Sustainable U.S. Manufacturing in the Chemical and Allied Industries

Sustainable manufacturing – "the creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound." (U.S. Department of Commerce)

Chemical and Allied Products Are A Critical Pillar of U.S. Manufacturing

The Chemical and Allied industries represent a key component of continued U.S. economic development and prosperity — operating 20,000+ domestic establishments with $1.5 trillion in annual sales, a $79 billion payroll, and 1.3 million direct employees. They account for over 5% of U.S. sales and shipments and provided more than $44 billion in federal tax revenues in 2006. More important, the industries support countless indirect jobs that provide goods and services to their establishments, their employees and families. These Chemical and Allied industries stand at the heart of the transformation this country needs in terms of energy savings, carbon emissions, jobs, and energy security. The Chemical and Allied industries produce in part or in whole the new materials and technologies for energy-efficient and green applications like batteries, photovoltaics, and insulation.

Sustainable Manufacturing in the United States Must Achieve Two Goals

- It must allow society to meet energy, environmental, economic, employment, security, health, quality of life and cultural needs without compromising the ability of future generations to progress and meet their own needs.
- It must give industry the ability to expand and provide their employees, adjacent communities and other stakeholders with the benefits that incentivize these entities to support a healthy, prosperous industrial base.

Potential of Sustainable Manufacturing

The U. S. Chemical and Allied industries estimates that with a federal investment of $1.5 billion dollars over 5 years (~0.7% of the industry's federal taxes for that period) matched by $1.7 billion from the Chemical and Allied industries and government incentives for commercial adoption, these technologies will produce significant benefits. The annual energy savings from full commercial deployment would equal 43 dollars per federal dollar invested, and these savings would allow for the creation of almost 500,000 new jobs in these or other sectors over the next 15 years.[1]

Sustainable Technology Areas[2]	(millions)
Alternative Feedstocks	$380
Energy Efficiency	$280
Materials for Sust. Manufacturing	$150
Next Generation Manufacturing	$480
Waste Reduction	$140
Water Conservation	$100
Federal Investment	***$1,500***

Fully Commercialized Benefits

- A 65% reduction in fossil fuel use (equivalent to 130 days of U.S. oil imports)
- A change in energy and feedstocks supply to 34% renewable resources
- A reduction of 63% in GHG emissions
- Savings sufficient to create almost 500,000 new jobs over the next 15 years[1]
- Growth of our national productive capacity

The following identifies six areas of improvement in the current manufacturing industry and the expected benefits from federal investments and the efforts of the Chemical and Allied industries. Past research has shown that every dollar invested in RD&D produces two dollars of income over a six year period.[3]

Area 1: Alternative Feedstocks

Investments - $380M Federal & $160M Industry

The long-term sustainability of the Chemical and Allied industries rests on dramatically lowering their dependence on petroleum and natural gas feedstock to >63 million tons annually, accounting for ~70% of production costs. Transitioning to alternative, bio-based feedstocks is not simply a matter of switching raw materials. It requires developing new growing, harvesting, supply, and feedstock preparation infrastructure, new chemical pathways, and new chemical processing technologies. It will require large investments in new RD&D work, increases in postgraduate degrees and highly-skilled workers to yield the most sustainable benefits.

Area 2: Energy Efficiency

Investments - $280M Federal & $360M Industry

Many practical energy efficient technologies and practices currently exist, but have not achieved widespread implementation because of economics and/or perceived risks. Many processes lose low-quality heat to their surroundings. RD&D will change this by developing materials and systems that enhance and extend the economic operating range of existing energy-efficient equipment and can effectively recover and manage low-quality waste heat. RD&D will continue to combine software, sensors and controls into tools that more efficiently monitor, manage and optimize energy and material flows within the manufacturing process.

Area 3: Materials for Sustainable Manufacturing

Investments - $150M Federal & $220M Industry

The U.S. Chemical and Allied industries have multiple interests in the development of these materials because as large energy users, and major suppliers of both the raw and finished advanced materials, they would greatly benefit from the improvements these materials enable. Most important, the Chemical and Allied industries provide a willingness, scale, flexibility and talented workforce to assist in their development and production. Overcoming the physical limits of existing materials will require RD&D in primary and supporting materials and in innovative, low-cost manufacturing.

Area 4: Next Generation Chemical Manufacturing

Investments - $480M Federal & $640M Industry

Current industrial production methods have approached the practical performance limits of established, contemporary technologies. The development of new transformational, disruptive, and enabling technologies will enable the Chemical and Allied industries to step beyond incremental manufacturing improvements. Developments in the last 50 years, including microelectronics, computer controls, computational science, novel materials, genetic and biological engineering, advanced analytical methods and nano-science, provide the underlying research that remains vital to developing these transformational technologies.

Area 5: Waste Reduction and Recovery

Investments - $140M Federal & $170M Industry

Technologies and practices to reduce internal process wastes and downstream wastes result in improved productivity, energy efficiency and resource conservation while reducing environmental impacts and operating costs. Serious technical challenges exist for internal waste reduction and recovery, which only increase as we move from solids, to liquids, to gases. The Chemical and Allied industries already recover post-consumer paper, plastics and oils and know that recovered materials can require less energy to process than do raw materials. RD&D will provide technologies for greater levels of internal and downstream waste recovery and sustainability.

Area 6: Water Conservation, Recycling and Reuse

Investments - $100M Federal & $100M Industry

The Chemical and Allied industries withdraw over 10 billion gallons of water per day for process use, heating and cooling. To protect our nation's most important natural resource, sustainable manufacturing goals seek near-zero discharge (i.e., closed-loop systems) that offer the potential to greatly minimize water withdrawals, save energy and reduce environmental impacts. Process, heating and cooling water also serves as a potential source of low-quality heat. RD&D can optimize water consumption, improve cooling and heating water chemistry, recycle/reuse technologies, and develop systems to extract valuable low-quality energy currently lost in water discharges.

Nationwide Benefits[4]

Technology Area	*Sustainable replacement of:* Natural Gas		Petroleum		Electricity		Reduced Carbon Dioxide equivalent		Increased Tax Revenue	Added Jobs
	trillion Btu saved per year	equivalent to use in million households	million barrels of oil per year	equivalent days of all U.S. oil imports	MW saved	equivalent to use in million households	million metric tons per year removed	equivalent million vehicles removed	million dollars per year	job reinvestment potential[1]
Alternative Feedstocks	150	3.4	130	13	-	-	17	3.3	$ 2,100	70,000
Energy Efficiency	440	10	120	13	3,900	2.8	78	15	$ 3,300	110,000
Materials For Sustainability	320	7.4	24	2.4	5,300	3.7	65	13	$ 1,600	55,000
Next Generation Manufacturing	870	20	250	25	7,800	5.5	160	31	$ 6,600	220,000
Waste Reduction	170	4.0	49	5.0	1,600	1.1	31	6.1	$ 1,300	44,000
Water Conservation	34	0.78	1.5	0.15	570	0.41	6.9	1.3	$ 270	9,100
Totals	1,984	46	575	58	19,170	14	358	70	$ 15,170	508,100

[1] New jobs created via the reinvestment of money saved due to decreased energy costs (fuel and electricity).
[2] Investment needs and government/industrial cost split vary between research areas depending on the inherent risk and the amount of demonstration, pilot, and research work needed to mitigate those risks and achieve minimum commercial viability.
[3] *Measuring Up; Research & Development Counts for the Chemical Industry*, Council for Chemical research, Chemical Heritage Foundations, 2001
[4] More details on sources and methods used for these calculations are available in the related document: *Sustainable U.S. Manufacturing Vision 2.0.*

This Summary brief describes the six areas in need of technological advances to support sustainable growth in the Chemical and Allied industries.

The ACS Presidential Roundtable on Sustainable Manufacturing brings together industrial, government, academic, and scientific and engineering organizations to enable sustainable manufacturing in the chemical and allied products industries. The Roundtable will provide a consistent source of credible, sound information on the application of principles of sustainability to chemical manufacturing industry stakeholders in order to influence public policy, standard setting organizations, and third parties directly relevant to the chemical enterprise. These briefs originated from the 2009 Vision 2020 Workshop. For more information on these areas, and how focused investment can maintain the United States' position as the leader in global RD&D, visit: www.acs.org/smrt