Green Chemistry Education Webinar Series

The Role of Policy in Green Chemistry Research & Adoption

June 16, 2015

GREEN CHEMISTRY & COMMERCE COUNCIL

Business Mainstreaming Green Chemistry

What is the GC3?

- Cross-sectoral, B2B network of over 70 companies and other organizations
- Formed in 2005
- Collaboratively advances green chemistry across sectors and supply chains

Today's Speakers

Joel Tickner

Director of GC3

Associate Professor, Environmental Health UMASS Lowell

Robert Giraud

Principal Consultant, Environmental Engineering, DuPont Company

Ground Rules

- Due to the number of participants in the webinar, all lines will be muted
- If you have a question or comment, please type in the Q&A box located in the drop-down control panel at the top of the screen
- Questions will be answered at the end of the presentation

Policy and its Role in Green Chemistry

Joel A. Tickner, ScD
Director, Green Chemistry & Commerce Council
June 16, 2015

GREEN CHEMISTRY & COMMERCE COUNCIL
Business Mainstreaming Green Chemistry

Key Take Aways

- Policy – public and private – plays an important role in:
  - Shaping chemicals and materials choices
  - Supporting research, development and adoption of green chemistry
  - Providing incentives/disincentives to move away from/ towards certain types of chemistries
- The sheer number of policies – sometimes with conflicting requirements – can be a challenge for chemists and designers
- Poorly designed policies can potentially serve as barriers to green chemistry while well-designed policies can support innovation

What do we mean by policy

- “a law, regulation, procedure, administrative action, incentive, or voluntary practice of governments and other institutions…Policy decisions are also frequently reflected in resource allocations.”

- US CDC http://www.cdc.gov/stltpublichealth/policy/

Forms of policy

- Broad statements/goals/principles
- Strategic plans (energy policy, agency sustainability policy, non-toxic environment policies, etc.)
- Guidance
- Laws/mandates/requirements
- Incentives/awards
- Information
- Education
- Resource allocation, budgets

Broad types of policy

- Private versus public policy
- Carrots versus sticks
- Regulatory (mandatory) versus discretionary

Traditional types of policies chemists/designers are familiar with

- Design standards
  - ASTM/NFPA, etc
    - Flammability
    - Safety (e.g., Toys)
  - Performance standards
    - Failure rates
    - Mil SPECS
    - Material properties
  - Single chemical restrictions (RoHS, CPSIA)
- Health Safety and Environment policies can be thought of as a type of design standard

Forms of Private Policy

- Corporate goals/metrics
- Requirements for use of particular standards, tools, or certifications
- Disclosure requirements
- Restricted Substances Lists/chemical restrictions
- Chemical Testing Programs
- Incentives – preferable purchasing, etc.
- Curriculum/Educational Standards (ACS/ ABET)

Government Policy at Multiple Levels

- International (ratified into national policy)
  - Conventions – POPs, Montreal Protocol
  - Regional - Conventions, agreements between nations
- National (including economic regions – EU)
- State
- Local
- The complexity can be challenging in a global supply chain

Types of regulatory government policy options for chemicals

- Standards – pre-market/manufacture requirements, acceptable exposure levels, permits, performance standards
- Restrictions
- Assessment requirements
- Testing requirements
- Information disclosure – on toxicity, ingredients, emissions, planning

Federal laws regulating toxic chemicals

Chemical Type/Use	Law	Implementing Agency
Pharmaceuticals/Medical devices	Federal Food Drug and Cosmetics Act	Food and Drug Administration
Cosmetics	Federal Food Drug and Cosmetics Act	Food and Drug Administration
Food additive/food contact articles	Federal Food Drug and Cosmetics Act	Food and Drug Administration
Toys	Consumer Product Safety Improvement Act and Federal Hazardous Substances Act	Consumer Product Safety Commission
Other types of products and manufacturing processes	Toxic Substances Control Act	Environmental Protection Agency
Pesticides	Federal Fungicide Rodenticide and Insecticide Act and Food Quality Protection Act	Environmental Protection Agency
Nanomaterials	Depends	Depends
Workplace exposures	Occupational Safety and Health Act	Occupational Safety and Health Administration

Discretionary types of federal policies affecting chemical regulation & development

- Purchasing/procurement policy
- Support/recognition programs
- Economic policies – technical support, liability, financing, tax incentives, subsidies
- Guidance documents
- Loan/grant programs
- R&D/Research Support Programs
- Innovation Programs
- Education policy
- Affected by: Budget/Resource allocation

States and localities advancing broad chemicals policies

- States are often innovators in environmental policy
- Started with single chemical restrictions now moving towards broader, information and substitution based policies
- Leaders - ME, MI, CA, WA, MA, NY, MN, OR as well as local – San Francisco, Seattle, etc
- Over 1000 policies proposed or implemented in last 10 years- more likely.
- New green chemistry support programs – MI, OR, WA, MN
- Greater interstate collaboration

INTERSTATE CHEMICALS CLEARINGHOUSE

Passed and Pending State Chemicals Legislation

Back to intro page

Reset form

To select more than one item in each list, hold down the command key (Mac) or control key (Windows) while making your selections.

State

All
Alabama
Alaska
Arizona
Arkansas

Region

All
Arctic
Midwest
Northeast
Pacific

Status

All
Proposed
Enacted
Failed

Chemical

All
2-ethyl-1-hexanol
4-phenylecyclohexene
Alkylphenol
Arsenic
benzyl butyl phthalate (BBP)

Policy Category

All
Alternatives Assessment
Biomonitoring
Data Collection
Design for the Environment
Environmental Health Tracking and Surveillance Systems

Product Types

All
Brake Friction Materials
Children's Products
Cleaning Products
Clothing and Footwear
Cosmetics

Year

All
2014
2013
2012
2011
2010

Search Entire Database

Enter words or phrases, separated by commas.

SEARCH

http://www.theic2.org/chemical-policy

Schifano, et al, 2009: http://www.chemicalspolicy.org/downloads/StateLeadership.pdf

So…Do these policies actually work?

- Evidence that well designed policies can stimulate innovation in safer chemistry and toxics reduction
- Greater attention to chemical toxicity in the design phase and safer substitutes but green chemistry is far from being “mainstreamed”
- Policy implementation and analysis are key to understanding why certain policies or types might succeed or fail

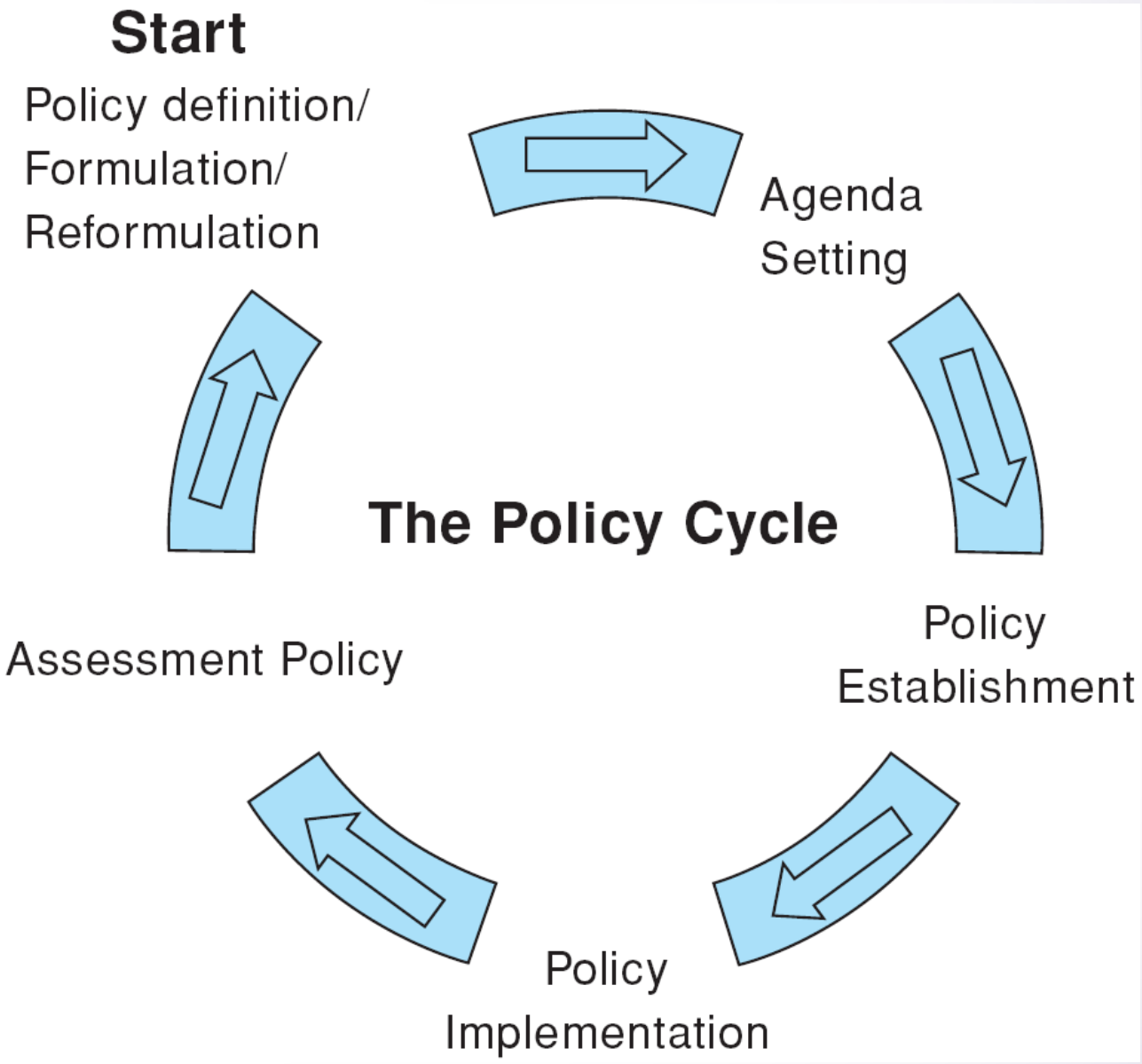

Start
Policy definition/
Formulation/
Reformulation
Agenda
Setting
Policy
Establishment
Policy
Implementation
Assessment Policy
The Policy Cycle

Figure 1-1
Participants in the Policy Process

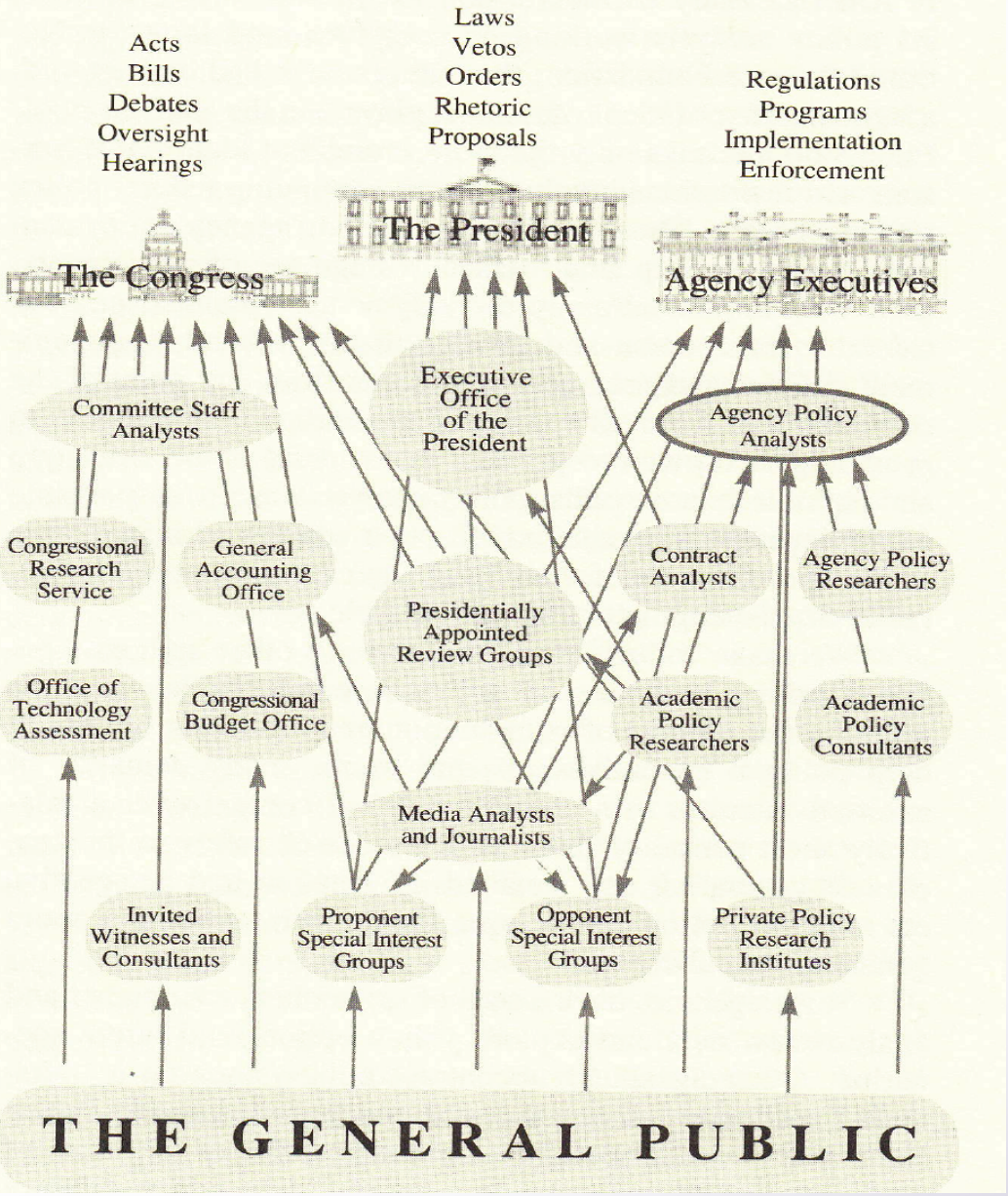
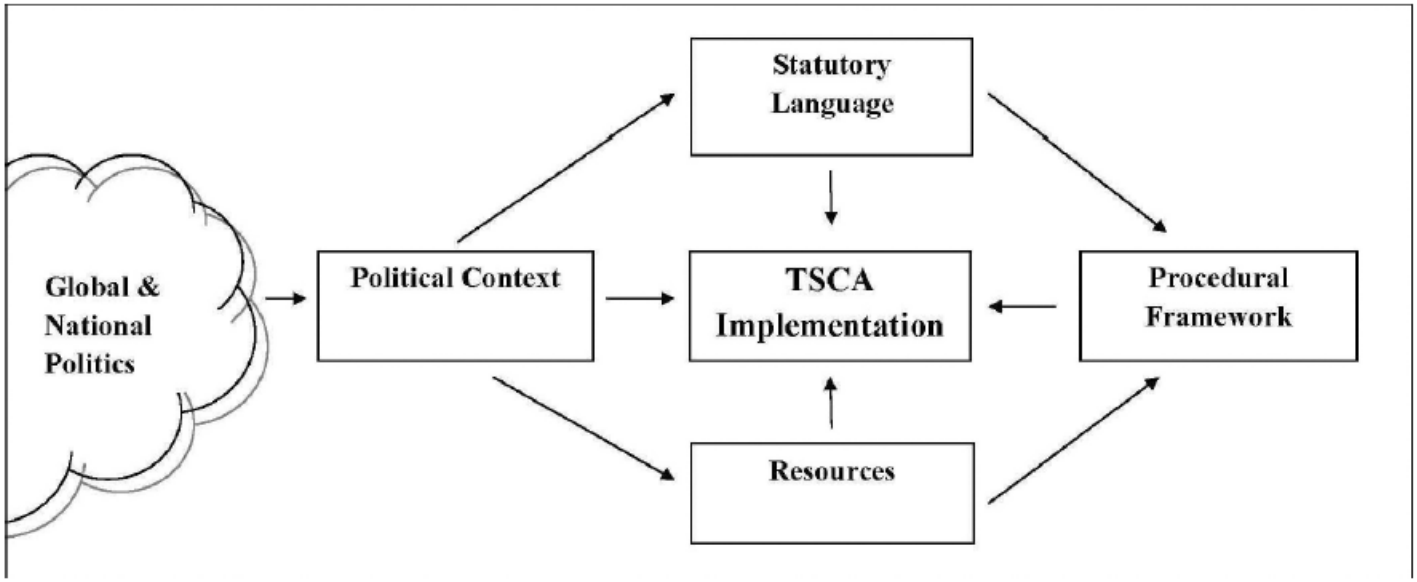


Figure 1: Factors Shaping the Implementation of TSCA



Schifano, Geiser, and Tickner. The Importance of Implementation in Rethinking Chemicals Management Policies: The Toxic Substances Control Act. 41 Environmental Law Reporter 10528, 2011 http://chemicalspolicy.org/downloads/ELRArticleonTSCAImplementation.pdf

Designing Policies to Support Green Chemistry Innovation

- Core Elements
  - Willingness
    - Restrictions, information requirements, planning requirements, purchasing policies, recognition
  - Capacity
    - Technical assistance, information requirements, R&D support, Education
  - Opportunity
    - Education, tax incentives, grants

- *Ashford, Nicholas. 1999. An innovation-based strategy for a sustainable environment. In Innovation-Oriented Environmental Regulation: Theoretical Approach and Empirical Analysis. Potsdam, Germany: European Commission Joint Research Centre.*

Example – Toxics Use Reduction in MA

- Goals and definitions
- Requirement to characterize and report on chemical use (metrics)
- Requirement to conduct planning and evaluate alternatives
- Fees that fund technical, research, and education support, demonstration and partnerships

States can support green chemistry and design for environment through:

Information development and dissemination

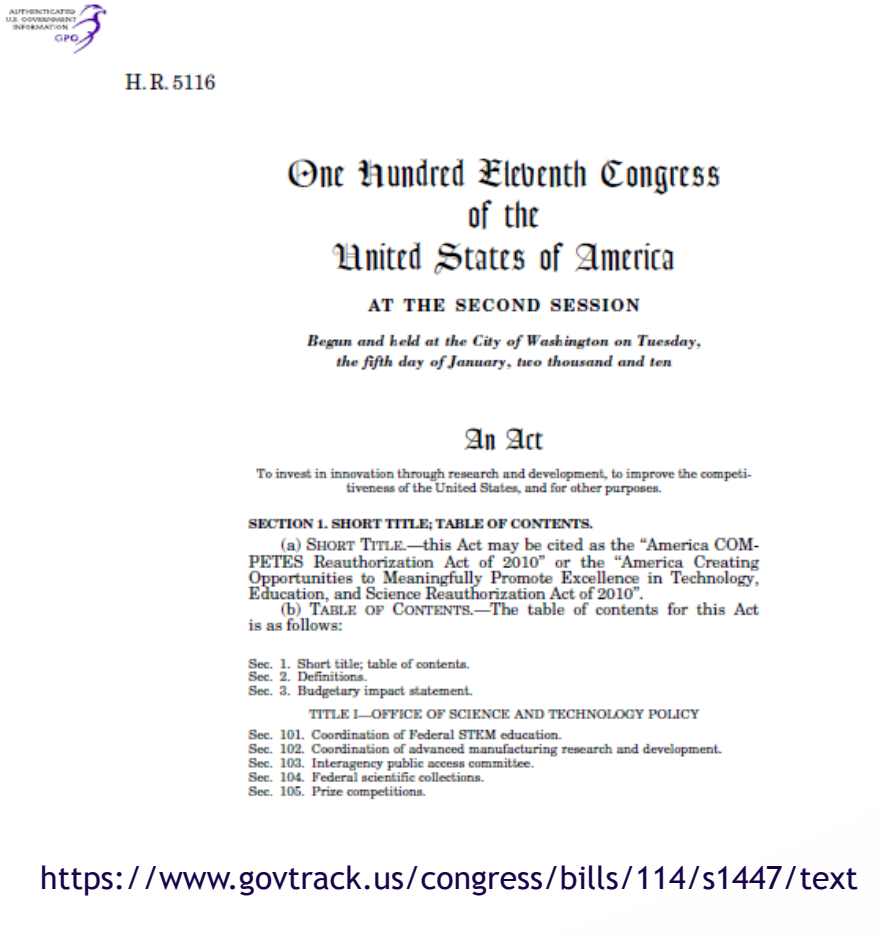
Economic Incentives

Recognition Programs

Regulation and Policy Tools

Federal Green Chemistry R&D Policies

http://www.nsf.gov/statistics/about/BILLS-111hr5116enr.pdf



H. R. 5116

One Hundred Eleventh Congress
of the
United States of America

AT THE SECOND SESSION

Begun and held at the City of Washington on Tuesday, the fifth day of January, two thousand and ten

An Act

To invest in innovation through research and development, to improve the competitiveness of the United States, and for other purposes.

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—this Act may be cited as the "America COMPETES Reauthorization Act of 2010" or the "America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Reauthorization Act of 2010".

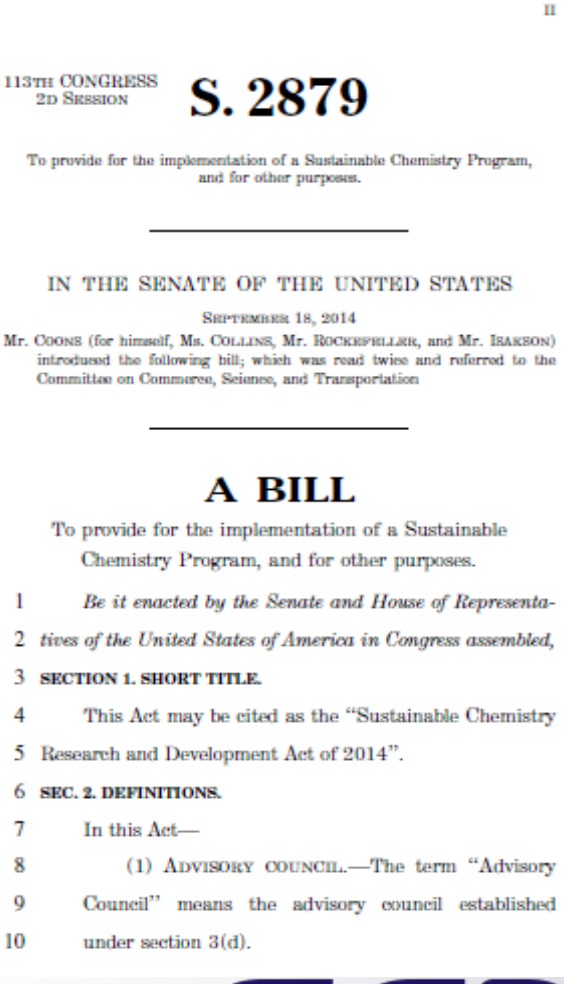
(b) TABLE OF CONTENTS.—The table of contents for this Act is as follows:

Sec. 1. Short title; table of contents.
Sec. 2. Definitions.
Sec. 3. Budgetary impact statement.

TITLE I—OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Sec. 101. Coordination of Federal STEM education.
Sec. 102. Coordination of advanced manufacturing research and development.
Sec. 103. Interagency public access committee.
Sec. 104. Federal scientific collections.
Sec. 105. Prize competitions.

https://www.govtrack.us/congress/bills/114/s1447/text



II

113TH CONGRESS
2D SESSION

S. 2879

To provide for the implementation of a Sustainable Chemistry Program, and for other purposes.

IN THE SENATE OF THE UNITED STATES

SEPTEMBER 18, 2014

Mr. COONS (for himself, Ms. COLLINS, Mr. ROCKEFELLER, and Mr. ISAKSON) introduced the following bill; which was read twice and referred to the Committee on Commerce, Science, and Transportation

A BILL

To provide for the implementation of a Sustainable Chemistry Program, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Sustainable Chemistry Research and Development Act of 2014".

SEC. 2. DEFINITIONS.

In this Act—

(1) ADVISORY COUNCIL.—The term "Advisory Council" means the advisory council established under section 3(d).

Sustainable Chemistry R&D Act - Core Elements - Interagency Sustainable Chemistry Program

- **Provides support for sustainable chemistry research, development, demonstration, technology transfer, commercialization, education, and training** through grants, partnerships, loans, prizes and interagency collaboration
- Examines **methods for federal government to create incentives for sustainable chemistry**, including funding.
- **Expands the education and training** of students and professionals
- **Collects and disseminates information on sustainable chemistry research, development, and technology transfer**
- Supports (including through technical assistance, participation, financial support, or other forms of support) **venues for outreach and dissemination of sustainable chemistry advances**
- **Develops metrics** to track the outputs and outcomes of the Program


Foster Collaboration
Inform the Marketplace
Support Smart Policies
An Agenda for Mainstreaming Green Chemistry
Track Progress
Understand the Marketplace
GC3
GREEN CHEMISTRY & COMMERCE COUNCIL

Thank You

For more information about the GC3:
www.greenchemistryandcommerce.org

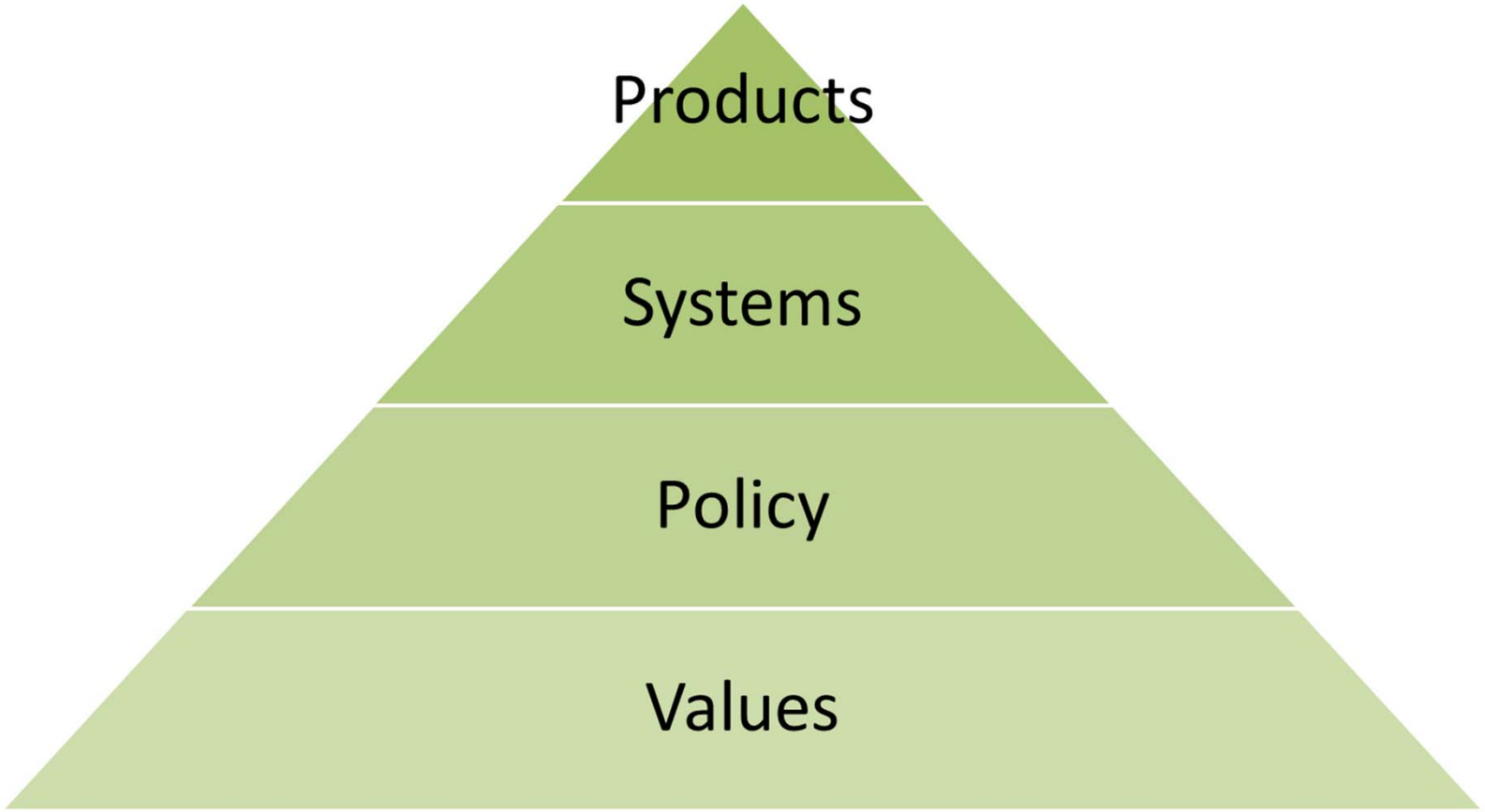
GC3 GREEN CHEMISTRY & COMMERCE COUNCIL
Business Mainstreaming Green Chemistry

Role of Policy in Advancing Green Chemistry Innovation

Robert J. Giraud
E. I. du Pont de Nemours and Company

GC3 Green Chemistry Education Webinar
June 16, 2015

Overview



Values

The Foundation of DuPont

DUPONT CORE VALUES

SAFETY & HEALTH

ENVIRONMENTAL STEWARDSHIP

RESPECT FOR PEOPLE

HIGHEST ETHICAL BEHAVIOR

Our Purpose

DuPont is a Science Company

We work collaboratively to find sustainable, innovative, market-driven solutions to solve some of the world's biggest challenges, making lives better, safer, and healthier for people everywhere.

Sustainability

Our mission is sustainable growth.

Sustainability is at the core of what we do – from reducing our operational footprint and creating market-facing sustainable solutions to addressing the global challenges of the future.

Our sustainability efforts create shareholder and societal value while reducing our environmental footprint along the value chains in which we operate.

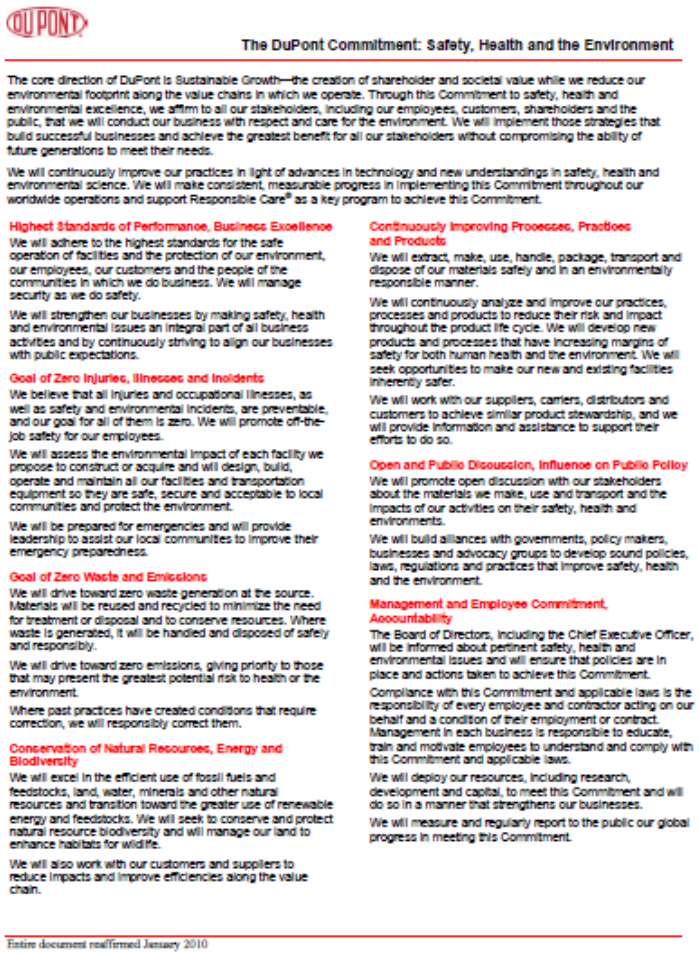
We are committed to inclusive innovation with suppliers, customers, governments, academic institutions and others.

http://www.dupont.com/corporate-functions/our-approach/sustainability/commitments.html
http://www.dupont.com/corporate-functions/our-approach/sustainability.html

Policy

Policy — set of principles that directs current and future business decisions and activities to carry out core values and behaviors held critical to the company.

The DuPont Commitment



The DuPont Commitment: Safety, Health and the Environment

The core direction of DuPont is Sustainable Growth—the creation of shareholder and societal value while we reduce our environmental footprint along the value chains in which we operate. Through this Commitment to safety, health and environmental excellence, we affirm to all our stakeholders, including our employees, customers, shareholders and the public, that we will conduct our business with respect and care for the environment. We will implement those strategies that build successful businesses and achieve the greatest benefit for all our stakeholders without compromising the ability of future generations to meet their needs.

We will continuously improve our practices in light of advances in technology and new understandings in safety, health and environmental science. We will make consistent, measurable progress in implementing this Commitment throughout our worldwide operations and support Responsible Care® as a key program to achieve this Commitment.

Highest Standards of Performance, Business Excellence

We will adhere to the highest standards for the safe operation of facilities and the protection of our environment, our employees, our customers and the people of the communities in which we do business. We will manage security as we do safety.

We will strengthen our businesses by making safety, health and environmental issues an integral part of all business activities and by continuously striving to align our businesses with public expectations.

Goal of Zero Injuries, Illnesses and Incidents

We believe that all injuries and occupational illnesses, as well as safety and environmental incidents, are preventable, and our goal for all of them is zero. We will promote off-the-job safety for our employees.

We will assess the environmental impact of each facility we propose to construct or acquire and will design, build, operate and maintain all our facilities and transportation equipment so they are safe, secure and acceptable to local communities and protect the environment.

We will be prepared for emergencies and will provide leadership to assist our local communities to improve their emergency preparedness.

Goal of Zero Waste and Emissions

We will drive toward zero waste generation at the source. Materials will be reused and recycled to minimize the need for treatment or disposal and to conserve resources. Where waste is generated, it will be handled and disposed of safely and responsibly.

We will drive toward zero emissions, giving priority to those that may present the greatest potential risk to health or the environment.

Where past practices have created conditions that require correction, we will responsibly correct them.

Conservation of Natural Resources, Energy and Biodiversity

We will excel in the efficient use of fossil fuels and feedstocks, land, water, minerals and other natural resources and transition toward the greater use of renewable energy and feedstocks. We will seek to conserve and protect natural resource biodiversity and will manage our land to enhance habitats for wildlife.

We will also work with our customers and suppliers to reduce impacts and improve efficiencies along the value chain.

Continuously Improving Processes, Practices and Products

We will extract, make, use, handle, package, transport and dispose of our materials safely and in an environmentally responsible manner.

We will continuously analyze and improve our practices, processes and products to reduce their risk and impact throughout the product life cycle. We will develop new products and processes that have increasing margins of safety for both human health and the environment. We will seek opportunities to make our new and existing facilities inherently safer.

We will work with our suppliers, carriers, distributors and customers to achieve similar product stewardship, and we will provide information and assistance to support their efforts to do so.

Open and Public Discussion, Influence on Public Policy

We will promote open discussion with our stakeholders about the materials we make, use and transport and the impacts of our activities on their safety, health and environments.

We will build alliances with governments, policy makers, businesses and advocacy groups to develop sound policies, laws, regulations and practices that improve safety, health and the environment.

Management and Employee Commitment, Accountability

The Board of Directors, including the Chief Executive Officer, will be informed about pertinent safety, health and environmental issues and will ensure that policies are in place and actions taken to achieve this Commitment.

Compliance with this Commitment and applicable laws is the responsibility of every employee and contractor acting on our behalf and a condition of their employment or contract. Management in each business is responsible to educate, train and motivate employees to understand and comply with this Commitment and applicable laws.

We will deploy our resources, including research, development and capital, to meet this Commitment and will do so in a manner that strengthens our businesses.

We will measure and regularly report to the public our global progress in meeting this Commitment.

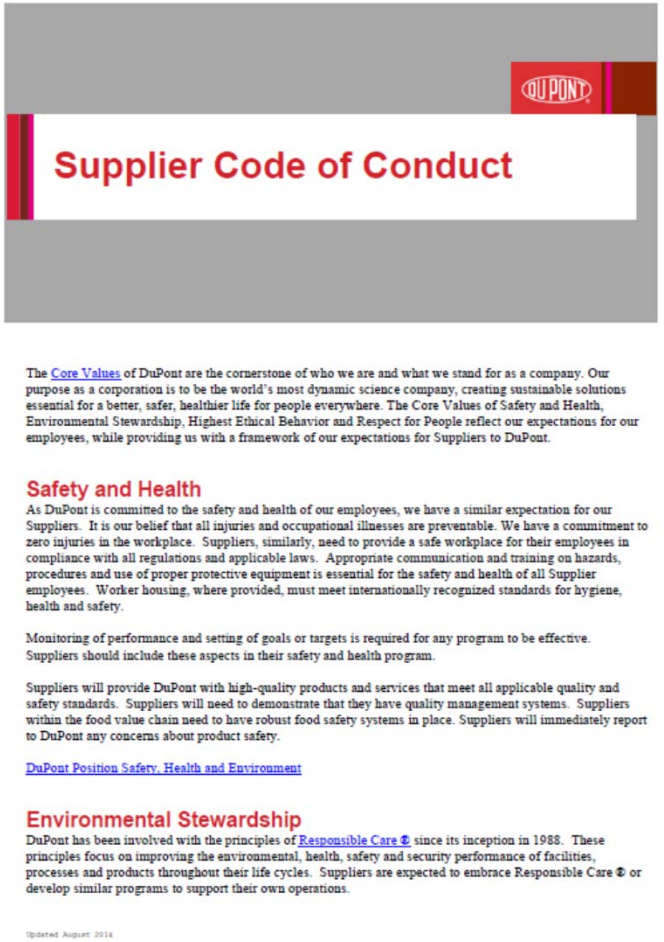
Entire document reaffirmed January 2010

* SHE Commitment originally issued in 1994.

- We will continuously analyze and improve our practices, processes and products to reduce their risk and impact throughout the product life cycle. We will develop new products and processes that have increasing margins of safety for both human health and the environment.
- Compliance with this Commitment and applicable laws is the responsibility of every employee and contractor acting on our behalf and a condition of their employment or contract.
- We will deploy our resources, including research, development and capital, to meet this Commitment and will do so in a manner that strengthens our businesses.

Supplier Code of Conduct

- Suppliers will provide DuPont with high-quality products and services that meet all applicable quality and safety standards. Suppliers will need to demonstrate that they have quality management systems.
- Suppliers will comply with all laws and regulations
- Suppliers will implement measures to protect any Trade Secrets provided during the course of our business transactions.
- Suppliers are expected to embrace Responsible Care® or develop similar programs to support their own operations.



Supplier Code of Conduct

The Core Values of DuPont are the cornerstone of who we are and what we stand for as a company. Our purpose as a corporation is to be the world's most dynamic science company, creating sustainable solutions essential for a better, safer, healthier life for people everywhere. The Core Values of Safety and Health, Environmental Stewardship, Highest Ethical Behavior and Respect for People reflect our expectations for our employees, while providing us with a framework of our expectations for Suppliers to DuPont.

Safety and Health

As DuPont is committed to the safety and health of our employees, we have a similar expectation for our Suppliers. It is our belief that all injuries and occupational illnesses are preventable. We have a commitment to zero injuries in the workplace. Suppliers, similarly, need to provide a safe workplace for their employees in compliance with all regulations and applicable laws. Appropriate communication and training on hazards, procedures and use of proper protective equipment is essential for the safety and health of all Supplier employees. Worker housing, where provided, must meet internationally recognized standards for hygiene, health and safety.

Monitoring of performance and setting of goals or targets is required for any program to be effective. Suppliers should include these aspects in their safety and health program.

Suppliers will provide DuPont with high-quality products and services that meet all applicable quality and safety standards. Suppliers will need to demonstrate that they have quality management systems. Suppliers within the food value chain need to have robust food safety systems in place. Suppliers will immediately report to DuPont any concerns about product safety.

DuPont Position Safety, Health and Environment

Environmental Stewardship

DuPont has been involved with the principles of Responsible Care ® since its inception in 1988. These principles focus on improving the environmental, health, safety and security performance of facilities, processes and products throughout their life cycles. Suppliers are expected to embrace Responsible Care ® or develop similar programs to support their own operations.

Updated August 2014

Responsible Care® Guiding Principles

- To lead our companies in ethical ways that increasingly benefit society, the economy and the environment.
- To design and develop products that can be manufactured, transported, used and disposed of or recycled safely.
- To work with customers, carriers, suppliers, distributors and contractors to foster the safe and secure use, transport and disposal of chemicals and provide hazard and risk information that can be accessed and applied in their operations and products.
- To design and operate our facilities in a safe, secure and environmentally sound manner.
- To instill a culture throughout all levels of our organizations to continually identify, reduce and manage process safety risks.
- To promote pollution prevention, minimization of waste and conservation of energy and other critical resources at every stage of the life cycle of our products.

- To cooperate with governments at all levels and organizations in the development of effective and efficient safety, health, environmental and security laws, regulations and standards.
- To support education and research on the health, safety, environmental effects and security of our products and processes.
- To communicate product, service and process risks to our stakeholders and listen to and consider their perspectives.
- To make continual progress towards our goal of no accidents, injuries or harm to human health and the environment from our products and operations and openly report our health, safety, environmental and security performance.
- To seek continual improvement in our integrated Responsible Care Management System® to address environmental, health, safety and security performance.
- To promote Responsible Care® by encouraging and assisting others to adhere to these Guiding Principles.

Responsible Care® Product Safety Code

Core Elements

Undertake scientific analyses of their products, and take steps so that they can be used safely.

Enhance cooperation and communications along the chemical value chain, so chemical producers and those who use, handle or sell chemicals work together to improve awareness of risk and manage chemical safety along the value chain.

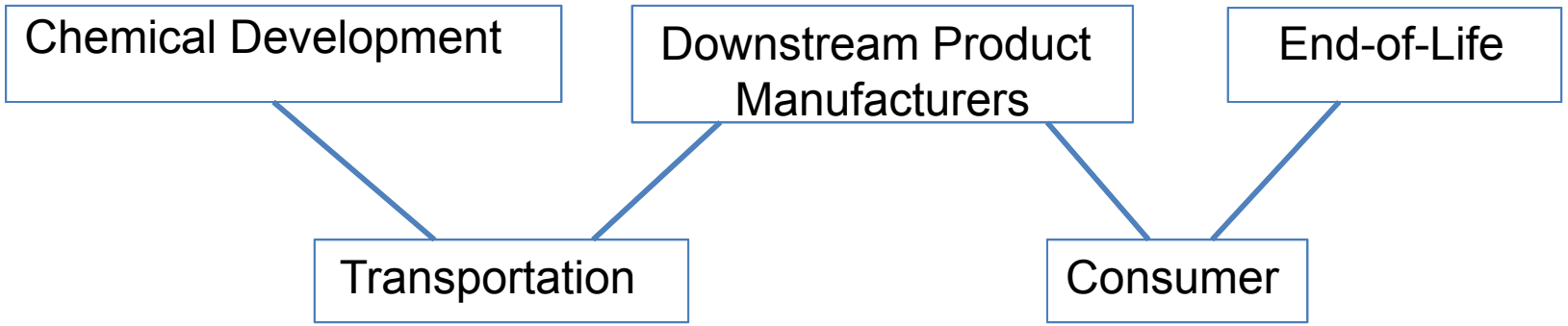
Consider impacts on public health and the environment as products are developed and improved.

Conduct risk characterization of their products based on their hazards, uses and exposures, considering new research and contact with children.

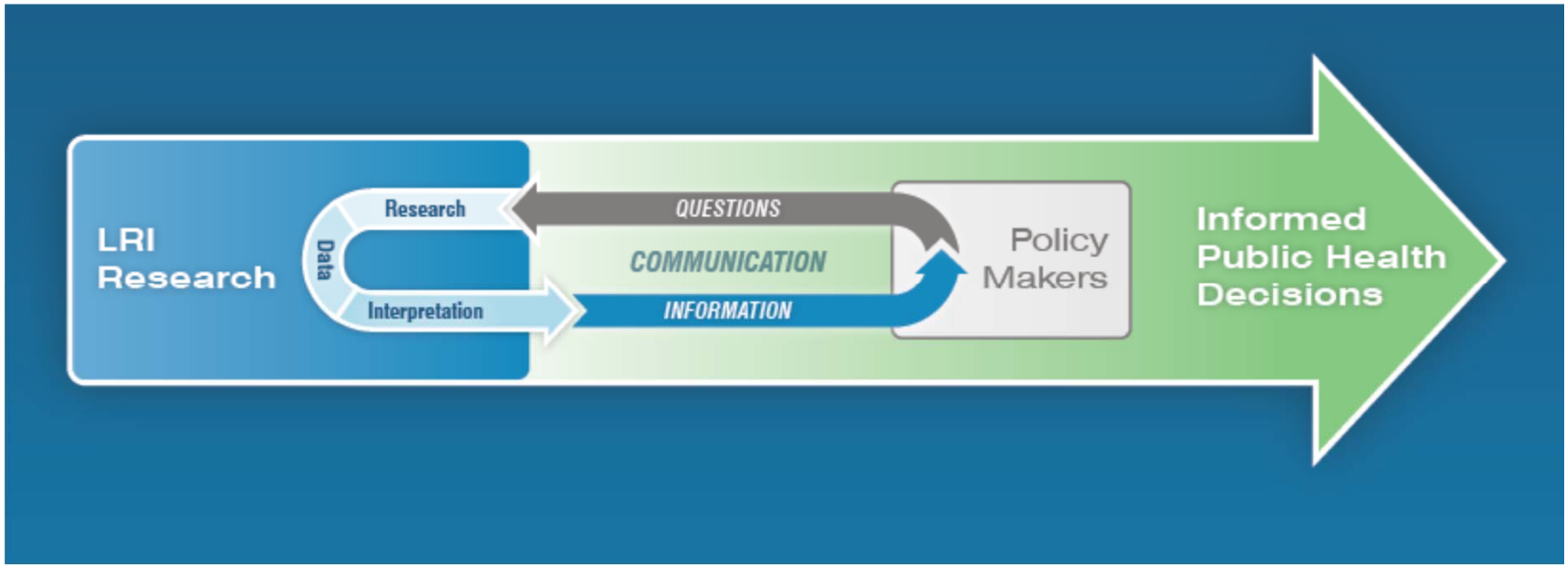
Provide public access to product safety and stewardship information.

Establish senior company leadership's commitment to a visible culture of product safety and accountability.

Across the Value Chain



Sound Science Informs Public Policy



Long-Range Research Initiative. *Global Research Strategy – 21st Century Approaches to Risk Sciences*

Public Policy: Montreal Protocol

Most successful multilateral environmental agreement in history because

- Grounded in sound science
- Aligned the goals of governments, industry, NGOs
- Developed innovative regulatory structure:
  - Combined flexibility with regulatory certainty, enabling governments to adapt to their own circumstances
  - Recognized HCFCs as interim solutions, providing confidence in the market for environmentally superior products
- Made special provisions for developing countries

Linda J. Fisher, 2012. "Fresh Challenges for a Proven Protocol" in OzonAction: Protecting our atmosphere for generations to come – 25 years of the Montreal Protocol", United Nations Environment Programme

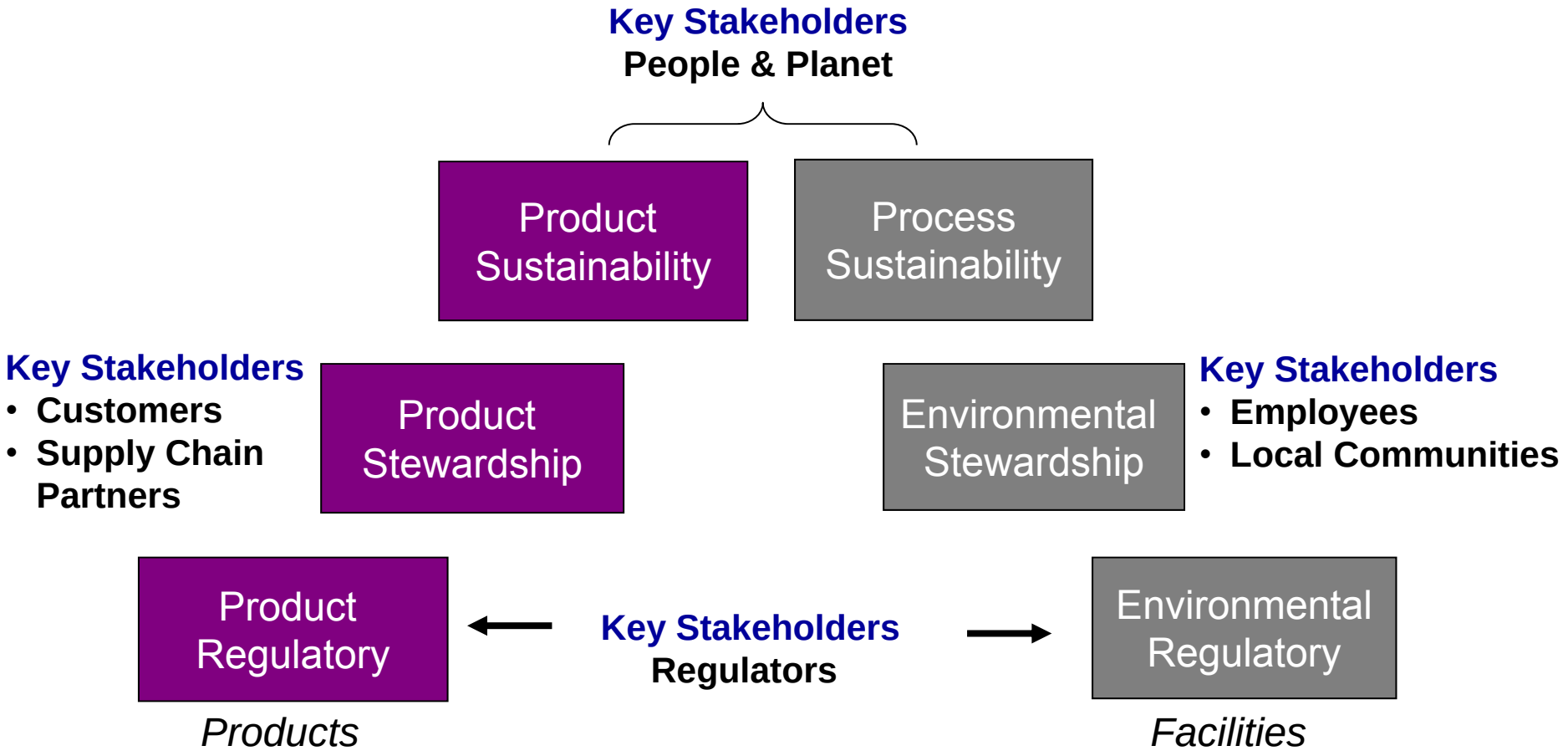
Public Policy: EU MAC Directive

European Commission (EC) HFC Regulations

- Predictable regulatory scheme with realistic timeline
- The 2006 European Directive on mobile air-conditioning systems (MACs) aims at reducing emissions of greenhouse gases which contribute to global warming.
- EC MAC Directive allows only refrigerants with a GWP less than 150 in “new type” vehicle models sold in EU countries beginning January 1, 2011 and in all new vehicles in 2017.

Systems

Sustainable Growth is built on strong stewardship



Product Stewardship Along the Value Chain

Defined as the shared responsibility for the identification, management, and communication of product health, safety, and environmental information and issues along the entire value chain in a way that adds value and meets customer, market, societal, and stakeholder expectations throughout the product life cycle, in support of our companies' right to operate, innovate and compete.

Product Stewardship and Regulatory Affairs Council
See https://www.conference-board.org/councils/councildetail.cfm?councilid=302

Product Stewardship Management System

Life cycle stages in which health & safety impact of products are assessed for improvement

	yes	no
Development of product concept	✓	
R & D	✓	
Certification	✓	
Manufacturing and production	✓	
Marketing and promotion	✓	
Storage distribution and supply	✓	
Use and service	✓	
Disposal, reuse, or recycling	✓	

http://www.dupont.com/content/dam/assets/corporate-functions/our-approach/sustainability/documents/DuPont2014GRIReport.pdf

Collaboration with customers & supply chain partners

DuPont Research

DuPont Innovation Centers

- Japan
- Thailand
- Taiwan
- India
- Mexico
- Brazil
- Russia
- USA
- Turkey
- Korea
- Switzerland

Markets, Customers and Partners

New Products	New Businesses	Product Improvements	Application Developments	Process Improvements

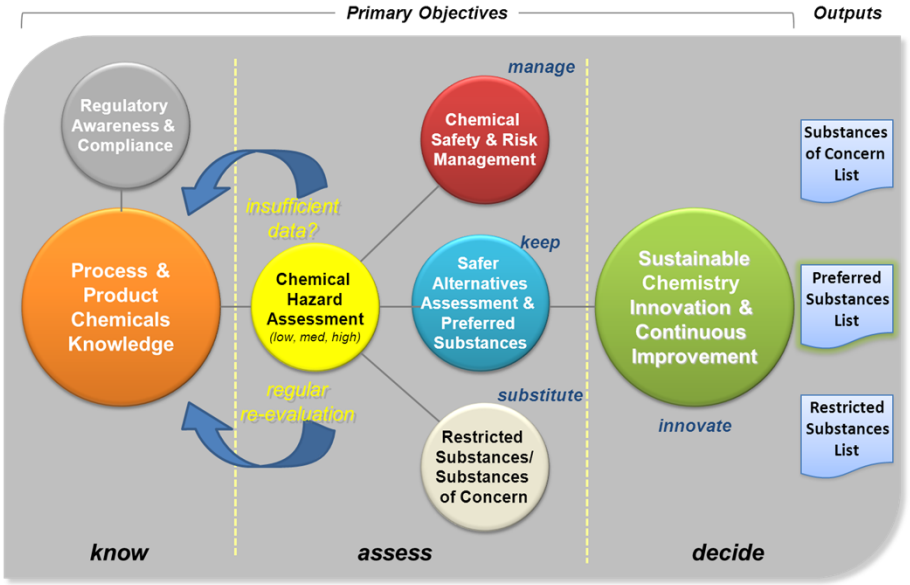
Chemicals Management Module

The outdoor industry (suppliers, global brands and retailers) are developing supply chain facing tools to understand and assess the life-cycle environmental impacts for apparel, footwear and equipment.

- **Chemical management is a key focus area**
- Framework
  - Comprehensive, tiered strategy
  - Roadmap for integrated chemicals management into your business

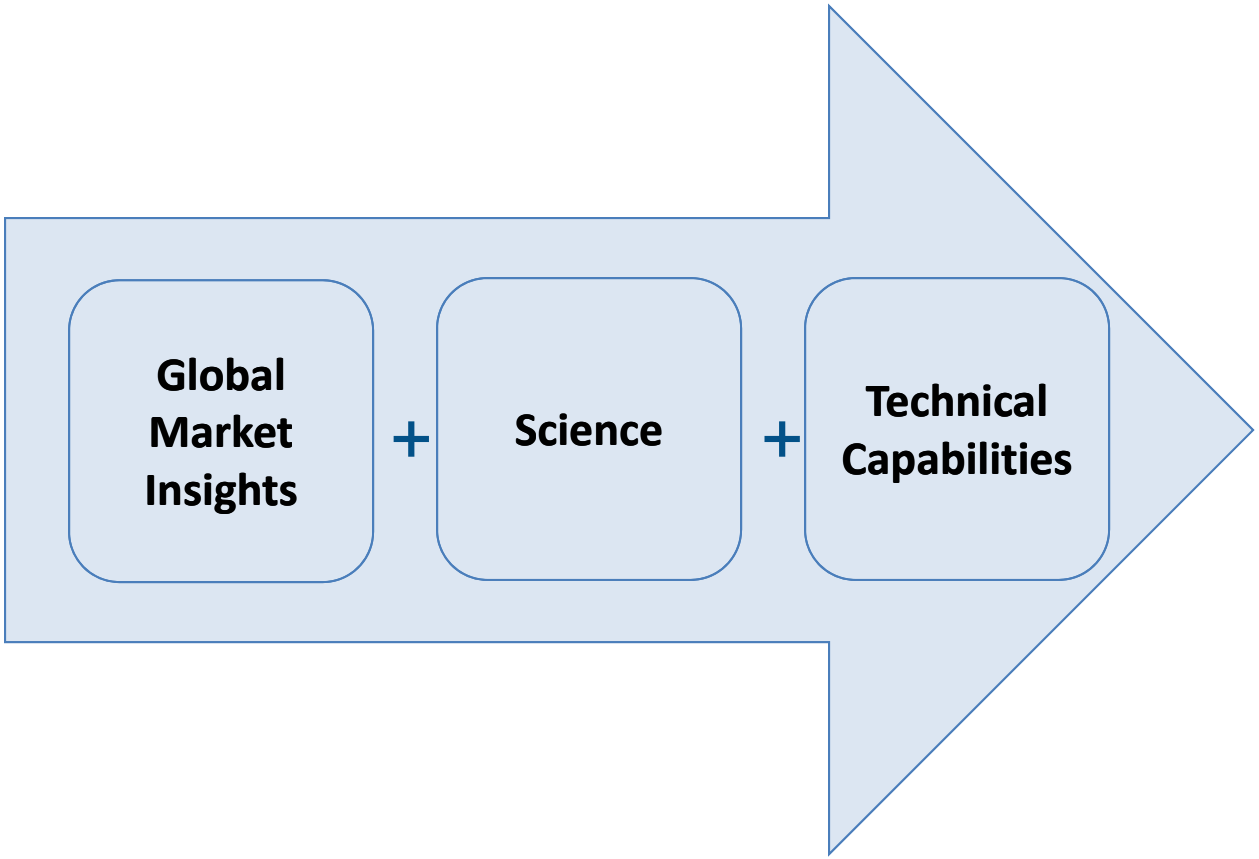
Success requires collaboration along the entire supply chain – a systematic approach

The goal of the Chemicals Management Module is to identify and drive improvements within your organization and supply chain toward sustainable chemistry.



Chemical Supplier — Supplier — Brand — Retailer

DuPont Innovation Platform



Solutions

- Agriculture
- Electronics & Communications
- Industrial Biosciences
- Nutrition & Health
- Performance Materials
- Safety & Protection
- Performance Chemicals

DuPont 2015 Sustainability Goals*

Reducing Environmental Footprint

- **Greenhouse Gas Emissions**
- **Water Conservation**
- **Fleet Fuel Efficiency**
- **Air Carcinogens**
- **Independent Verification of Site Programs**

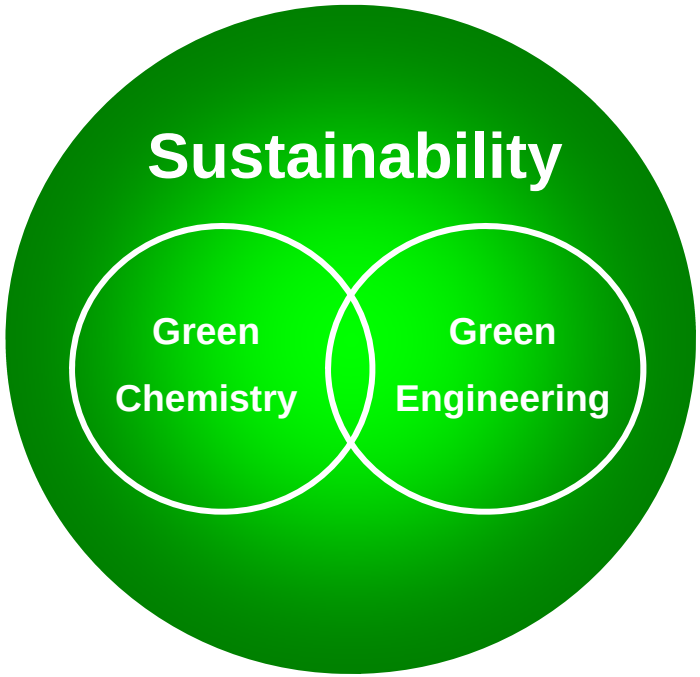
Serving the Marketplace

- **Environmentally Smart Market Opportunities from R&D Efforts**
- **Products that Reduce Greenhouse Gas Emissions**
- **Revenues from Non-Depletable Resources**
- **Products that Protect People**

* 2015 Sustainability Goals were announced in October 2006.

Sustainability Trends

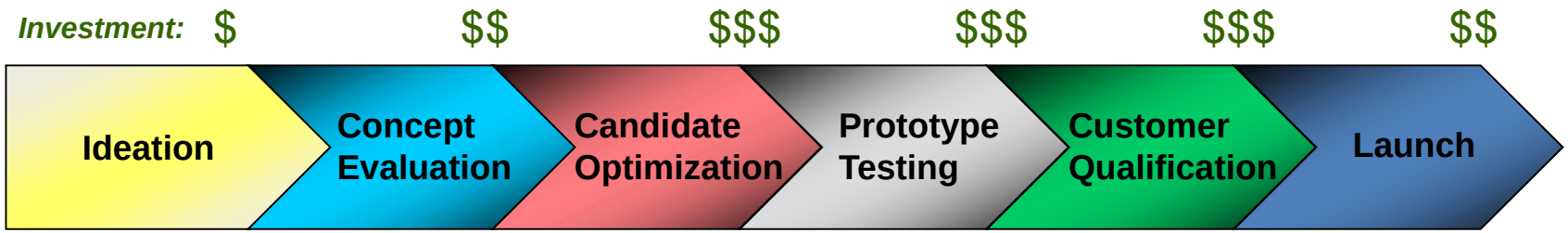
Green Chemistry at DuPont



- Green Chemistry utilizes a set of 12 design principles[1] that seeks to maximize efficiency and minimize health and environmental impacts throughout all stages of a chemical's life cycle.
- DuPont takes a holistic approach to putting the 12 principles of Green Chemistry into practice.
- DuPont is a leader in the industrial application of the 12 principles of Green Chemistry.

[1] Anastas, P.T. and Warner, J.C. *Green Chemistry: Theory and Practice.* Oxford University Press: New York, 1998.

Disciplined R&D Project Management



- Front End Loading: Generate as much knowledge as early as possible while options are still open
- 'Fail Fast / Succeed Early'
- Two-phases of R&D[1]
  1. Early → quickly eliminate poor candidates and absorb risk
  2. Late → increase probability of launch
- Disciplined, but flexible "Stage Gate" process with well defined advancement criteria

[1] Bonabeau, E.; Bodick, R. A More Rational Approach to New Product Development. *Harvard Business Review*, **March 2008**, 96-102.

Proactive product stewardship

Concept Phase: develop ideas and evaluate business merit and technical feasibility

- Determine whether this product is new or if it is significantly changing an existing product which would require you to initiate this product stewardship process.
- Get basic property, regulatory and public perception data about the chemicals.

Evaluation and Planning Phase: refine the product and its definition

- Determine global inventory listing status for product, raw materials, & support chemicals.
- Explore potential export control restrictions.
- Identify applications and end uses.
- Build a product stewardship review team.
- Explore gaps in toxicological or environmental fate data.

Candidates and Prototype Phase: develop process concept for larger scale production

- Screening co-products, intermediates, emissions and waste.
- Identify impacts on the environment.
- Consider sustainability of the product/process.

Demonstration Phase: define and demonstrate final process/products

- Develop permit strategy.
- Develop process safety guidelines.
- Finalize occupational health procedures.

Commercialization Phase: full scale operation and maintenance

- Conduct pre-launch formal product stewardship review.
- Establish frequency of future product stewardship reviews.

Products

Our Science Accelerates Discovery, Inventions & Growth

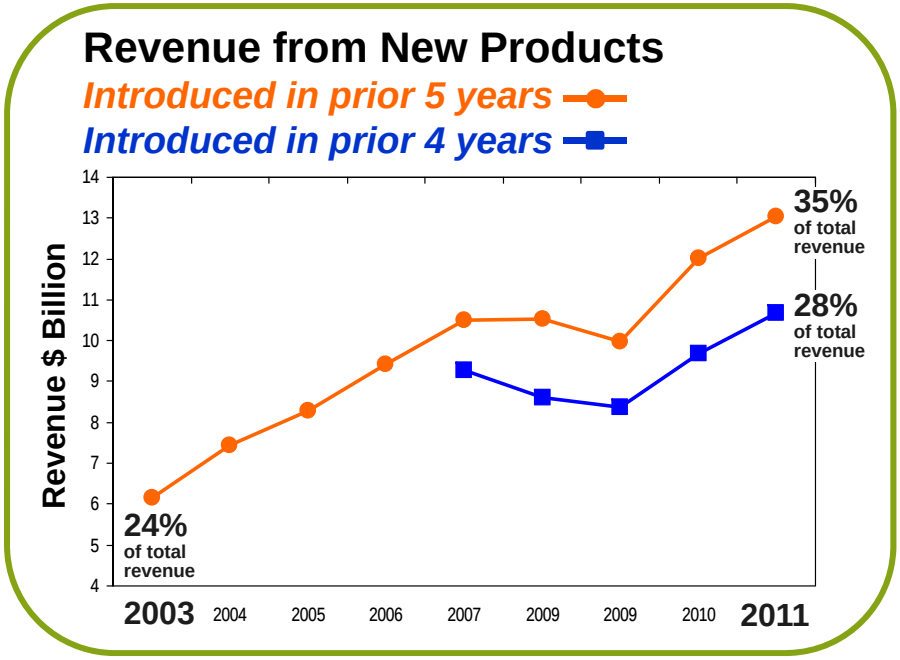
When DuPont science meets the demands of the global market, the result is innovation.

>10,000 SCIENTISTS AND ENGINEERS

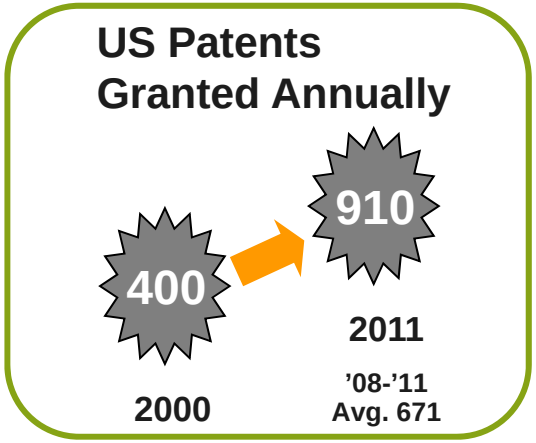
$2.2 BILLION SPENT ON RESEARCH & DEVELOPMENT IN 2013

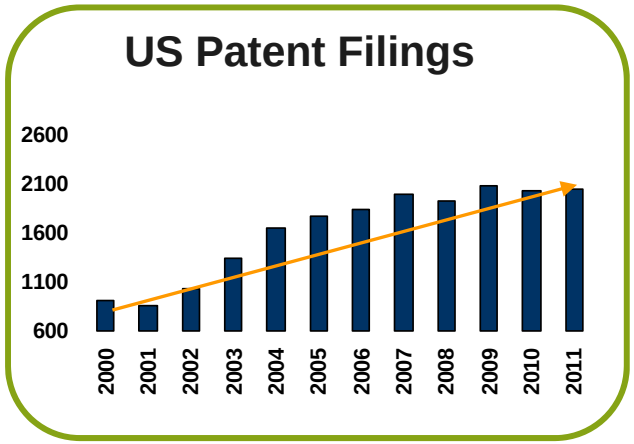
OVER 150 RESEARCH & DEVELOPMENT LOCATIONS WORLDWIDE

R&D Results



DuPont Record of Sustained Innovation

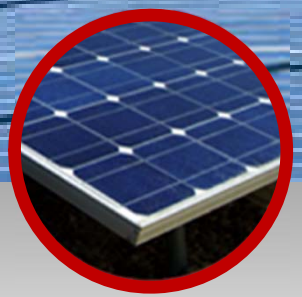




Over The Last Decades, We Introduced Game-Changing Innovations

Biobased Industrials – Bio-PDO®

- Sorona® is used in carpets, textiles, auto parts and packaging
- Zemea® has applications in cosmetics & personal care, as well as in other markets



Solamet® Photovoltaic metallization paste and Tedlar® films

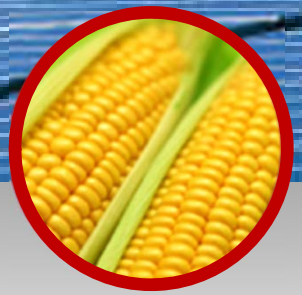
- New technology drives solar energy toward grid parity

Rynaxypyr® and Cyazypyr™ for Insect Control

- New class of blockbuster chemistry with minimal impact to non-target species, low environmental impact and lower use rates

Hytrel® RS and Zytel® RS

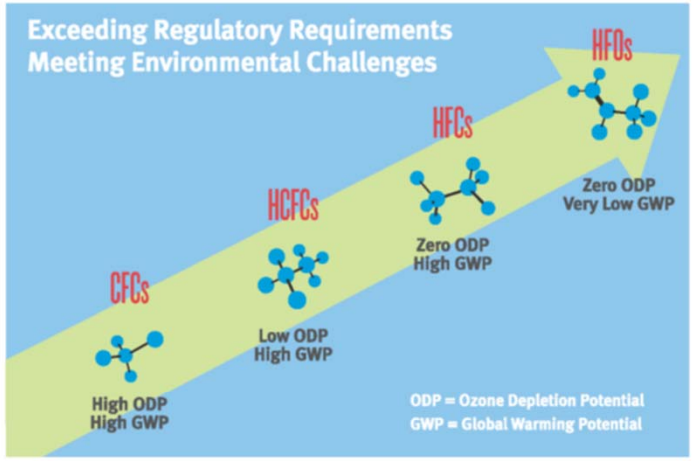
- BioBased polymers engineered to reduce use of fossil fuels without reducing performance

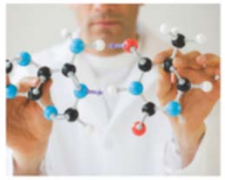


Optimum® AQUAmax® Hybrids / Optimum® AcreMax® insect protection technology

- Yield advantage in water-limited environments and improved productivity

DELIVERING INNOVATIVE SOLUTIONS FOR A CLEANER, SAFER PLANET





COLLABORATE

- Work with regulatory agencies
- Engage stakeholders across the value chain

INNOVATE

- Apply science to meet market challenges
- Develop proprietary new products

COMMERCIALIZE

- Create manufacturing and supply chain processes
- Deliver cost-effective solutions that meet customer and societal needs

OPTEON™ YF

OPTEON™ YF FOR MOBILE AC—COOLING CARS WITHOUT HEATING THE PLANET

REGULATORY COMPLIANCE

Meets EU Mobile Air Conditioning (MAC) Directive with GWP of 4

OPTIMAL BALANCE

Optimal balance of safety, environmental sustainability, performance and cost vs. other options

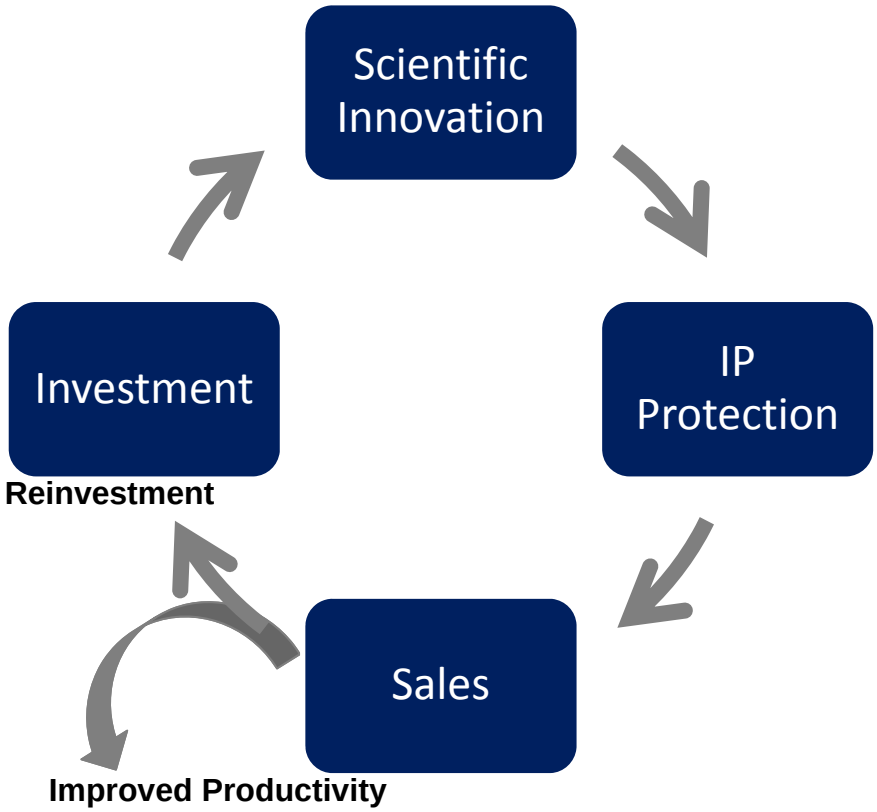
INTERCHANGEABLE

"Drop-in" replacement for current refrigerants

SAVES 600 MILLION GALLONS OF FUEL PER YEAR

Could save more than 600 million gallons of fuel annually

CBI protection is required to sustain innovation



- The ability to preserve legitimate CBI and prevent piracy of intellectual property is critical to competitiveness and innovation.
- There is active industrial espionage seeking to steal trade secrets that needs to be recognized – if we simply give innovation away, there is little reason to innovate.

Statement of Linda J. Fisher, DuPont, Before the Senate Committee on Environment and Public Works, March 9, 2010, Business Perspectives on Reforming U.S. Chemical Safety Laws

Development of Safer, More Sustainable Products Is Promoted by:

- Focus on meeting customer needs (inclusive innovation)
- Multidisciplinary, well integrated teams
- Holistic approach to reducing environmental footprint along the value chain
- Disciplined R&D project management that integrates Green Chemistry and Product Stewardship from the start
- Exposure-based tiered approach to hazard data collection
- Implementation of '21st Century' approaches to hazard identification and risk assessment

Ongoing Needs

Stable, predictable regulatory environment for products and processes

- Science-based approach to risk management: risk = f(hazard, exposure)
- Engagement of industrial innovators in the development of regulations
- Strong protection of confidential business information

Government support for development of transformational technologies

- Partnerships with academia and government labs on technology development
- Facilitation of pilot scale and demonstration facilities to overcome the issues of scale and incumbency for new technologies

Collaboration to assure improvement in research tools with better predictive capabilities, e.g.:

- Global regulatory acceptance of validated new *in vitro* assays
- Development of AOP library toward more mechanistically-based QSARs

Together, we can accomplish what no *one* can do alone.

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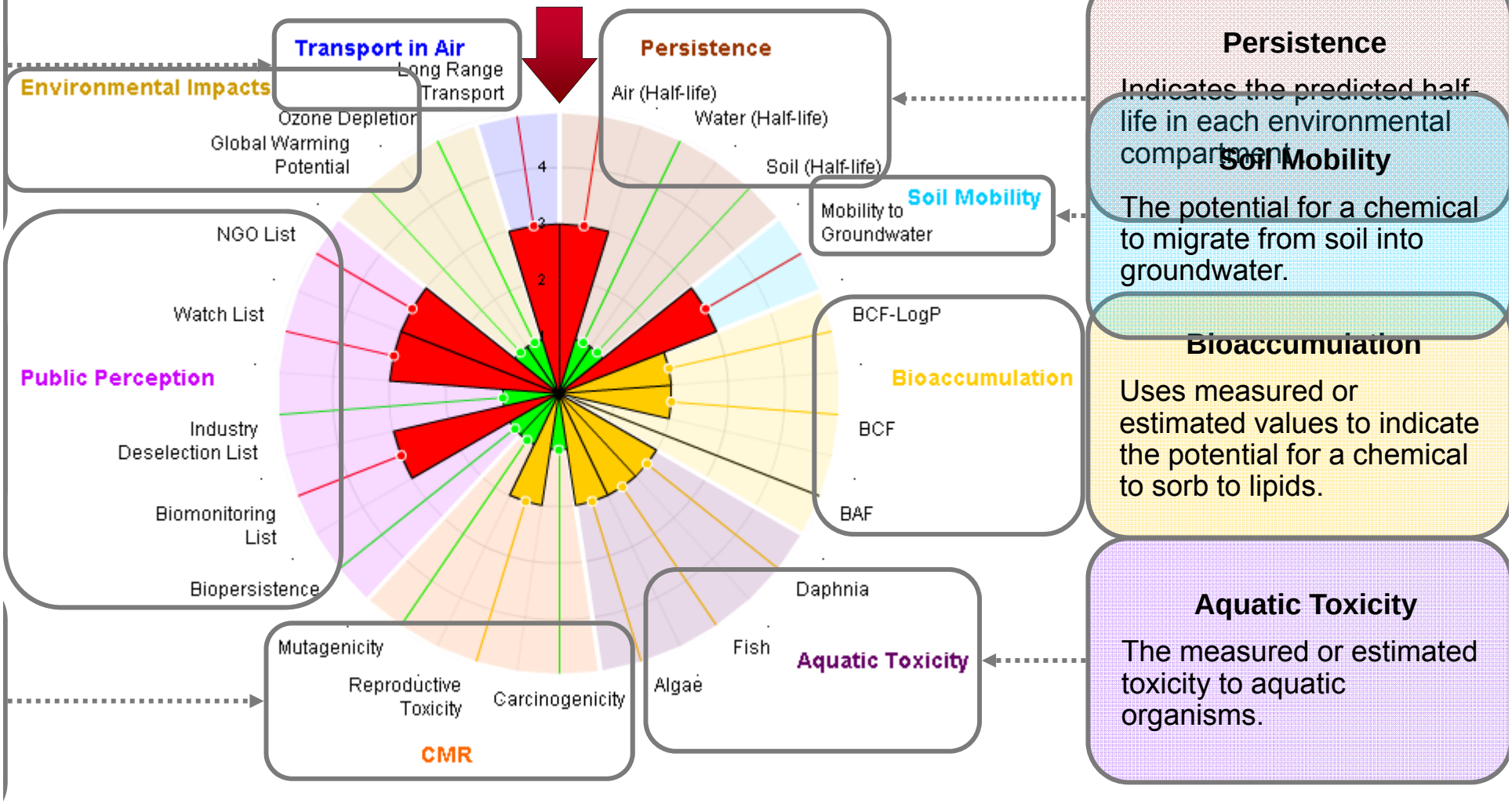
Mark Harmer
John Carberry
Paul Tebo

Back-up Slide

METIS Chemical Screening Visualization Tool (CSVT)

Potential for Concern
Indicated by Color: Green: Low; Orange: Moderate; Red: High/Very High
or
Indicated by Wedge Length: 1 = Low; 2 = Moderate; 3 = High; 4 = Very High



Persistence

Indicates the predicted half-life in each environmental compartment.

Soil Mobility

The potential for a chemical to migrate from soil into groundwater.

Bioaccumulation

Uses measured or estimated values to indicate the potential for a chemical to sorb to lipids.

Aquatic Toxicity

The measured or estimated toxicity to aquatic organisms.

Upcoming Events

The Clariant Portfolio Value Program System: How a Leading Specialty Chemical Company has Developed a Systematic Approach for Improving the Sustainability Performance of its Products

Wednesday, June 17, 2015 | 11:00 AM EDT

GC3 Green Chemistry Education Webinar Series: Introduction to Life Cycle & Alternatives Assessment

Thursday, June 18, 2015 | 2:00 PM EDT

Advancing Green Chemistry: Barriers to Adoption & Ways to Accelerate Green Chemistry in Supply Chains

Thursday, July 23, 2015 | 12:00 PM EDT

11th Annual GC3 Innovators Roundtable

May 24-26, 2016 | Burlington, VT

Thanks for joining us!

For more information about the GC3:
www.greenchemistryandcommerce.org

GC3 GREEN CHEMISTRY & COMMERCE COUNCIL
Business Mainstreaming Green Chemistry