




# **Using the TRI to Assess Application of Green Chemistry Practices by the Pharmaceutical Industry in Achieving Sustainability**



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Washington, DC  
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# Sustainable Development: An Ongoing Priority

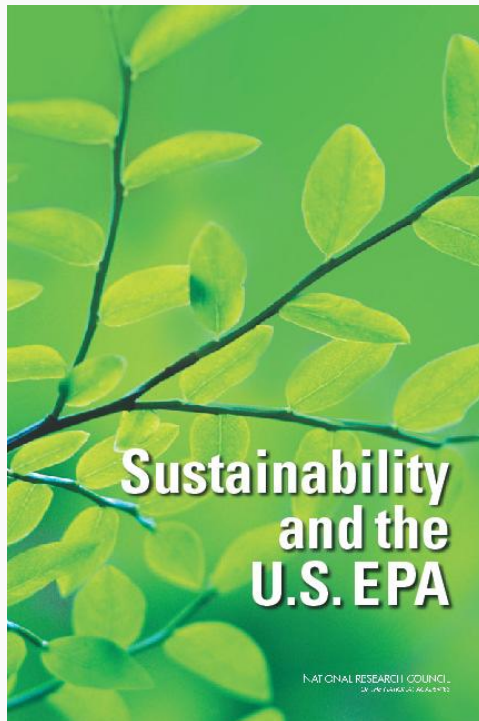
*“Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.”*

( From: C.G. Brundtland. “Our Common Future”. The World Commission on Environmental Development, Oxford Univ. Press, Oxford, 1987.)



# National Academy of Sciences

Sept. 2011: Report on EPA and Sustainability



- **4.1. Key Recommendation:**  
*“EPA should develop a “sustainability toolbox” that includes a suite of tools for use in the Sustainability Assessment and Management approach.”*



# Green Chemistry

- That sub-discipline in chemistry that strives to develop environmentally friendly chemical products through synthesis pathways that neither use or generate hazardous chemicals or wastes;
- Evolved in EPA/OPPT's Industrial Chemistry Branch in the early 1990s following passage of the Pollution Prevention Act (PPA) of 1990;
- The practice of Green Chemistry is a primary means of achieving sustainable development.



## Example: Commercial Synthesis of Acetophenone

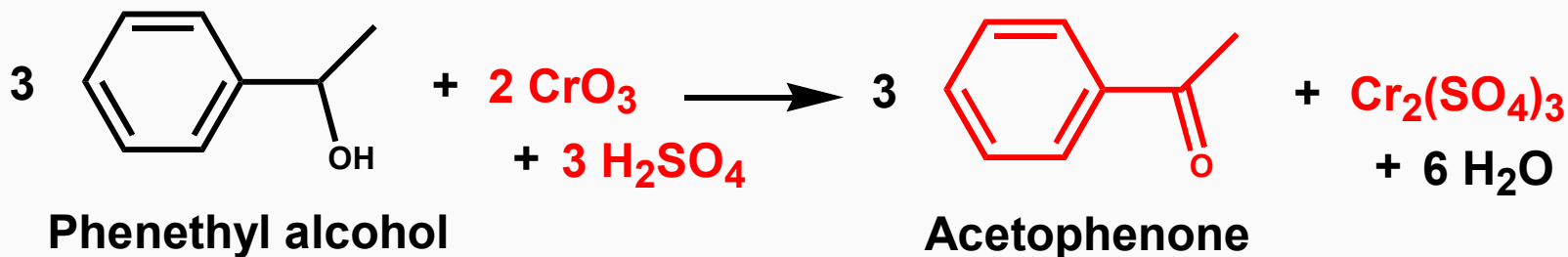
Time-Honored Synthesis of Acetophenone (a TRI chemical):



This synthesis:

## Example: Commercial Synthesis of Acetophenone

Time-Honored Synthesis of Acetophenone (a TRI chemical):

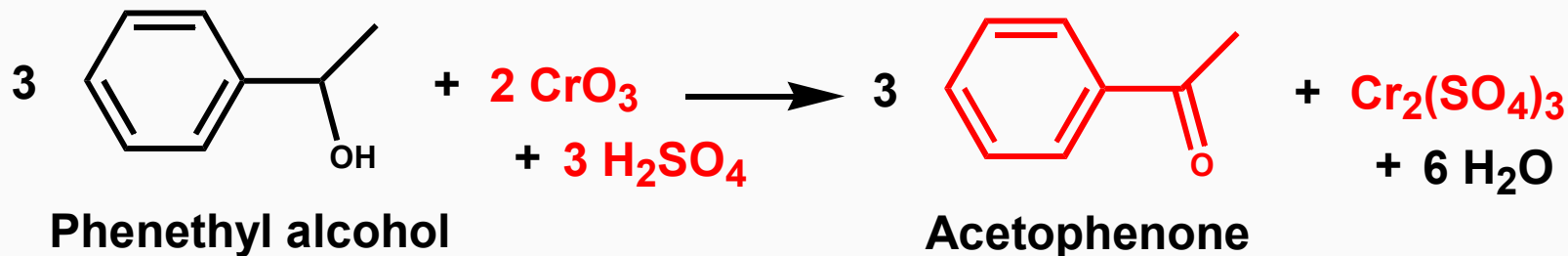


This synthesis:

- requires the use of two TRI chemicals (one of which is a known human carcinogen);

## Example: Commercial Synthesis of Acetophenone

Time-Honored Synthesis of Acetophenone (a TRI chemical):



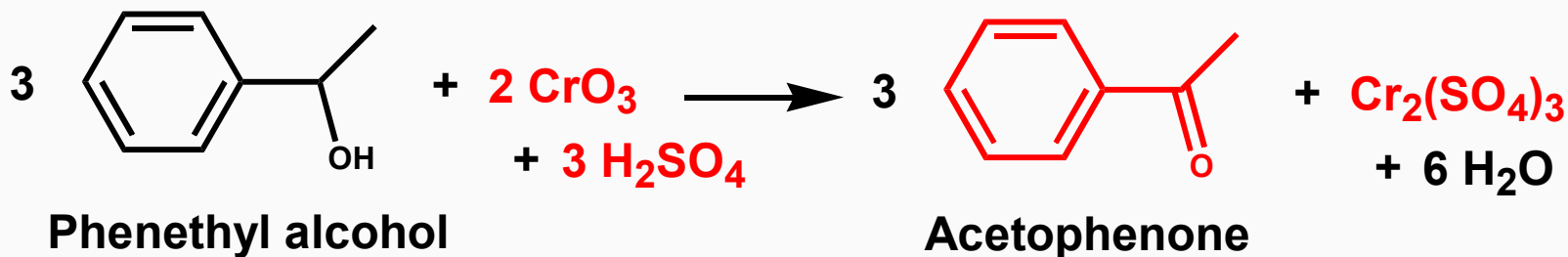
This synthesis:

- requires the use of two TRI chemicals (one of which is a known human carcinogen);

- generates a TRI chemical (also a known human carcinogen) as a waste and in large quantity;

## Example: Commercial Synthesis of Acetophenone

Time-Honored Synthesis of Acetophenone (a TRI chemical):



This synthesis:

- requires the use of two TRI chemicals (one of which is a known human carcinogen);

- generates a TRI chemical (also a known human carcinogen) as a waste and in large quantity;

- is only 42 % efficient.



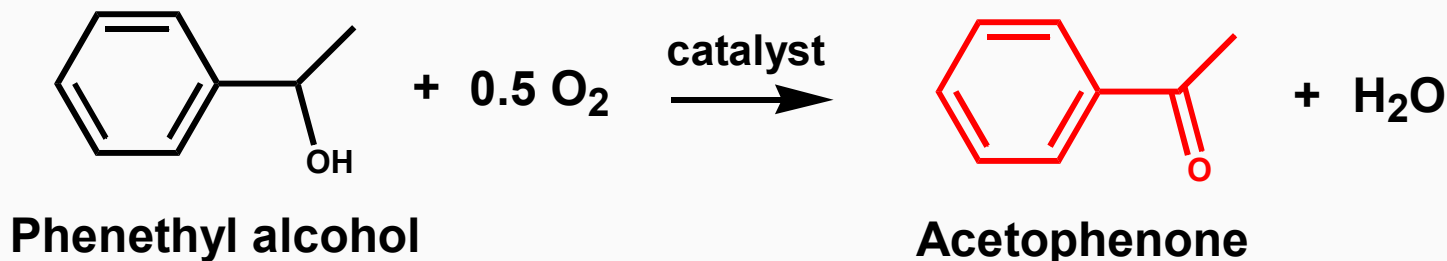
## Example: Commercial Synthesis of Acetophenone

Time-Honored Synthesis of Acetophenone (a TRI chemical):



overall synthesis efficiency only 42 %

"Green Chemistry" Synthesis of Acetophenone:



overall synthesis efficiency = 87 % !!

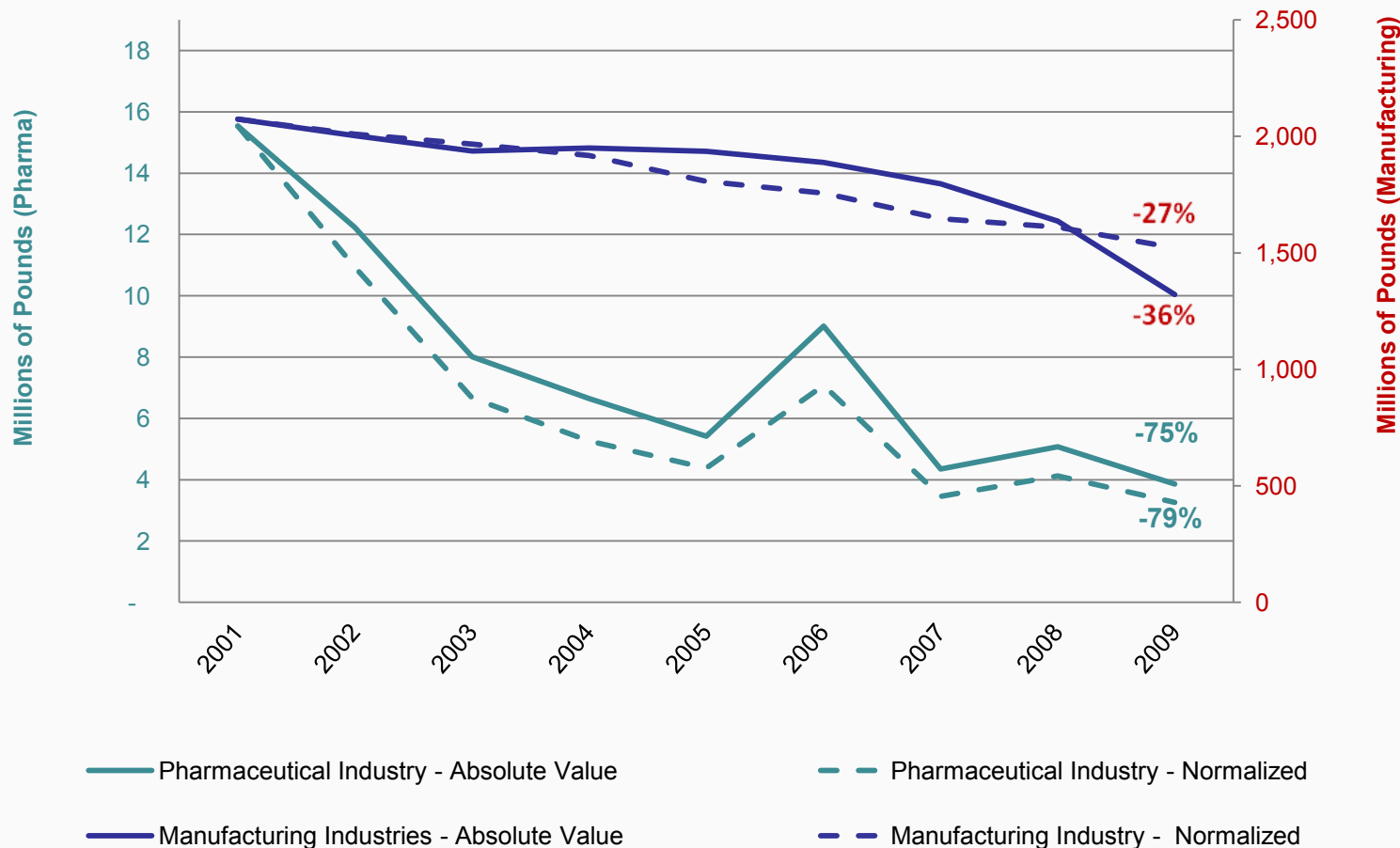


## The Practice of Green Chemistry has Become Widespread in Some Industry Sectors

- Particularly in the pharmaceutical manufacturing sector;
- Examples of drugs made from “green” syntheses:
  - Sitagliptin phosphate (Januvia®)
    - Pfizer received EPA’s Presidential Green Chemistry Challenge Award
  - Pregabalin (Lyrica®)
- See the Green Chemistry Institute’s Pharmaceutical Roundtable website for more information.

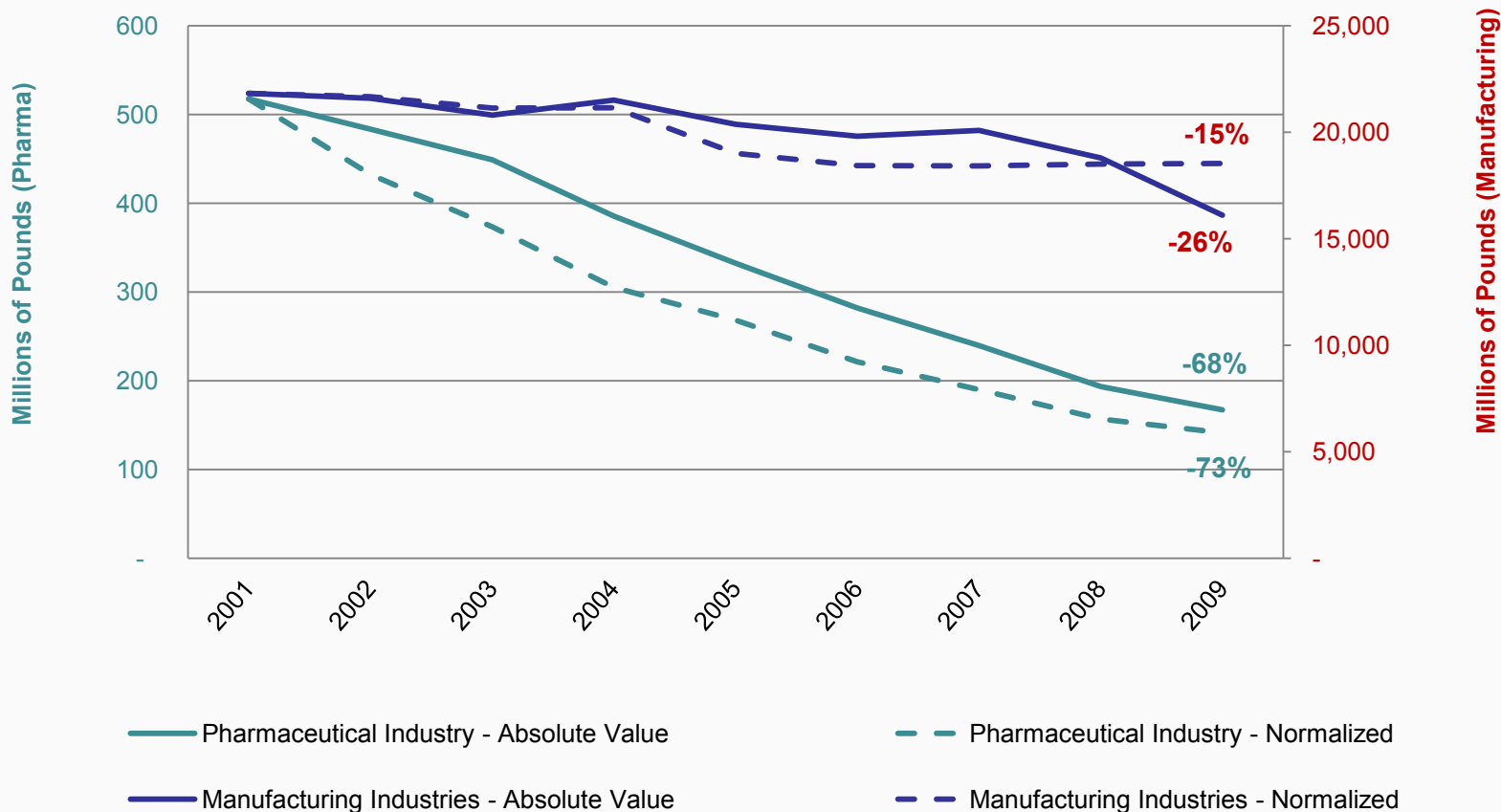


## Total Releases Reported to EPA's TRI From Pharma Industry vs Manufacturing Industry



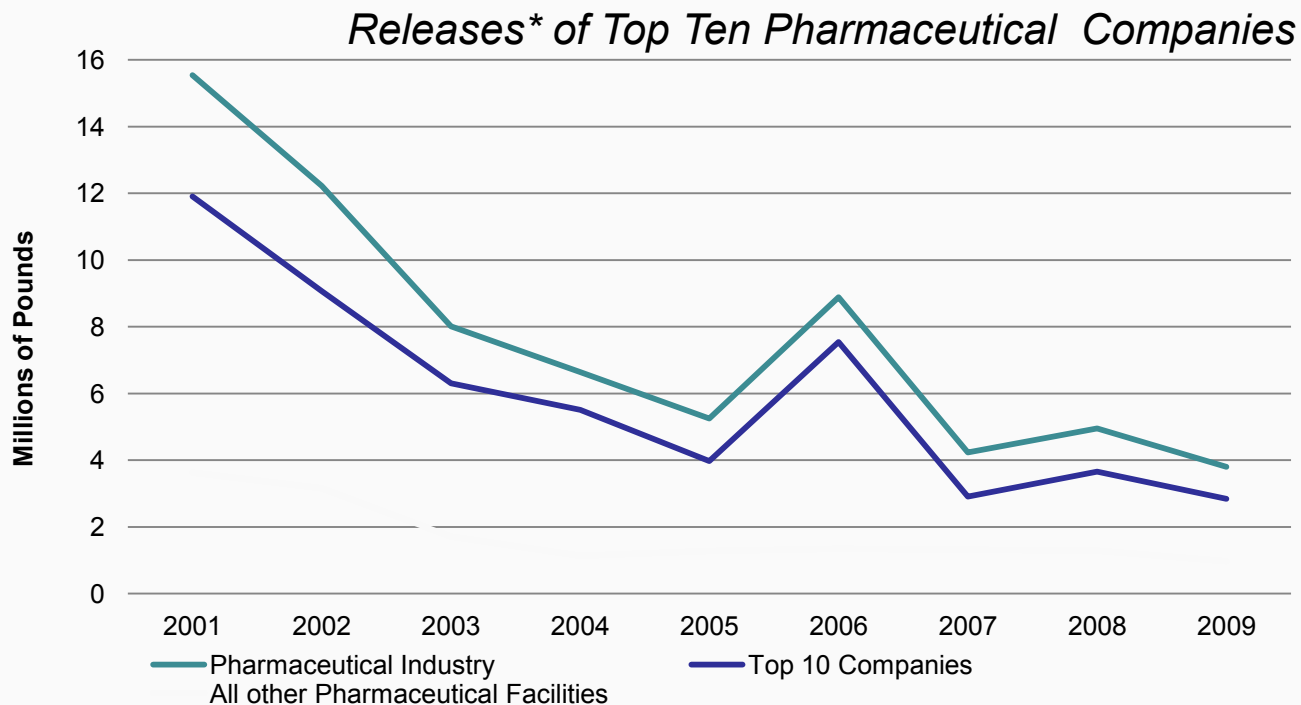


## Total Production Related Waste Managed (Sections 8.1 - 8.7) Reported to EPA's TRI from Pharma Industry vs Manufacturing Industry





Release Reductions are Sector-Wide:  
Decline in releases is seen amongst the top ten pharmaceutical companies as well as the rest of the industry





## Preliminary Conclusions & Next Steps

The results of our analyses indicate that the implementation of green chemistry by the pharmaceutical industry is reflected in the TRI data.

The results more broadly suggest a potential for the use of TRI data as a practical tool to track environmental progress (or lack thereof) within all manufacturing sectors.

We are currently identifying those TRI chemicals for which the pharmaceutical industry reports fewer quantities.



# Acknowledgements

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