

Sustainability Metrics in Chemical Manufacturing

**National Academies' Roundtable on Science and
Technology for Sustainability**

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Center for Energy
and
Environmental
Resources

Metrics in chemical manufacturing from a decade ago

- Metrics were primarily applied at a process level and included:
 - Raw materials used per pound of product
 - Energy used per pound of product
 - Greenhouse gas emissions per pound of product
 - Wastes per pound of product
 - Targeted pollutants per pound of product
- Benchmarking done for major commodity chemicals by U.S. Department of Energy

Metrics in Chemical Manufacturing

(Update from ACS GCI Chemical Manufacturer's Roundtable)

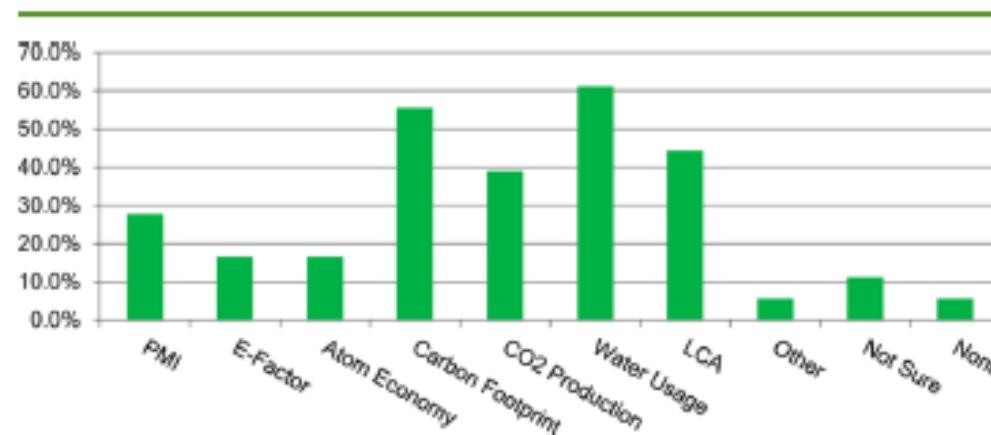


Feature

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Implementing Green Chemistry in Chemical Manufacturing: A Survey Report

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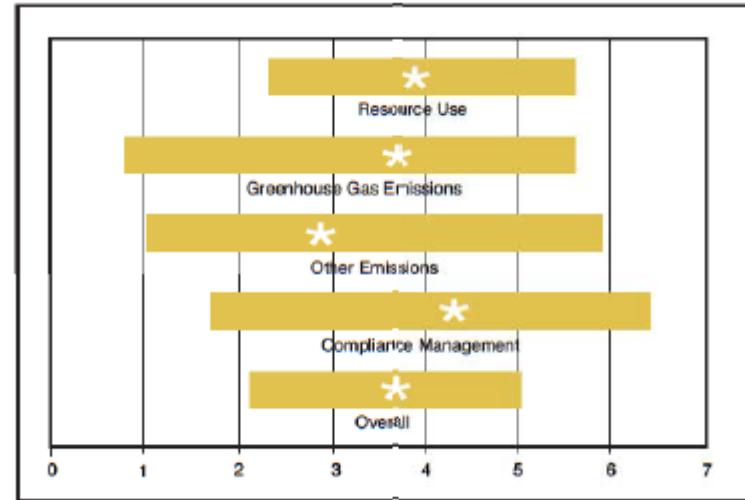


Another scale at which metrics are applied: Organizational (AIChE Institute for Sustainability Metrics Initiative)

Major metrics



Each major category has multiple components



Some company specific tools

- Dow Chemical Sustainability Footprint

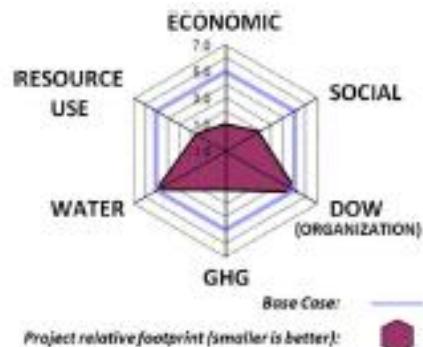


Figure 1. DCSFT evaluation of a longer-life building and construction system.



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Thinking about More Sustainable Products: Using an Efficient Tool for Sustainability Education, Innovation, and Project Management To Encourage Sustainability Thinking in a Multinational Corporation

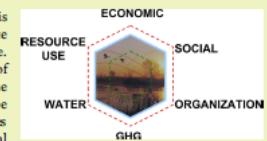
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ABSTRACT: Embedding the concept of sustainability into a company's culture is immensely challenging but is likely to be critical to the long-term viability of science and technology companies that rely on successful innovation to remain competitive. Moving to a more sustainable society can be expected to provide plenty of commercially attractive business opportunities for forward-thinking organizations. The combination of life cycle thinking with the enabling science of chemistry will be essential to successfully address world challenges such as the strain on resources caused by population growth and changing demographics. The Dow Chemical Company has been developing strategies and tools around holistic thinking for more than 20 years and has recently introduced a methodology to broaden sustainability knowledge and encourage life cycle thinking among innovators new to this topic while providing insight into the sustainability of new product development. A tool, the Dow Chemical Sustainability Footprint Tool, is described, using examples to illustrate the insights gained by project teams and business management. With more than 250 project assessments carried out so far, it is fair to say that sustainability knowledge among innovators is increasing, that the tool has met its design criteria such as being self-explanatory and easy and quick to use, and that it is providing business management with sustainability overviews of their project portfolios.

KEYWORDS: Sustainability, Sustainable, Education, Innovation, Project management, Footprint, Holistic thinking, Life cycle, Dow Chemical



Other scales at which metrics are applied

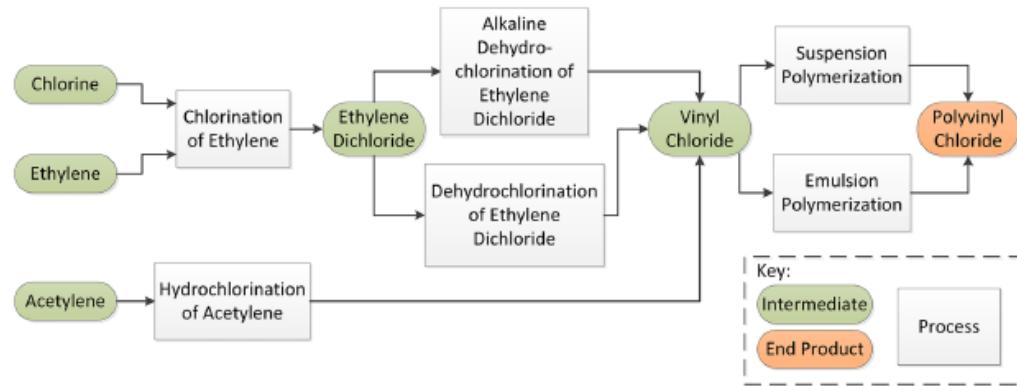
Molecular Scale

- Typically only information available is chemical structure and stoichiometry
- Analyses (e.g., those required under TSCA) typically focus on molecular persistence, bioaccumulation and toxicity

Process Scale

Mass, water, energy efficiency; total and targeted pollutants

System scale



Multiple combinations of processes can be used to transform raw materials to products; the optimal process within a network may not be the same as the optimal process for a single transformation

Metrics in Pharmaceutical Manufacturing (ACS GCI Pharmaceutical Roundtable)



Green Chemistry

PAPER

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Towards a holistic approach to metrics for the 21st century pharmaceutical industry†

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James H. Clark*

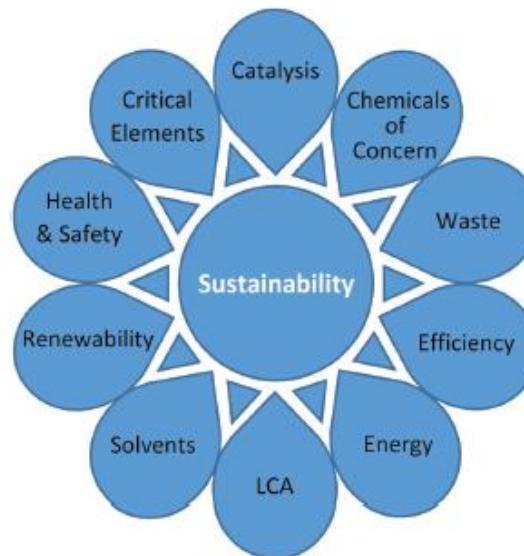


Fig. 1 Summary of the key parameters covered by the metrics toolkit.

Sustainability metrics in research

Should research articles addressing sustainability report quantitative metrics?



Launched by American Chemical Society in 2012

Scope is green chemistry, green engineering and the sustainability of the chemical enterprise

Anticipate publishing ~400 papers in 2015

First impact factor due this summer

To date, definition of sustainability has been qualitative and subjective

Intent of Editors is to encourage authors to use multiple metrics that consider life cycles

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