyurethanes

Thermoplastic polyurethanes are multiphase block co-polymers with versatile properties ranging from hard, engineering thermoplastics to soft rubbers

Chemical, salt and moisture resistance



Automotive Under Carriage and Trim



Reworkable, suitable for bonding and welding



Adhesives and Laminating Films



Inherent toughness and elasticity



High-Performance Sports and Leisure Goods



Inherent™ C18 based TPUs yield stronger, tougher materials

- 2X the tensile strength of a polyurethane based on commonly used chemistries
- With 40% less material
- Improved moisture and grease resistance

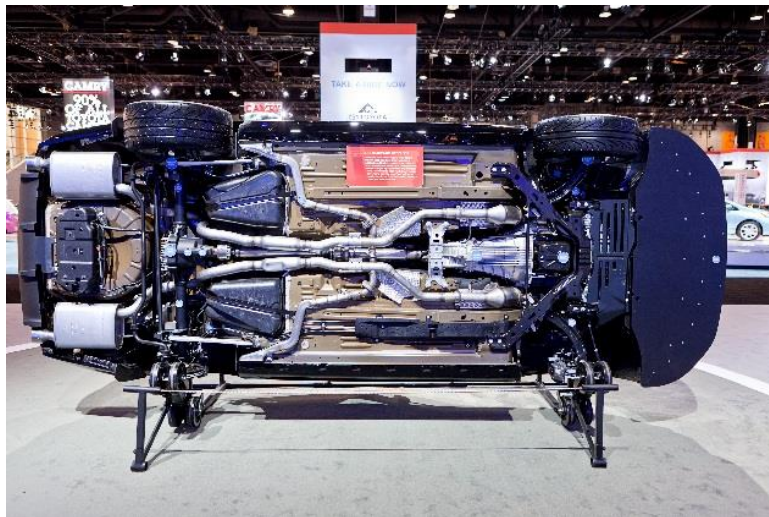


Resulting in a lighter sport shoe sole, ski boot or other equipment with, increased toughness and resistance to the elements and at least the same flexural strength.



“Applying” C18 to TPU’s enables

- Unique properties such as hydrolytic stability and low moisture pickup in addition to excellent mechanical properties.
- A wide range of physical properties ranging from hard and strong to elastomeric with small changes in the diol co-monomer.
- Better performance in demanding environments such as
 - automotive undercarriage parts,
 - hydraulic seals,
 - adhesives, and
 - high-end sporting goods.



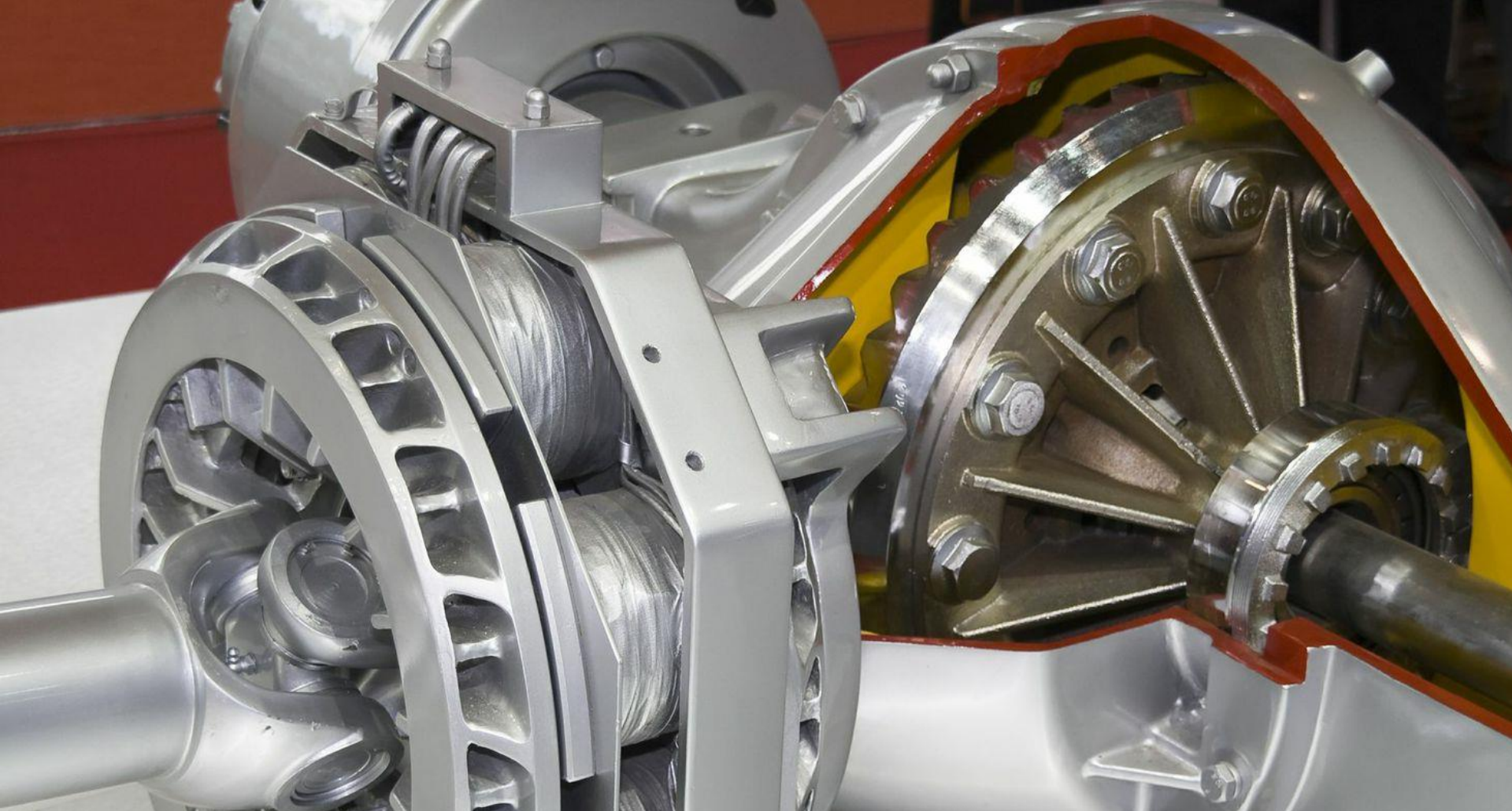
Megatrends relevant to Elevance Renewable Sciences

Advanced Materials

The New Energy
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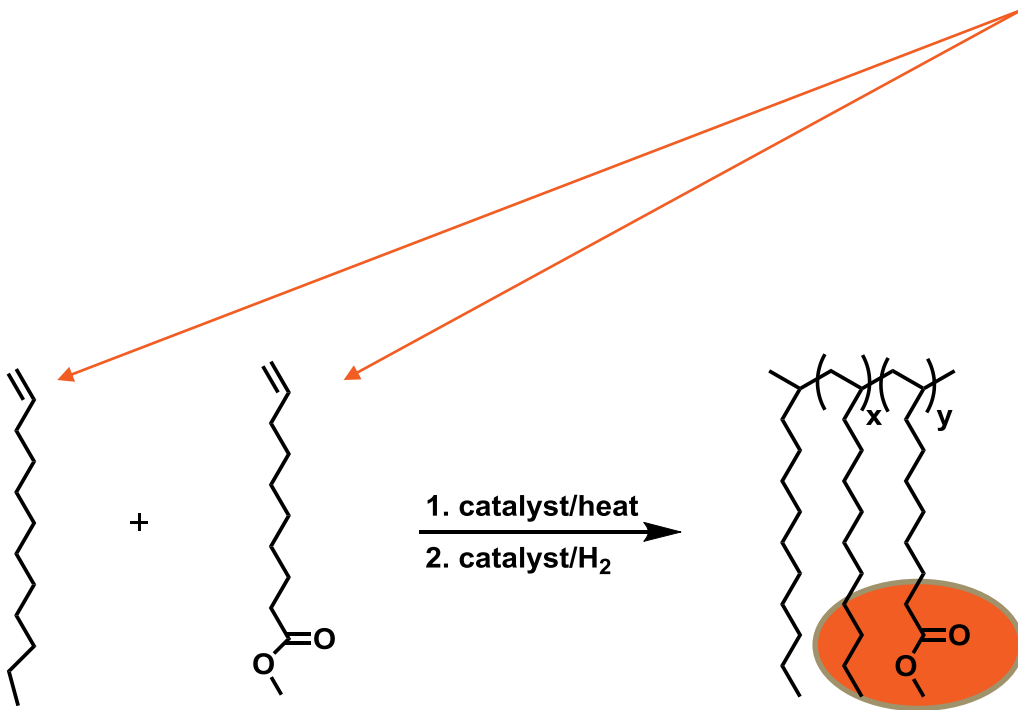




Elevance Aria™ base stocks improve lubricant properties for increased formulating flexibility

Elevance high-viscosity synthetic base stock technology

- Novel, synthetic high-performance base stock combines the performance of Groups IV and V into one base stock
- Both “components” (monomers) are potentially **bio-sourced**



Bio-sourced in
future products

Bio-sourced now

Novel architecture
incorporates ester group
naturally occurring in plant
oils

Performance Benefits

Designed to help increase operational efficiency and equipment life through:

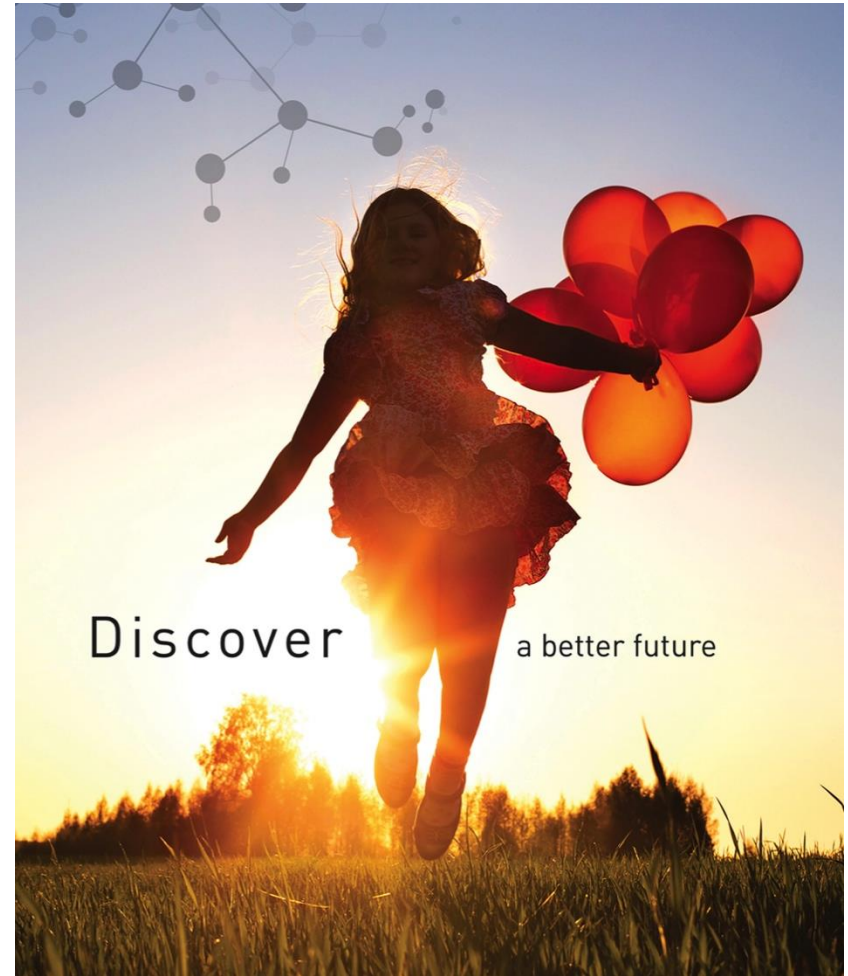
- Improved additive solvency & formulation compatibility
- Seal compatibility
- Low-foaming
- Lower friction
- Reduced wear

Megatrends relevant to Elevance Renewable Sciences

Advanced Materials

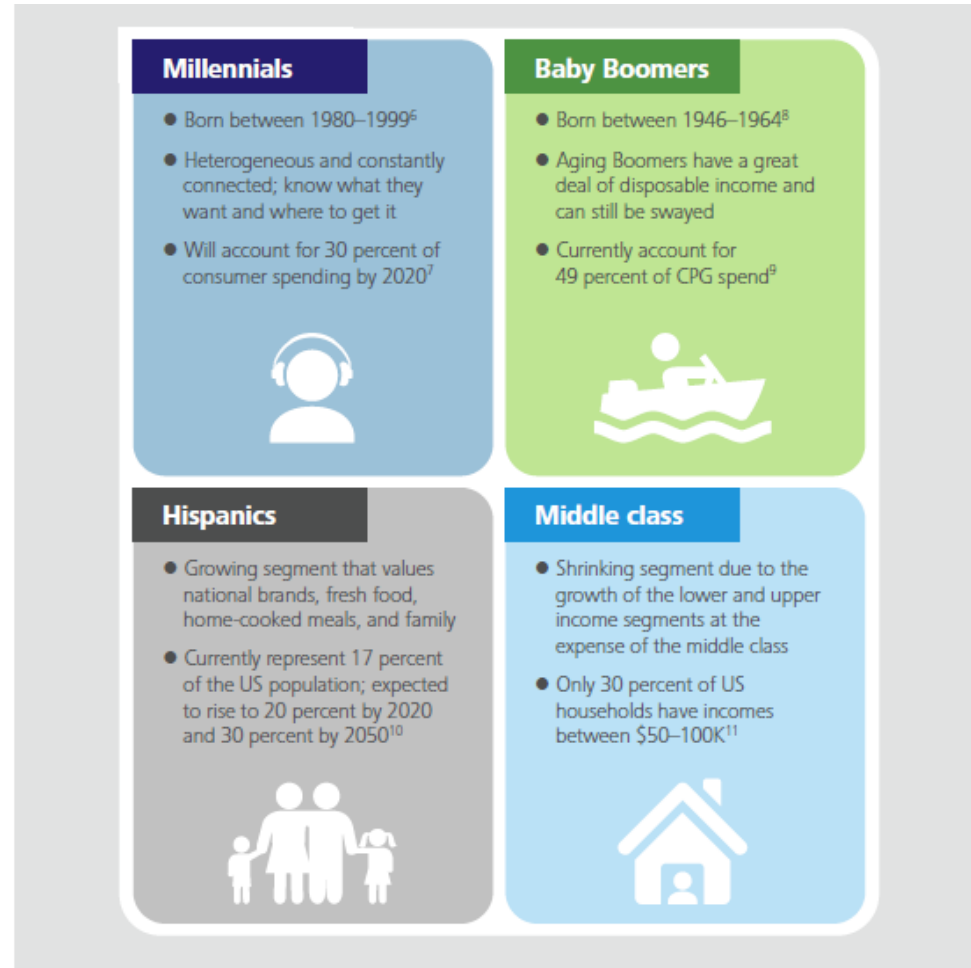
The New Energy
Economy

Fragmented but
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Fragmented but Emboldened Consumers

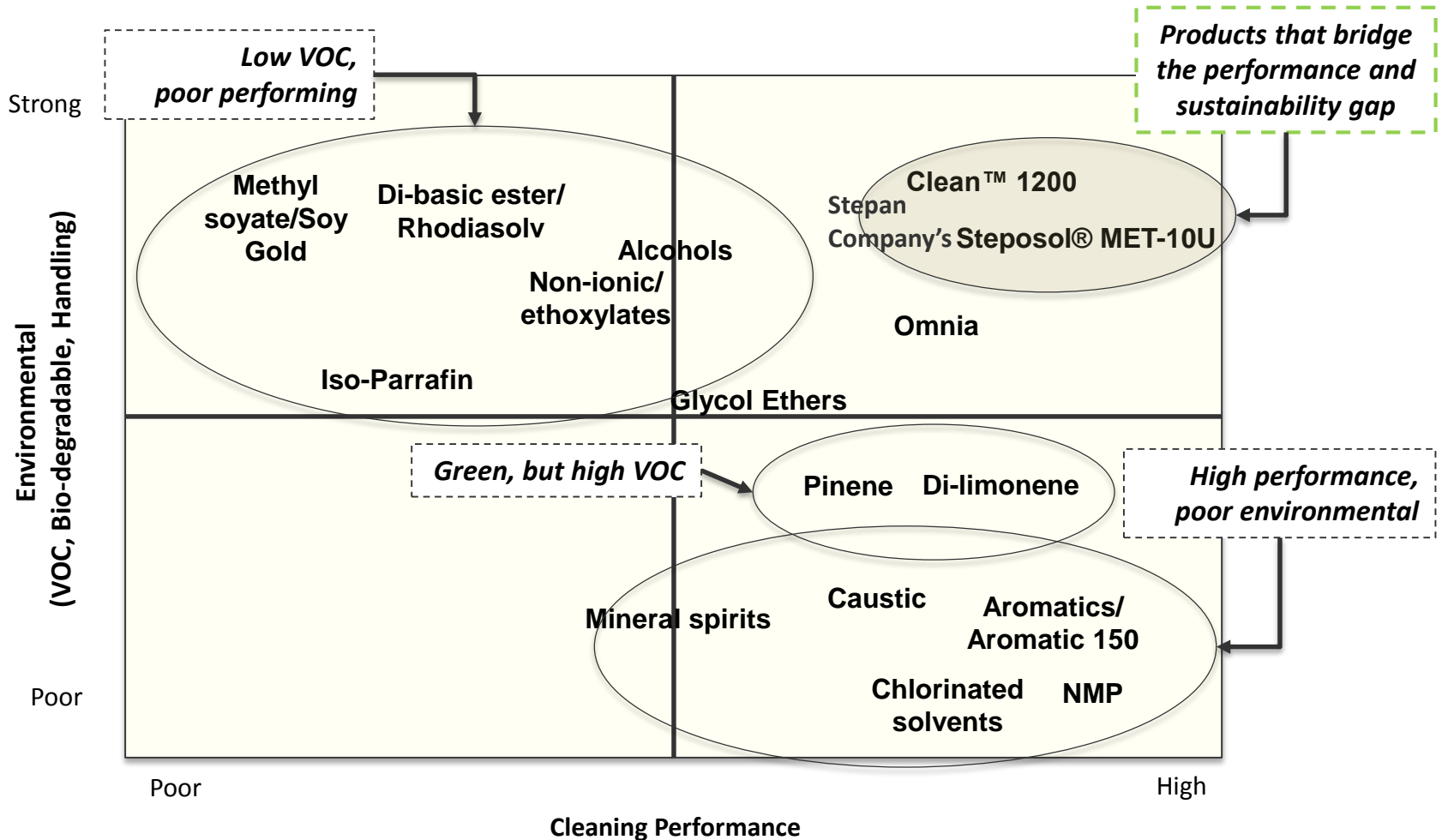
- *Deloitte Review*: Consumers are more heterogeneous in their preferences and expectations.
- Millennial's are plugged-in, trust their networks, and do their homework.
- They also expressed a willingness (59%) to pay more for green products?
- This sector is likely to undergo significant change over the next 20 years.



Graphic: Deloitte University Press | DUPress.com

Removing a Barrier: the performance and sustainability gap

Elevance Clean™ 1200 and Steposol® MET10U offer complete solutions for cleaning and degreasing applications:
 High Performance, Non Flammable, Low/No VOC, and Readily Biodegradable



Metathesis enables optimization of solvent performance

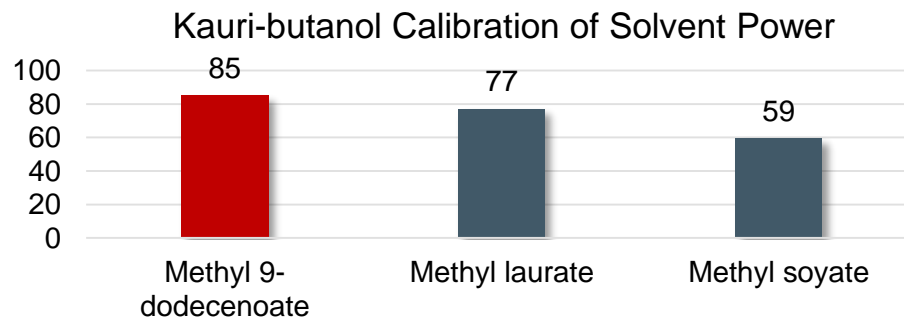
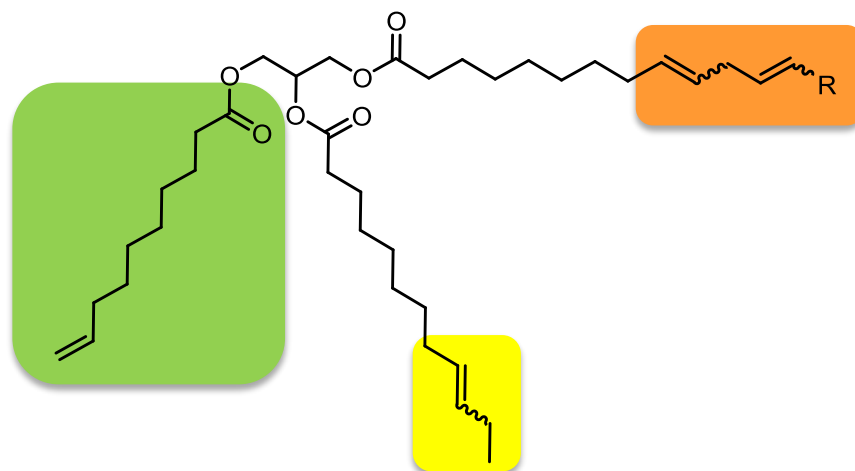
The fundamental physicochemical properties that affect the solvent characteristics and efficacy of biomass can be tuned by olefin metathesis.

The solubility of chemically related compounds decreases with increasing molecular mass since the intermolecular forces of interaction increase.¹

The solvent power of fatty esters increases with decreasing chain length.^{2,3}

The solvent power of fatty esters increases with degree of unsaturation.^{2,3}

The degree of unsaturation in a nonaromatic solvent is directly proportional to its oxidative *instability*.



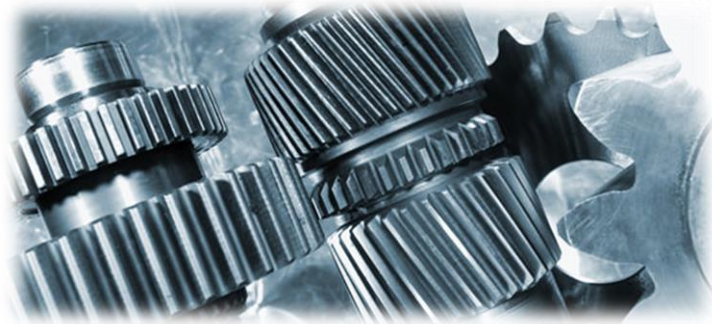
¹ Stoye, D. **2000**. Solvents. *Ullmann's Encyclopedia of Industrial Chemistry*.

² Knothe, G. et al. *Ind. Eng. Chem. Res.* **2011**, 50, 4177.

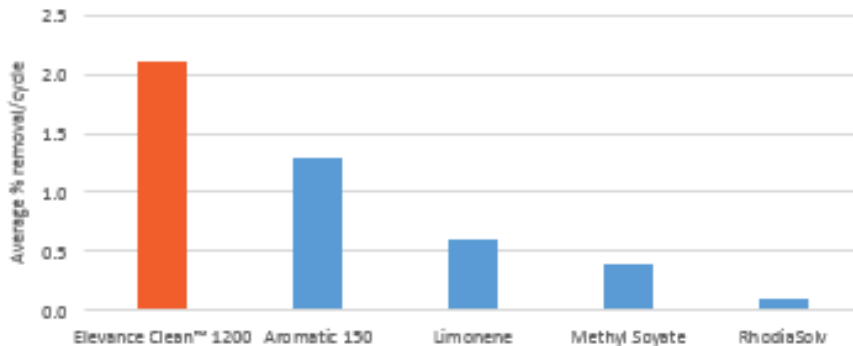
³ Hu, J. et al. *Ind. Eng. Chem. Res.* **2004**, 43, 7928.

Case Study: Novel Solvent Elevance Clean™ 1200

“Elevance launches Clean™ 1200, a Superior-Performing Degreasing and VOC-Exempt Solvent “ June, 10, 2014



Industrial Grease Removal vs. competition



New Elevance Clean™ 1200.

Meets tough environmental requirements. Tougher on grease than other solvents.

REQUEST
A SAMPLE

Performance

- ✓ High performance degreasing
- ✓ Compatibility for semi aqueous formulations
- ✓ Applicable across H&I applications
- ✓ Strong cost/performance

Environmental

- ✓ Safe to handle, safe to use
- ✓ Low Vapor Pressure (LVP-VOC)
- ✓ Bio-renewability 73-75% (BCI)
- ✓ Meets regulatory requirements (PMN, REACH)

A breakthrough category
of novel products

A paradigm shift in addressing
industry and consumer demand,
delivering improved performance

All while leaving a smaller footprint



Renewicals™



Making better specialty chemicals today,
for tomorrow

Elevance
RENEWABLE SCIENCES®



Thank you.