Catalysing the Adoption of Green Chemistry – What Works

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By definition, Green Chemistry must have an impact beyond the R&D lab. The route to this impact usually means successful commercialization.
How do we accelerate the commercialization of Green Chemistry?
Perception vs Reality

All our knowledge has its origins in our perceptions.

Leonardo Da Vinci

Vincent van Gogh’s perception versus current reality.

John Brody Photography
There is a lot of diversity in the responses to this question. You can assume that the person sitting next to you has a different view – a different set of perceptions – about the best ways to advance Green Chemistry.
Does the introduction of Green Chemistry generally lead to a higher price for the customer?

Answered: 52  Skipped: 3
# Regulations

<table>
<thead>
<tr>
<th></th>
<th>Strong Negative Impact</th>
<th>Somewhat Negative Impact</th>
<th>No Impact</th>
<th>Somewhat Positive Impact</th>
<th>Strong Positive Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expedited Approvals based on Life Cycle Analysis</td>
<td>0% (0)</td>
<td>5.66% (3)</td>
<td>11.32% (6)</td>
<td>66.04% (35)</td>
<td>16.38% (9)</td>
</tr>
<tr>
<td>Transparent Reporting Requirements for Industry</td>
<td>3.92% (2)</td>
<td>9.80% (5)</td>
<td>11.76% (6)</td>
<td>47.06% (24)</td>
<td>27.45% (14)</td>
</tr>
<tr>
<td>Penalties/Taxes on Non-Sustainable technologies</td>
<td>7.69% (4)</td>
<td>15.38% (8)</td>
<td>21.15% (11)</td>
<td>30.77% (16)</td>
<td>25% (13)</td>
</tr>
<tr>
<td>Regulations and Standards that require significant innovation over a longer time frame</td>
<td>0% (0)</td>
<td>11.32% (6)</td>
<td>18.87% (10)</td>
<td>52.83% (28)</td>
<td>16.98% (9)</td>
</tr>
<tr>
<td>Regulations and Standards that require more incremental improvements over a short time frame</td>
<td>3.85% (2)</td>
<td>15.38% (8)</td>
<td>25% (13)</td>
<td>46.15% (24)</td>
<td>9.62% (5)</td>
</tr>
<tr>
<td>Regulations should only set a minimum standard</td>
<td>2% (1)</td>
<td>30% (15)</td>
<td>36% (18)</td>
<td>24% (12)</td>
<td>8% (4)</td>
</tr>
</tbody>
</table>
R&D Investments in Green Chemistry have greater Return on Investment (ROI) than standard investments.

Answered: 53   Skipped: 2
Which of the following Green Chemistry approaches has the greatest potential impact?

Answered: 50  Skipped: 5

<table>
<thead>
<tr>
<th>Answer Choices</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Green Chemistry approaches to make current processes more sustainable</td>
<td>64% 32</td>
</tr>
<tr>
<td>Using Green Chemistry to develop new products</td>
<td>36% 18</td>
</tr>
</tbody>
</table>

Total 50
Which of the following types of R&D investment has the greatest impact in accelerating the adoption of Green Chemistry?

Answered: 50   Skipped: 5

- University Research
- Industrial Research
- Government Research

Where is the majority of Green Chemistry R&D currently taking place?

Answered: 51   Skipped: 4

- Universities
- Small Businesses
- Large Companies
- Government
The Green Chemistry
Entrepreneurs/Intrapreneurs of the future will come from:

Answered: 50    Skipped: 5

- Teaching sustainability concepts to future business leaders: 20% (10 responses)
- Training and encouraging Green Chemists to understand business opportunities: 16% (8 responses)
- Encouraging more cross-disciplinary training in business/green chemistry/engineering: 64% (32 responses)

Total: 50
All types of research need to consider the negative impacts of the research itself. That's not to say that all research has to be applied green chemistry, but when doing any research, scientists need to be thinking about the impacts of their choices——solar fuels, Biofuels…Alternative fuels’’’…Energy is the key…… Explore and quantify long-term savings (especially for revisions/alternatives to current processes), as well as market potentials (especially for new products)……Multidisciplinary thinking…….INTERDISCIPLINARY Reserch in the Science-Technology-Environment-Society-Economy-Policy (STES) interfaces……..reduction of required resources in current standard manufacturing systems - Replacement of hazardous chemicals (general consensus required) by safer and lower impact alternatives - Move away from oil based chemistry….biomimicry… new enzymes, green industrial processes…. catalysts, safer solvents, non-covalent technologies….. education in sustainable molecular design…..cost competitiveness ……..More accurate tools to evaluate the environmental impact of a process or material. Efforts to generate toxicology data and other safety hazard parameters for many chemicals through predictive tools. This will be a major driver for green chemistry research…….Water based industrial processes, and recycling in every possible step………………CO2 as feedstock……..GC and competitiveness. Improvement of the life cycle analysis. improvement in testing and screening methods to decipher predictive binding affinities vis a vis observed ones.
VALUE CAPTURE
Sustainable Business Value = Environmental Performance + Economic Payback (TCO)

Ecolab partners with you to help optimize your performance with proactive service, solutions and expertise.

*eROI is a trademark of Nalco Company
PROJECT RENEWABLES
Revitalize Ecolab’s Hard Surface Cleaners

Customer Driver
- Perception that cleaning products are harsh and un-safe; desire “green” chemistry, but do not want to sacrifice efficacy.

Unique solution
- Products designed to maximize performance, while meeting broad sustainability guidelines.

Opportunity
- Growth in Facility Care segments (where third party certifications heavily influence decision)
- Retain core business (stay well ahead of “defending” environmental and/or human health impact)

Investment
- $52K from MPCA, exceeded matching requirements
PRODUCT PERFORMANCE
Sustainability Chemistry with Enhanced Performance

MORE EFFECTIVE CLEANING THAN THE LEADING COMPETITOR

PERFORMS 17% BETTER THAN COMPETITOR

Recent lab tests show Ecolab Acid Bathroom Cleaner cleans the toughest soils better than the leading competitor.
Arriving at Green Chemistry: A Case Study in Integrating Sustainability into a Construction Chemicals Company
Process Excellence: Operations Initiatives and Programs

• Continual improvement teams examining process time reductions in our facilities:
  
  • Ex: Reduction in cycle time by 40% for #1 volume (gallons) product
    • Reduced energy per unit
  • THIS IS LEAN!

• Solvent Use Reduction:
  • Reduced cleaning solvents 90%.
  • Solvent reuse reduces needs, limits emissions
Process Excellence: Product Development Initiatives

- Exploration and/or emphasis of new technology platforms

  - Water Catalyzed Urethanes:
    - Reduced needs for amines or organometallic complexes (ex: tins)
    - NOTE: 10 years old!

  - Hybrid Sealant Technologies:
    - Silane-terminated urethanes w/ potential for renewable based polyol backbones
    - Nearing performance life of silicone
    - Less energy in LC stages 1-3
    - Cost less
    - NOTE: 15 years old!

  - Aliphatic Urethanes:
    - Ideal tomorrow step… isocyanate free
    - NOTE: 10+ years!
Sustainable Chemistry

Increase the percentage of sales to 10% for products that are highly advantaged by sustainable chemistry.

We will publicly report on our progress by:

- Reporting our overall annual assessment of our sustainable chemistry index, and performance against our % of sales having sustainable chemistry advantages
- Presenting and/or publishing life cycle assessments that are validated independently by an external stakeholder, on existing or planned Dow products.
- Providing ongoing updates on promising areas of research and investments and collaborations that spur sustainable chemistry innovation.
- Promoting sustainable chemistry internationally through student prizes and Dow employee awards under The Dow Sustainability Innovation Challenge Award program.
Example 2: Concentrating Solar Power

Description

- DOWTHERM™ A heat transfer fluids collect, transport, and store solar heat energy to power electricity-generating turbines.

Sustainability Profile

- Dow supplies enough fluid globally to generate more than 700 MW of electricity from the sun
- Projects in Spain use more than 20,000 metric tons of DOWTHERM™ A heat transfer fluids
- Energy produced by 12 plants is enough to power 400,000 homes
- These plants prevent about nearly 1.5 million tons of carbon dioxide from releasing into the atmosphere, vs. traditional fuels
Clorox Green Works

- Clorox identified elements that consumers desire in the product/brand experience:
  - Dramatically reduce the use of harsh chemicals
  - No compromise on functional performance
  - No compromise on convenience or ease of use
  - Be priced right
  - Be readily available
  - Assure it comes from a credible/trustworthy source
- Initial success ($53M in 2008) followed by decline after recession ($32M in 2012)
  - Decrease of price premium in 2013
SC Johnson Concentrates

**Targets:**
- Ingredients that have same or better Greenlist™ environmental classification
- Concentrate lasts same number of cleaning occasions as standard
- Same performance as RTU product
- Decreased transport costs
- Significantly lower plastic content relative to standard trigger bottle
- Convenience of multiple cleaners in one dispenser
Lysol Power & Free
Line of Hydrogen Peroxide Cleaners

- **Targets**
  - **Safety Labeling**
    - Recognized safe, effective active ingredient
    - No residue – Water and oxygen as breakdown products
  - Lower carbon footprint
  - Maintain brand standards in cleaning and germ kill

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**2020 Our Net Revenue Goal**

By 2020, 1/3 of our net revenue will come from products that are significantly more sustainable than their predecessors and continue to deliver excellent product performance.

**Our Better Design Targets**

1. 100% of product innovations assessed by our Sustainable Innovation Calculator
2. 100% compliance with RB’s Global Ingredient Guidelines
3. 100% responsibly sourced natural raw materials
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