Green Chemistry & Commerce Council

Moving Business Toward Safer Alternatives

GC3 Green Chemistry Education Webinar Series

October 23, 2013

The Value of Green Chemistry

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Webinar Discussion Instructions

- Due to the number of participants on the Webinar, all lines will be muted.
- If you wish to ask a question, please type your question in the Q&A box located in the drop down control panel at the top of the screen
- All questions will be answered at the end of the presentation.

The Value of Green Chemistry to Business

Helen Holder / Oct 2013

Why is HP so interested in Green Chemistry?

RoHS – the law that changed everything

EU Directive 2002/95/EC on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment

Logo from companion regulation
Waste Electrical and Electronic Equipment (WEEE) Directive

Assessing Alternatives for RoHS Compliance

"Traditional" Alternatives Assessment

Material selection based on:

- Cost
- Performance
- Reliability
- Manufacturability

All unregulated substances treated as equally acceptable.

1 July 2006

Substance Regulations

Substance restrictions have become a major class of regulation for finished electronic products

- More substances
- More jurisdictions
- More reporting

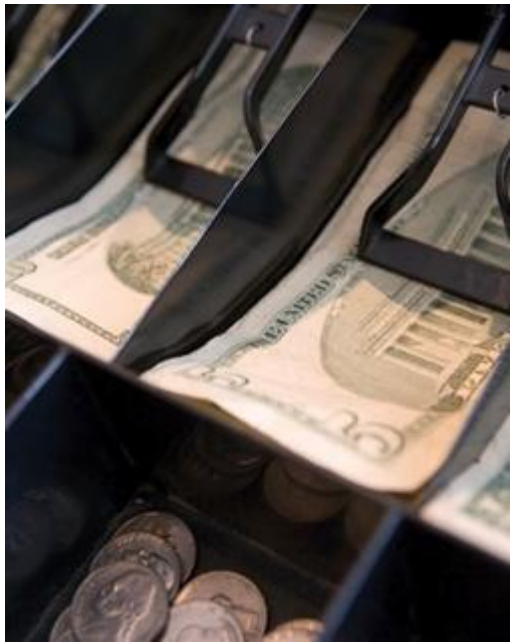
Business Case for Better Alternatives

Replacing materials is expensive

- Want to select alternatives that won't be restricted in the future
- Avoid unintended consequences

Common sense

- If you go through the trouble of getting rid of a substance because of environment or human health impacts, you should make sure the replacements have lower impact.



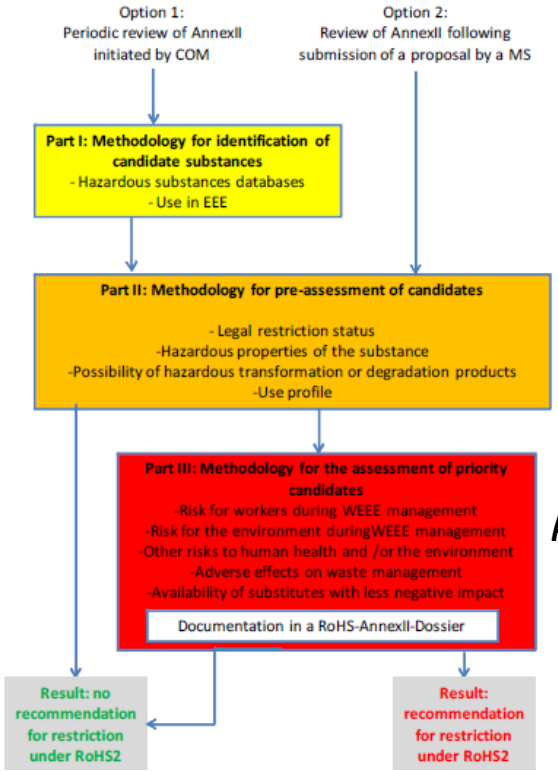
Regulators Catching On

Jurisdictions requiring assessing alternatives to restricted substances:

- EU (ROHS 2 Methodology)
- California
- Washington
- Maine

Building expertise in AA:

- EPA DfE
- EU JRC/DG Env
- Washington Ecology
- California DTSC



AA required in Part III

From proposed methodology for ROHS 2, as described in the *Study for the Review of the List of Restricted Substances under RoHS2*

What do these trends mean for Green Chemistry?

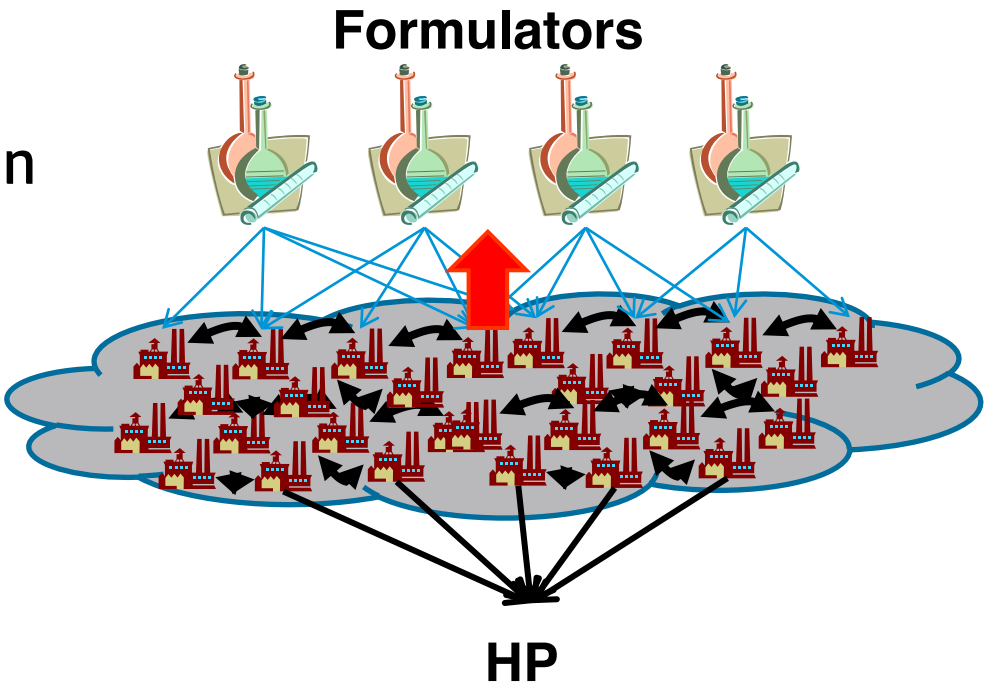
- **Chemicals get restricted**
- **Companies choose lower impact alternatives as part of a risk mitigation strategy**
- **Green Chemistry becomes a business opportunity for suppliers**

Articulating Materials Goals

If we don't articulate environmental requirements to suppliers, we won't get better materials

Engaging with Formulators

- Engage directly with formulators far up supply chain
- Give a range of feedback, in addition to cost
- Successfully used with other materials criteria (not just environment)



Influencing What's on the Menu

- Introduce Green Chemistry tools and metrics to formulators
- Create white lists and procurement guidance
- Encourage design of green materials from the beginning
  - Reduces cost adders
  - Reduces multiple substitutions

Green Screen Assessments of Similar Function Chemical

Common Name	CAS #	Full Name
Preferred		
Design	none	Design material out, dematerialize
Substance 0	######-##-#	Chemical name
Use but still opportunity for improvement		
Substance 1	######-##-#	Chemical name
Substance 2	######-##-#	Chemical name
Use but search for alternatives		
Substance 3	######-##-#	Chemical name
Substance 4	######-##-#	Chemical name
Substance 5	######-##-#	Chemical name
Substance 6	######-##-#	Chemical name
DO NOT USE		
Substance 7	######-##-#	Chemical name
Substance 8	######-##-#	Chemical name
Substance 9	######-##-#	Chemical name
Substance 10	######-##-#	Chemical name
Substance 11	######-##-#	Chemical name
Substance 12	######-##-#	Chemical name

Suppliers Will Need to Do More

- Chemical producers and EMS companies may have additional operations goals and constraints
  - EH&S of manufacturing process
  - Energy/carbon of processes and transport
  - Water use
  - Raw material sourcing
- TREND: Expect more reporting of carbon, water, material sourcing, process chemicals, and waste/emissions

Genentech
A Member of the Roche Group

Green BioPharma @Genentech

Tse-Sung Wu, PhD
October 2013
tsesung@gene.com

Outline

Genentech Backgrounder

Definition of Green BioPharma

Green Chemistry at Genentech

Organizational Change Model

Highlights of Accomplishments to Date

Roadmap

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- Genentech Backgrounder

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Backgrounder

Since 2009, Genentech fully owned by Roche, 80,000 EE worldwide

Genentech South San Francisco (15,000 EEs)

- US Roche HQ, R&D, process development, mfg, sales/mktg
- Global clinical development

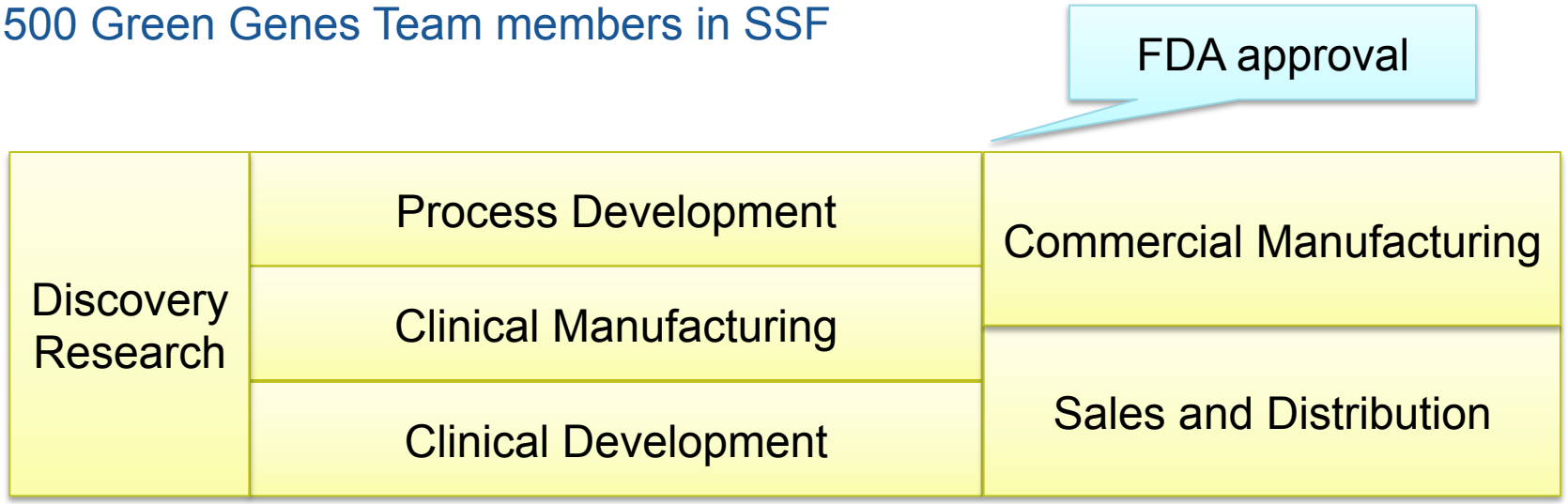
Strong mission-oriented corporate culture, driven by science, innovation and patients

Consistently on Fortune's "Great Place to Work" list

Oncology, immunology, metabolism; new: neuroscience, infectious diseases

Roche Group commitment to stay on DJSI (top 3 among health care)

1500 Green Genes Team members in SSF



Outline

Genentech Backgrounder

- Definition of Green BioPharma

Green Chemistry at Genentech

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Roadmap

Definition and Vision

Definition

Green BioPharma is the design, development, and implementation of biological and chemical products and processes that reduce or eliminate our impact on human health and the environment.

Vision

With the incorporation of Green BioPharma:

- Customers, business partners, and the community regard Genentech as a leader in efforts that **reduce its ecological footprint resulting from its core competencies**.
- Employees continuously **innovate**, evaluate, and implement ways to reduce the environmental impact of their decisions and operations.
- Wherever possible, the result of green innovations are **quantified.**

Green BioPharma forges the bridge between patients, people and the environment.

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Green Chemistry @Genentech: a short timeline

~2009

- Roche Technical Working Group on Green Chemistry established
  - 1-2 Genentech process chemists involved
  - sponsors lectures and annual process chemistry contest
  - limited exposure to rest of company
  - no organizational structures

Fall 2011

- Green Genes "lunch 'n' learn" talks by Green Chemistry scientists at Berkeley
  - Great response from employees
  - Green Genes subteam
- Launched the Green BioPharma Program
  - Established Green BioPharma Steering Committee, as part of Sustainability Council

2012

- Steering Committee endorsed 2012 goals and projects
- Green Genes Subteam is ~~28~~ ~~90~~ 130 volunteers
- Obtained VP support in key department

2013

- Published a video on this effort
- Formalized the role of Green BioPharma Project Manager

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Organizational Change Model

1 Operationalize environmental values into action:

Help define what it is to be greener in one's work

2 Presented as opportunities for innovation

Diffuse changes within your target audience

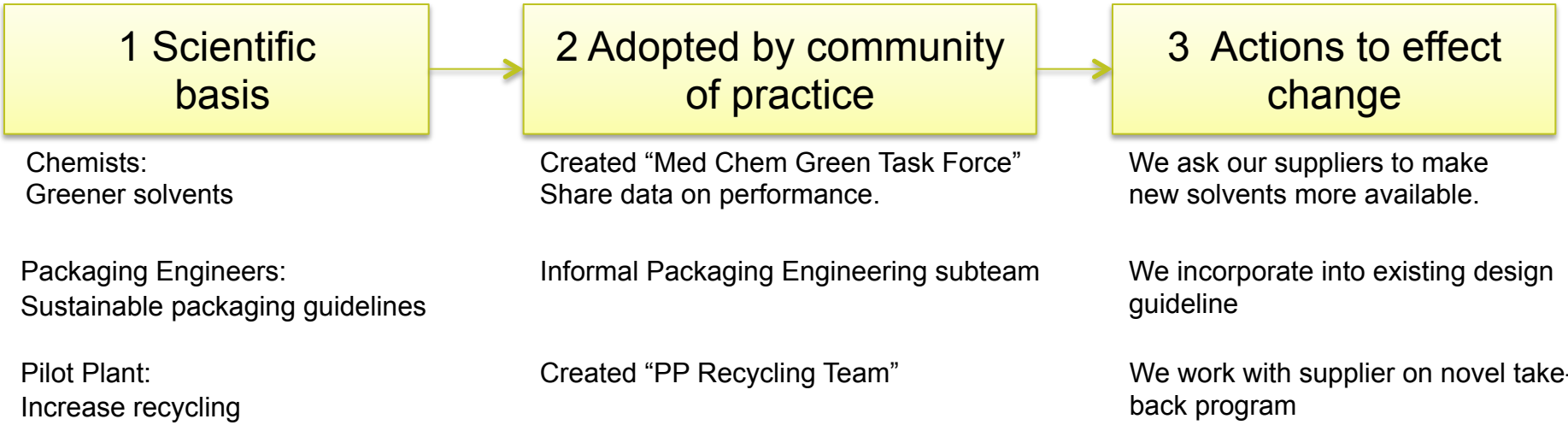
3 Behavioral changes lead to influencing decision-making

Pick low-hanging fruit

Ensure all efforts are rational, scientific, scalable.

•••

Changes must be at parity if not superior to existing processes/ products.



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Accomplishments

Internal

- Steering Committee empaneled and meeting monthly
- 11 of 12 goals completed in 2012; 2013 goals are on-track
- Green BioPharma Project Mgr role made permanent
- Program documentation

External

- Discovery Chemistry Green Team established
  - driving green solvent substitution
  - entirely staffed and led by Disc Chemistry employees
  - has VP approval
- Surplus Chemical Recycling Program piloted & improving
- Performed 10 Green Lab Assessments
  - building a network of peer resources to demonstrate and share best green practices in labs
- Container recycling/diversion, saving $10,000s in supplies and waste costs.
- Industry collaboration to develop Green BioPharma tools
  - BioPharma Focus Group of the Pharmaceutical Roundtable of the ACS Green Chemistry Institute

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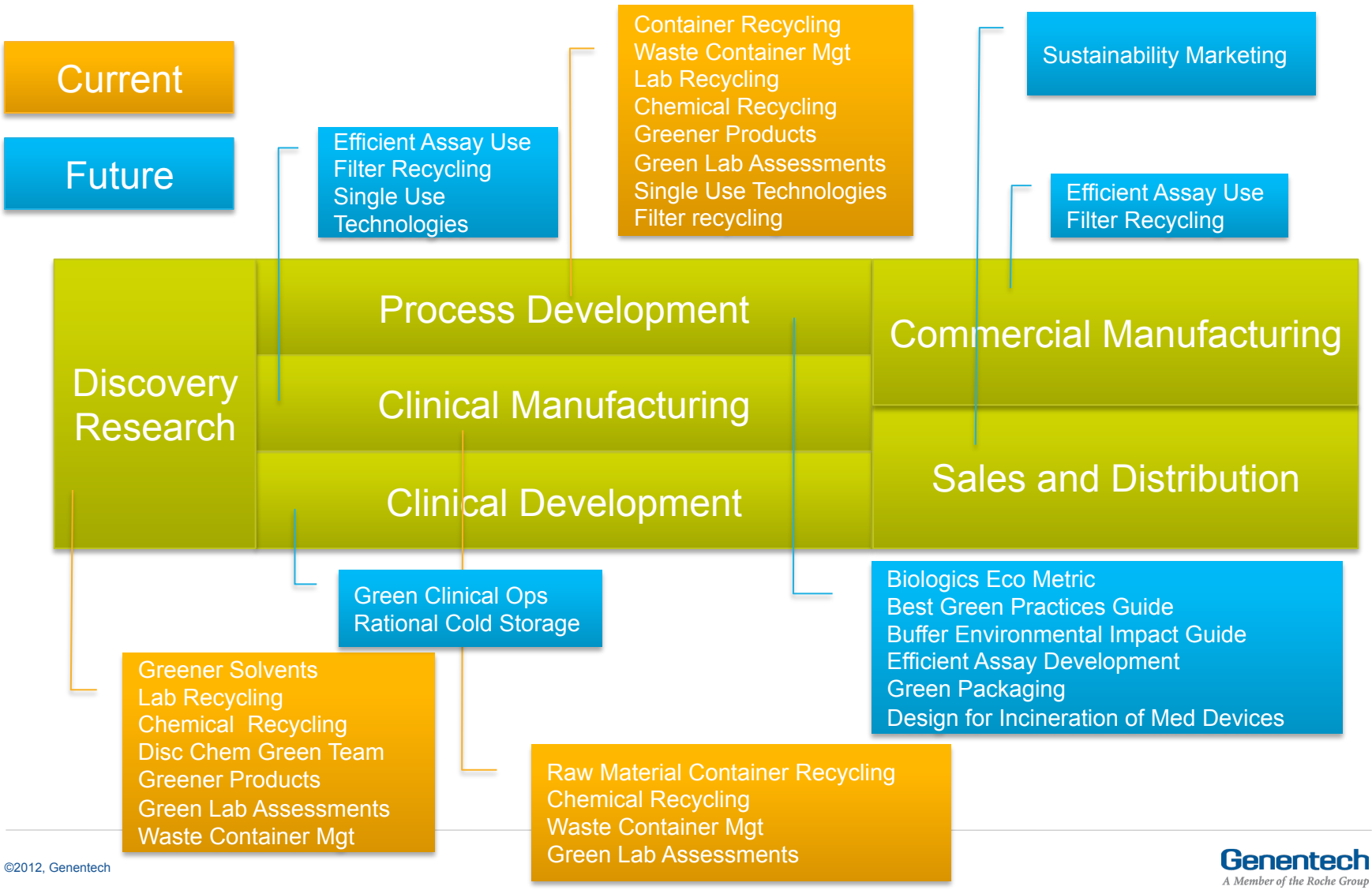
Organizational Change Model

Strategic Focus Areas and Success Factors

Highlights of Accomplishments to Date

- Roadmap

Greening Genentech's core competences: a roadmap



Acknowledgements

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GB Steering Committee

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Debbie O'Connor, Sr. Mgr, Pilot Plant
Asha Radhamohan, Engineer, Process Dev

Process Dev

Jacob Corn, Scientist, Early Development Biochemistry Research
Stefan Koenig*, Scientist, Small Molecule Process Chemistry Research

Research

Joe Jerkins, Sr. Mgr, Quality Systems, Production
Srinavyana Vutukuru, Engineer, Manuf Sci & Tech

Manufacturing

Tse-Sung Wu, EHS (Team Lead)
Kristi Budzinski, EHS (GB Project Mgr)

*Chair of the Roche-Genentech Green Chemistry Technical Working Group

Bruce Roth, VP Discovery Chemistry

Many Green Genes volunteers and emerging leaders

GREEN CHEMISTRY
Technical Working Group

Better Chemistry Video Clip (3:35)

http://www.youtube.com/watch?v=R2_0i-6nyQ0

(search for “genentech better chemistry”)


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Elevance
RENEWABLE SCIENCES®

GC3 Green Chemistry Education Webinar

Andy Shafer

October 23, 2013

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 traditional and novel specialty chemicals

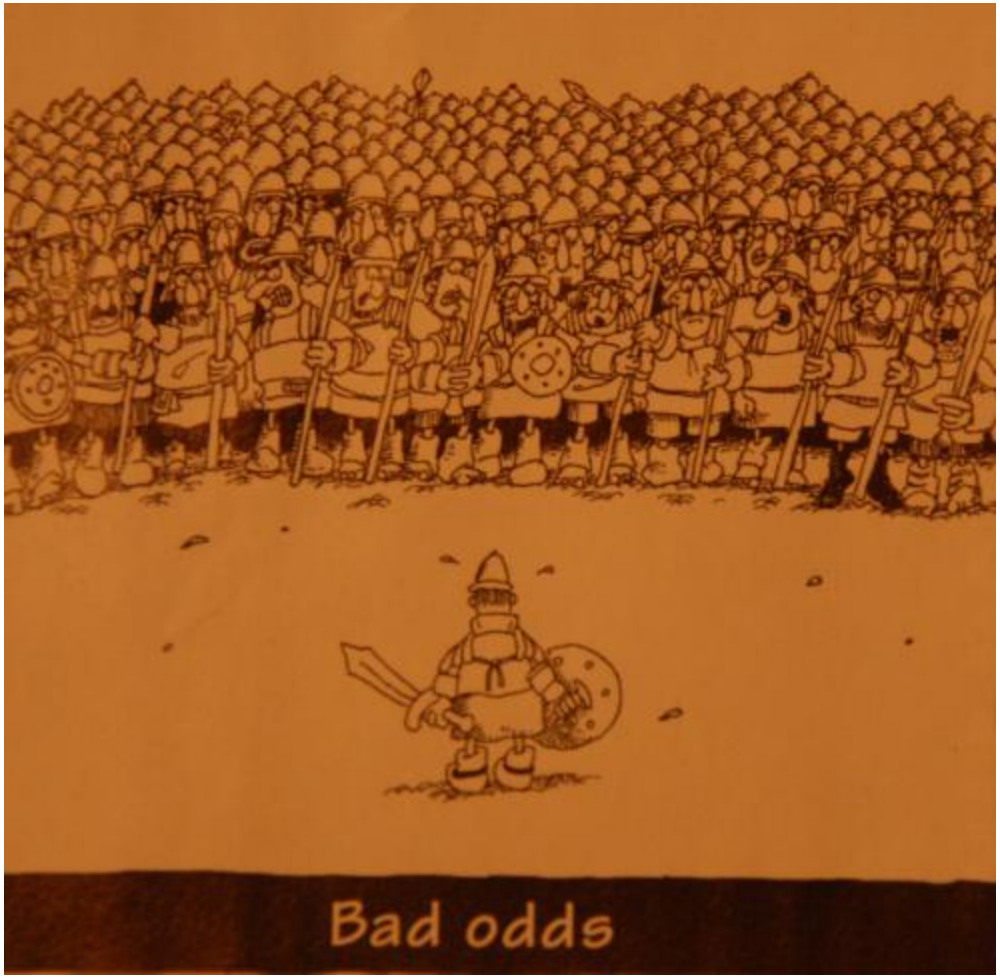
What We Do

Elevance produces a wide range of specialty chemicals from renewable oils using proprietary, olefin metathesis technology

Key Stats

Employees: ~150
Founded: 2007
Headquarters: Woodridge, IL

Beginnings…



Source: Rose Walker LLC

The Challenges …

- Delivering competitive and novel performance
- Cost competitiveness
- Efficient manufacturing
- Feedstocks and supply chain
- Access to markets & customers
- Regulatory requirements

The impact is just emerging and is affecting several major markets

	Market Size Sales, USD	**Bio-based products** Current examples
Fuel	~ $500 billion	• Ethanol • Biodiesel • Advanced Biofuels
Polymers and petro-chemicals	~ $500 billion	• PLA, PHA, Sorona • Glycols • Ethylene • Acrylic acid
Specialty chemicals	~ $300 billion	• Surfactants • Lubricants • Detergents & Cleaners • Flavors, fragrances • Ag & Oil Field Chemicals
Fine chemicals	~ $100 billion	• Pharma intermediates • Amino acids • Vitamins • Citric acid

Key drivers

- Downstream customer requirements
- Technology breakthroughs
- New bio-based building blocks
- Regulatory push
- Recognized need for innovation
- Major private investments

Source: McKinsey, SRI, press clipping, company publications

Potential for major discontinuities

Elevance™

Benefits of the Bio-based Products

Better products for consumers

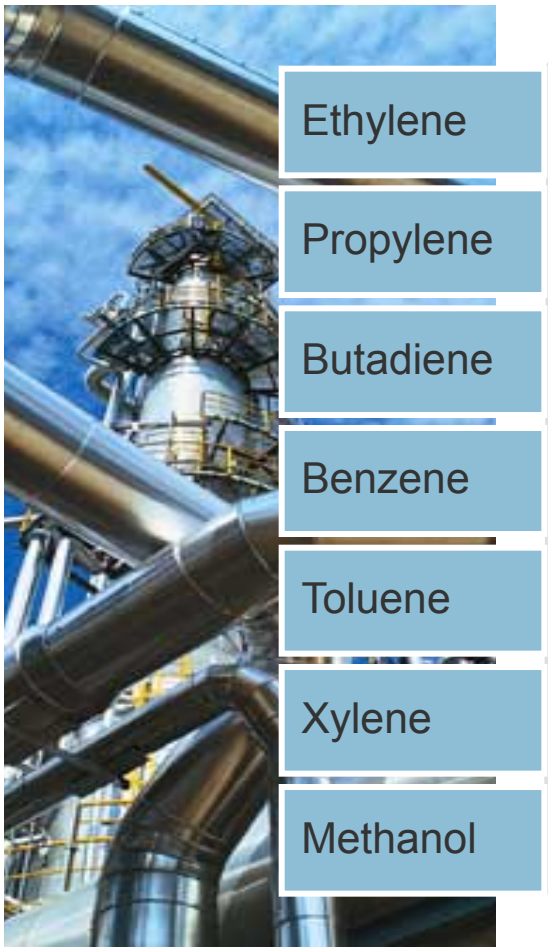
More economical for industry and consumers

More dependable, renewable and lower-cost feedstocks

Smaller environmental footprint:

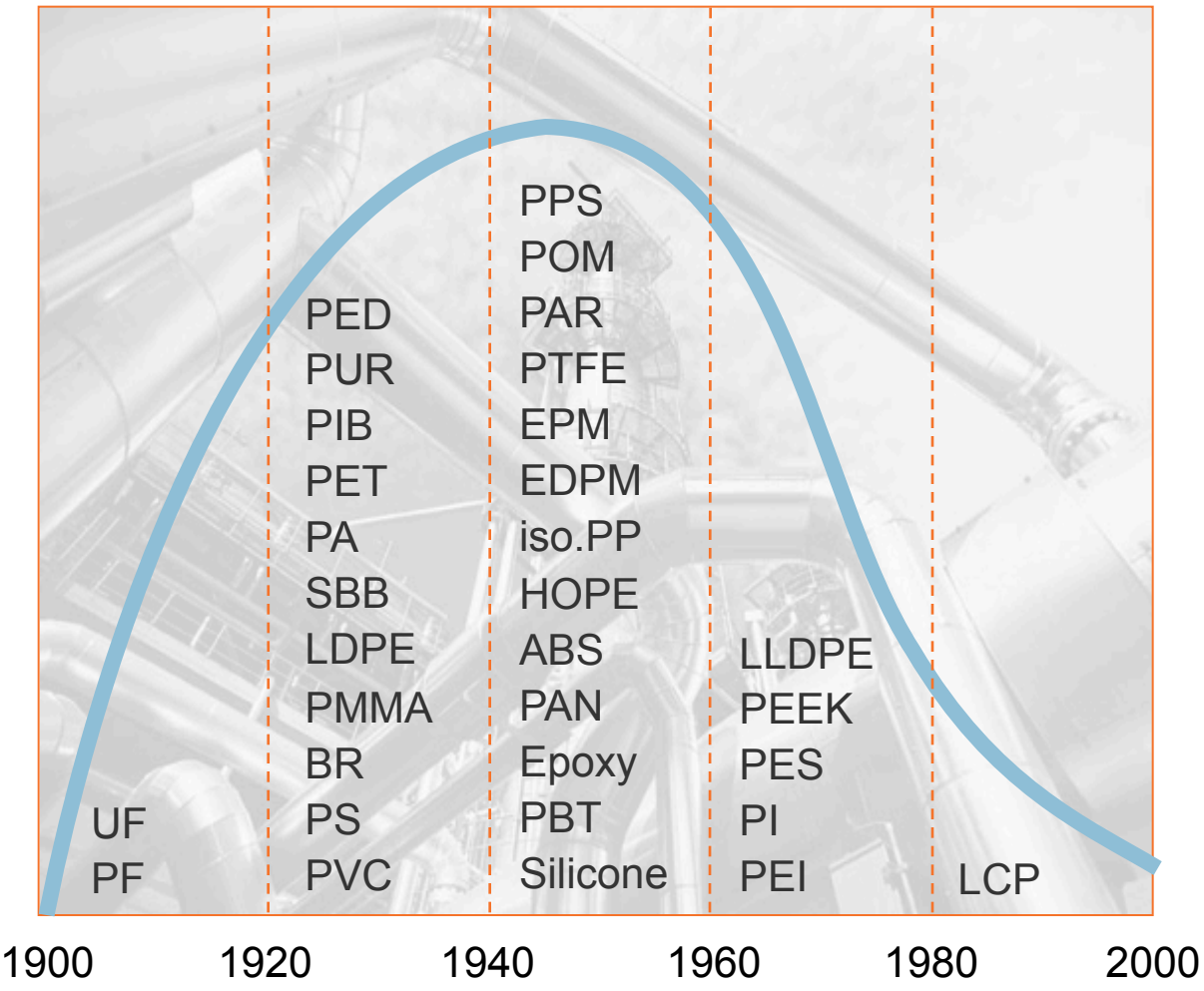
- More environmentally friendly products/processes

The innovation potential of fossil building blocks appears largely exploited

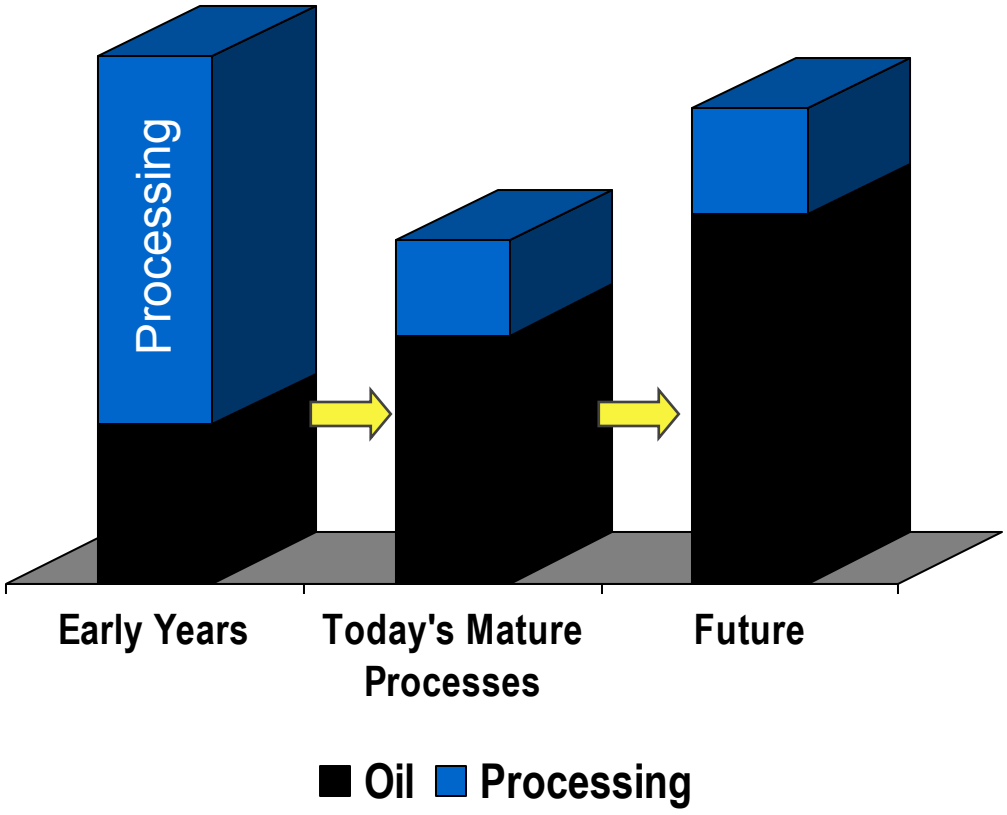


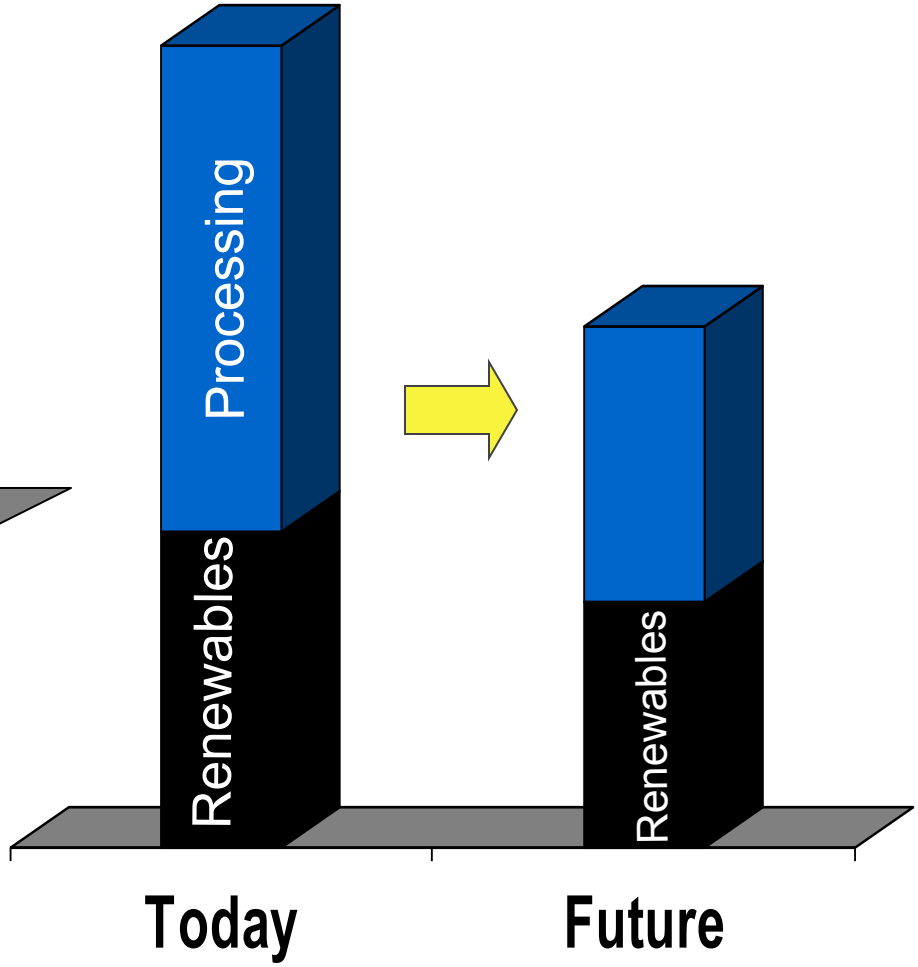
Slide courtesy of McKinsey

Polymer innovation based on fossil building blocks



Impact of Raw Material & Processing Costs





Elevance™

Elevance Products address critical customer needs

Detergents & Cleaners	✓ Improved cold water performance ✓ Alternative feedstock with pricing/supply dynamics	
Personal Care Products	✓ Anti-frizz and shine for leave-in hair care ✓ Moisturizing benefits & smoother feel for skin care	
Performance Waxes	✓ Thermal stability ✓ Increased fragrance loading	
Lubricant Base Oils	✓ Reduction in formulation costs ✓ Improved fuel economy	
Lubricant Additives	✓ Improved lubricity ✓ Enhanced cold flow properties	
Engineered Polymers & Coatings	✓ Feedstock and monomers that enable existing & new polymers ✓ Advancing product portfolios via performance and/or sustainability	

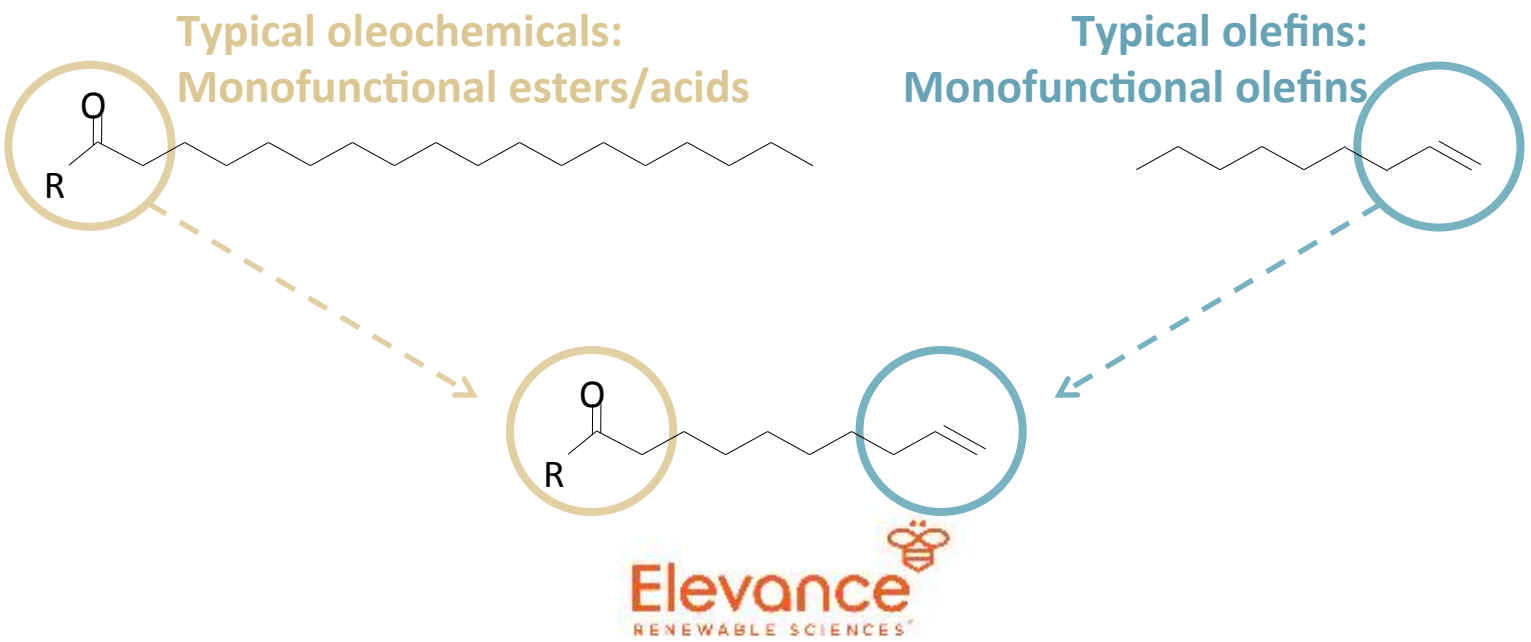
Products specifically target customer-desired functional attributes

Broad applications with large addressable markets

	End Product Applications		
Consumer & Industrial Ingredients			
Lubricants & Additives			
Engineered Polymers & Coatings			
Olefins			
Oleochemicals			

Elevance™

Specialty chemicals based on novel di-functional molecules

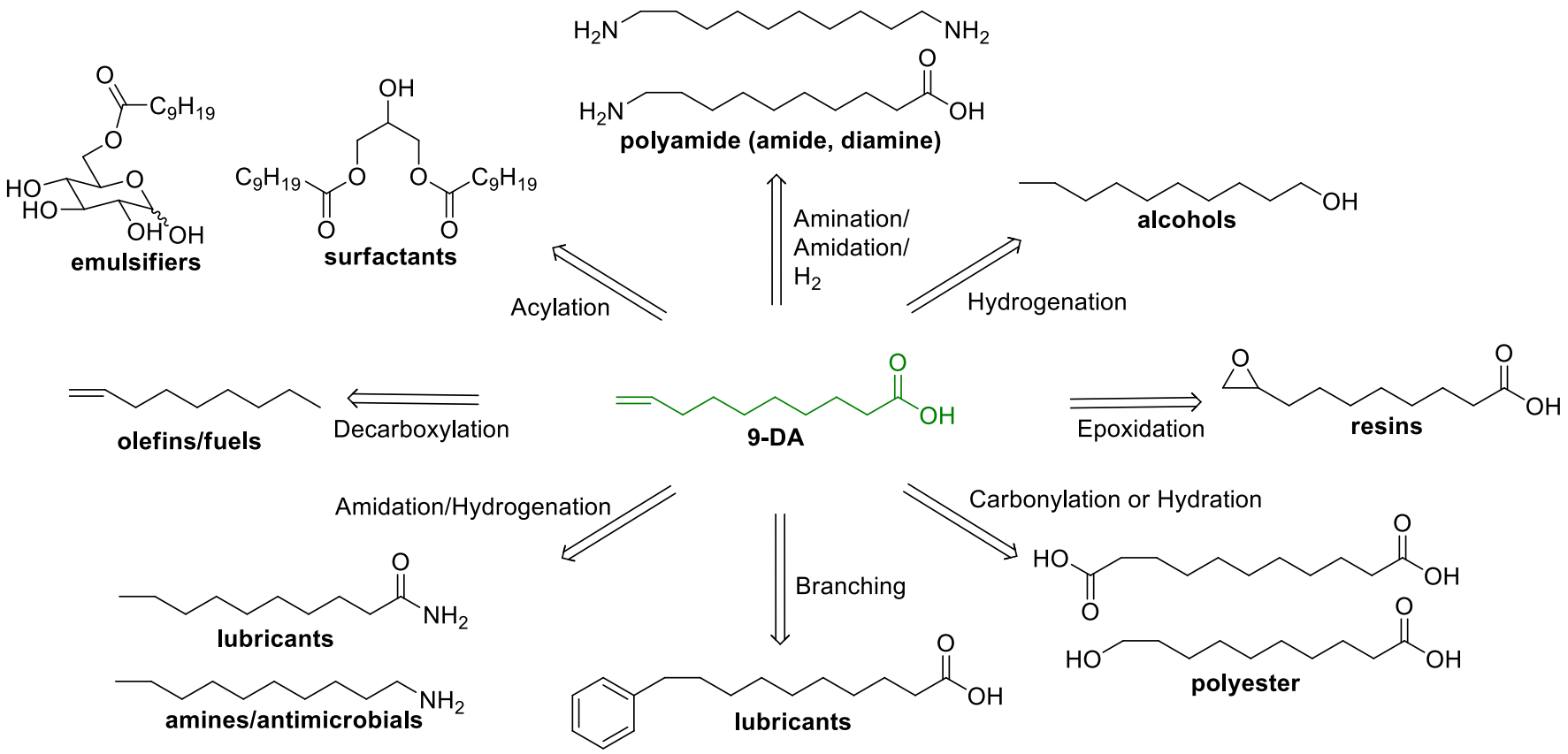


Di-Functional Molecules

Chemicals from the Elevance process combine functional attributes of olefins and oleochemicals in a previously unachievable single molecule

Novel di-functional specialty chemicals: 9DA

- The natural product equivalent of a petrochemical building block
- Possibilities for considerable innovation in a wide variety of markets and applications



Elevance™

High-performance specialty and intermediate chemicals from natural oils

- ✓ Variety of Natural Oils
- ✓ Widely Available

- ✓ Low Capital
- ✓ Low Operating Costs
- ✓ Commercial Today

- ✓ High Value Product Mix
- ✓ Addresses Critical Shortages
- ✓ Meets Customer Performance Needs

Specialty Chemicals

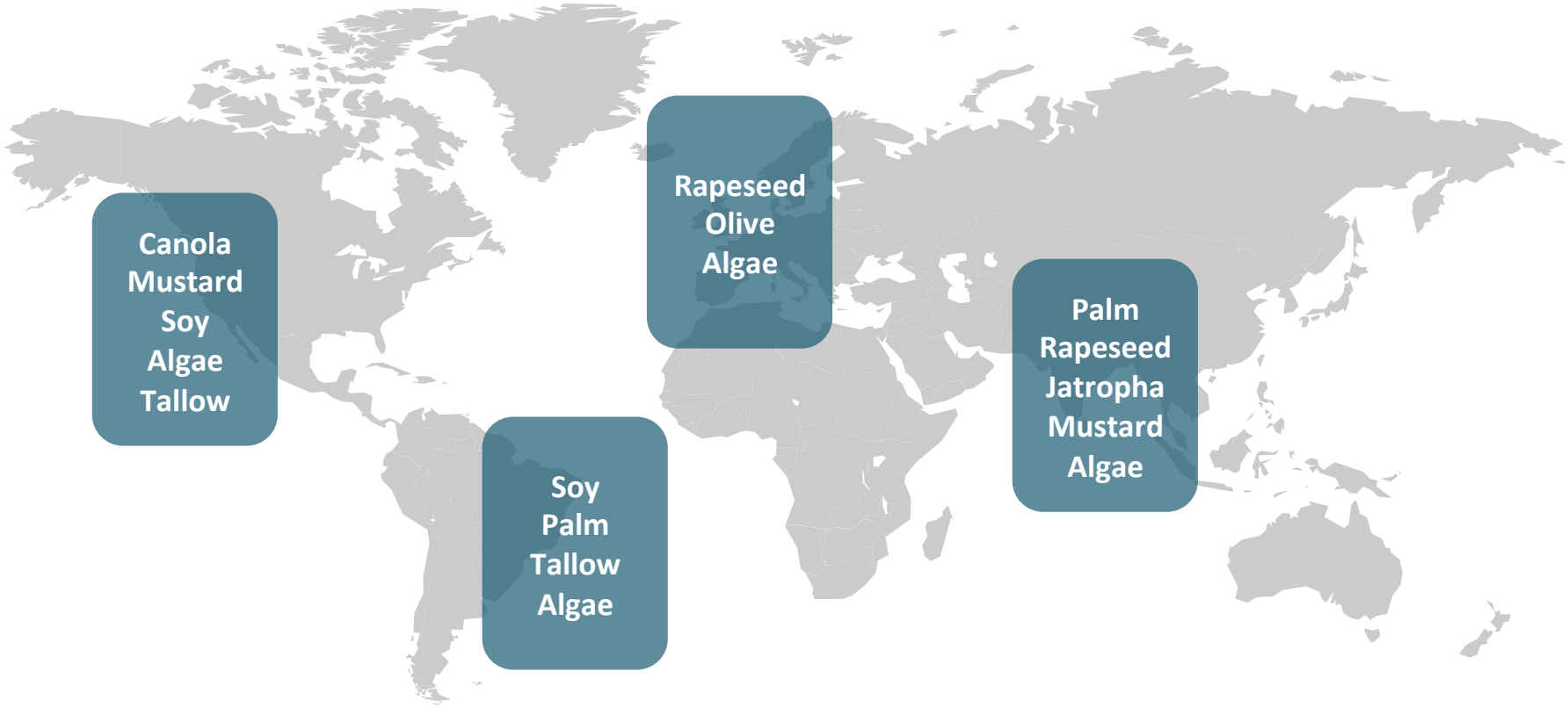
Olefins

Oleochemicals

Elevance™

Elevance *Advantage*: Feedstock diversity

- ✓ Widely available and easily transportable feedstocks provide significant advantages
  - Industrial scale quantities available in all regions
  - Low cost transportation and storage in liquid form



Elevance™

Collaborative business model

Feedstock & Technology

Reduce costs & expand functionality

Manufacturing

Speed commercialization & reduce capital requirements

Markets

Accelerate access to large, existing end markets

Leverage complementary assets and capabilities

Accelerate time to market

Reduce development investment & risk

Challenges

Regulatory

- Incumbent technology in chemicals is advantaged; bio-based chemistries/products need equal footing

Connecting the value chain: from feedstocks to consumer goods

- Translating requirements from one step to the next
- Aligning on priorities between what steps need and can deliver/accept
- Leveraging non-competitive business models and vertical collaboration to accelerate progress

Business Development skills and experience

- Real experience in BD is limited – many industries have been focused on costs not development
- Understanding of Chemistry, Green Chemistry Basics, Value chain needs and structure/ property relationships

Leadership

- By companies and individuals
- Internal and External

The audio recording and slides shown during this presentation will be available to GC3 Members on the GC3 Website:
http://www.greenchemistryandcommerce.org

Non- GC3 Member Attendees who would like to view these slides please contact Sarah Shields at sarah_shields@uml.edu

Topics for Upcoming Webinars

Toxicology and Why You Should Care
Date/Time TBA

Overview of Decision Tools in Green Chemistry and Alternative Assessment
Date/Time TBA