TRI as a Tool to Measure Green Chemistry Progress

A pharmaceutical case study

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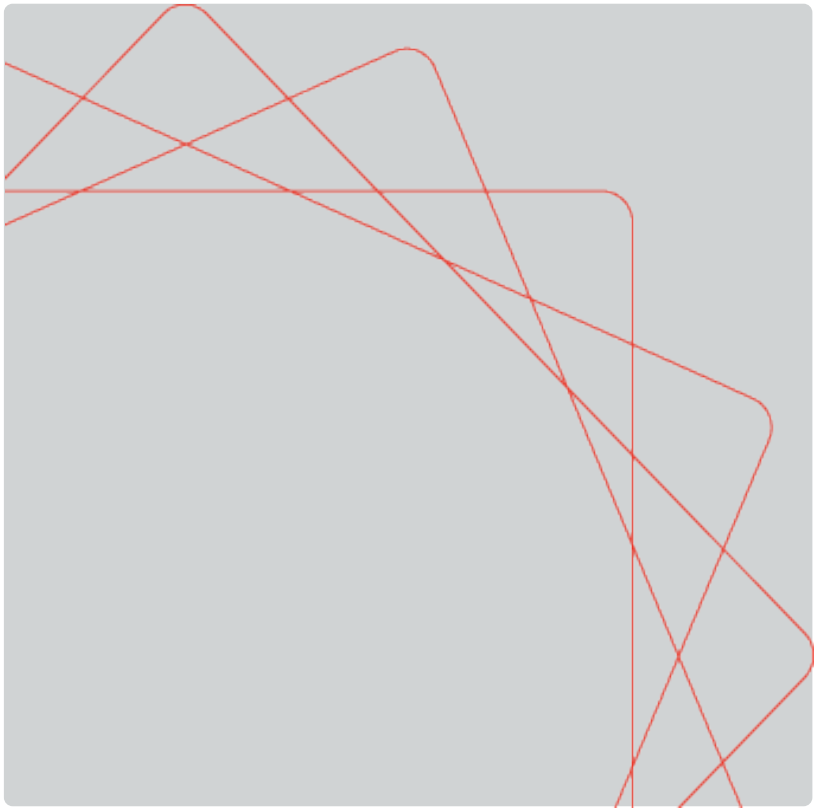


Overview

- Many examples highlighting green chemistry successes
- Can EPA's Toxics Release Inventory (TRI) be used as a tool to measure progress?
- More broadly, can TRI be used as a tool to evaluate progress toward sustainability goals?

Green Chemistry in Pharmaceuticals

- Many examples of such in the literature
  - Pfizer identified a greener synthesis of sildenafil citrate (Viagra™)
  - Merck and Codexis developed a green synthesis of sitagliptin, the active ingredient in Januvia™, a treatment for type 2 diabetes.*
  - Pfizer developed a sustainable biocatalytic process for making Pregabalin, the active ingredient in Lyrica®, which is used to treat neuropathic pain.*

*Received EPA's Presidential Green Chemistry award

Quantifying the Impacts

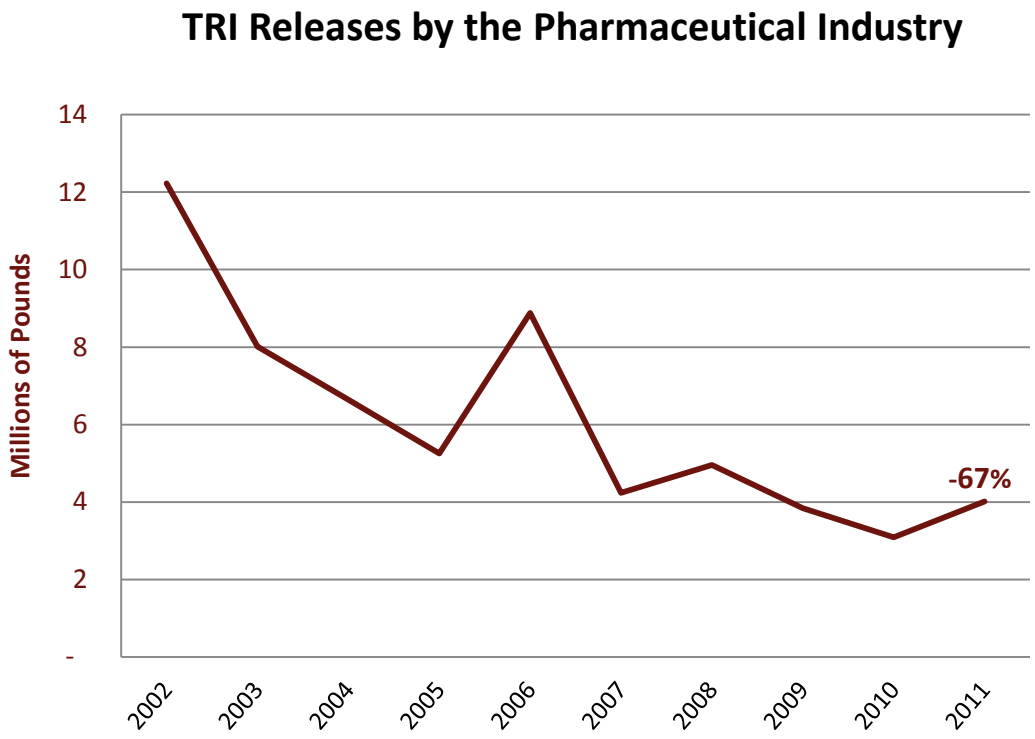
- Articles did not consistently quantify the environmental impacts of green chemistry initiative
- If these advances are occurring on a wide-scale across the sector, we should be able to see these advances in the Toxics Release Inventory (TRI) data
  - Do we?

Approach

- Examined trends in TRI releases by the pharmaceuticals sector.
- Examined likely drivers for the trends observed:
  - Economic trends
  - Outsourcing
  - Regulations
  - Shifts to other waste management practices
  - Influence of large firms
- Conclusion by exclusion

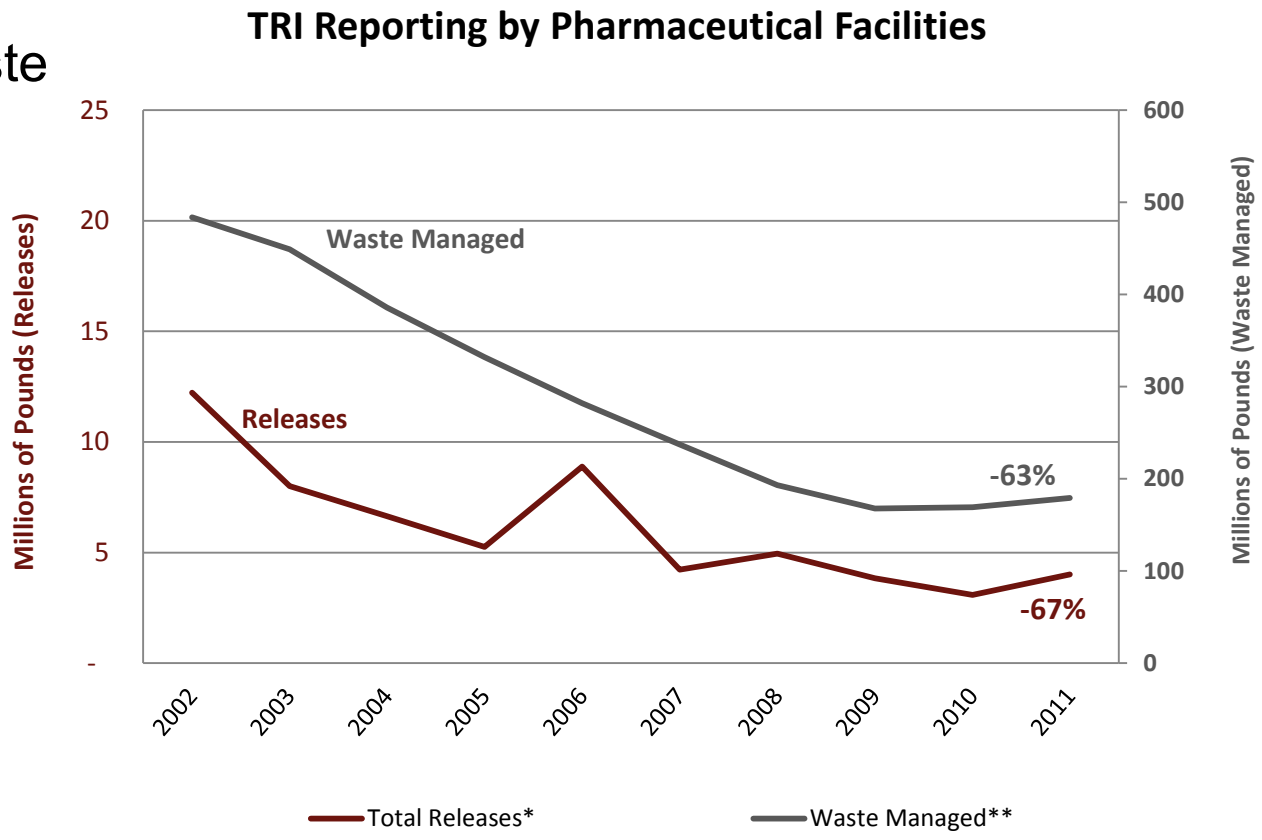
Pharmaceutical sector's TRI releases have declined dramatically

- Releases have declined by 67% since 2002
  - But, is it due to green chemistry?
    - Investigate other potential causes



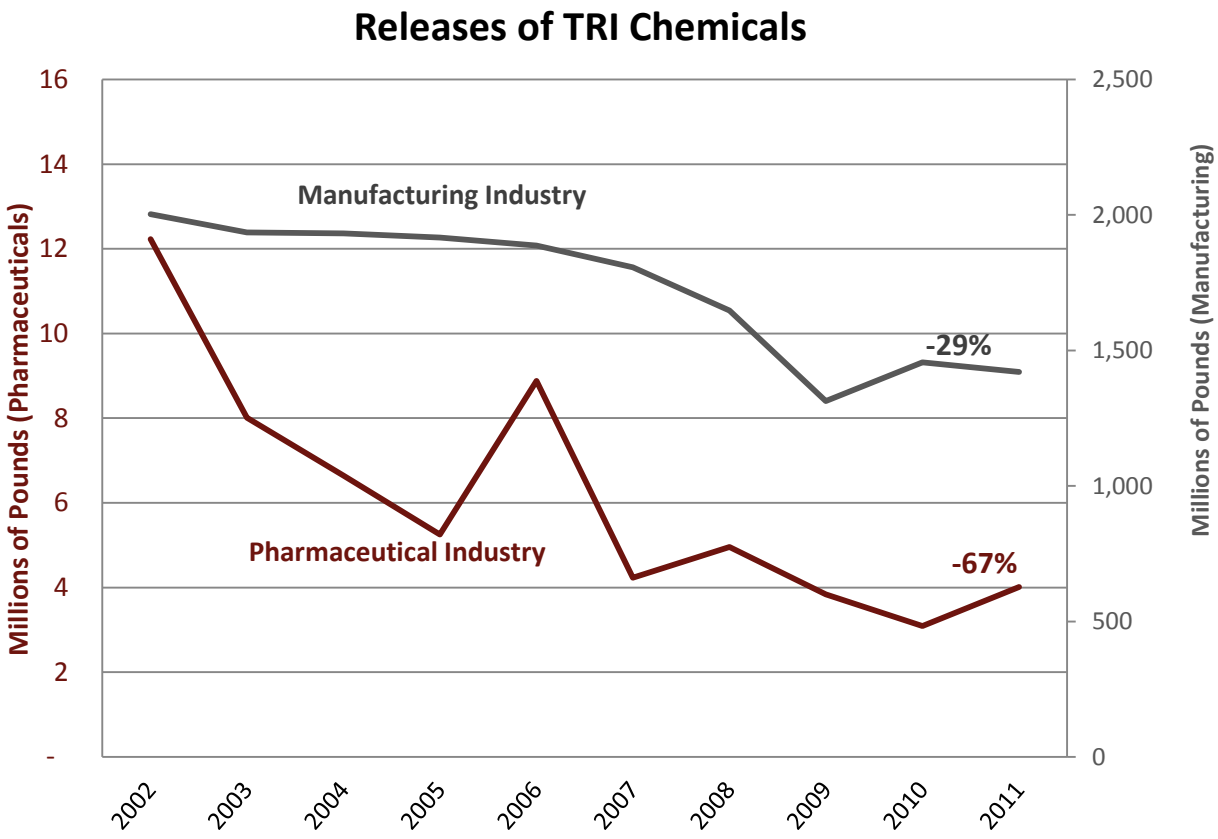
Did wastes just shift from releases to other waste management?

- Similar trend in quantity of waste managed indicates real reductions



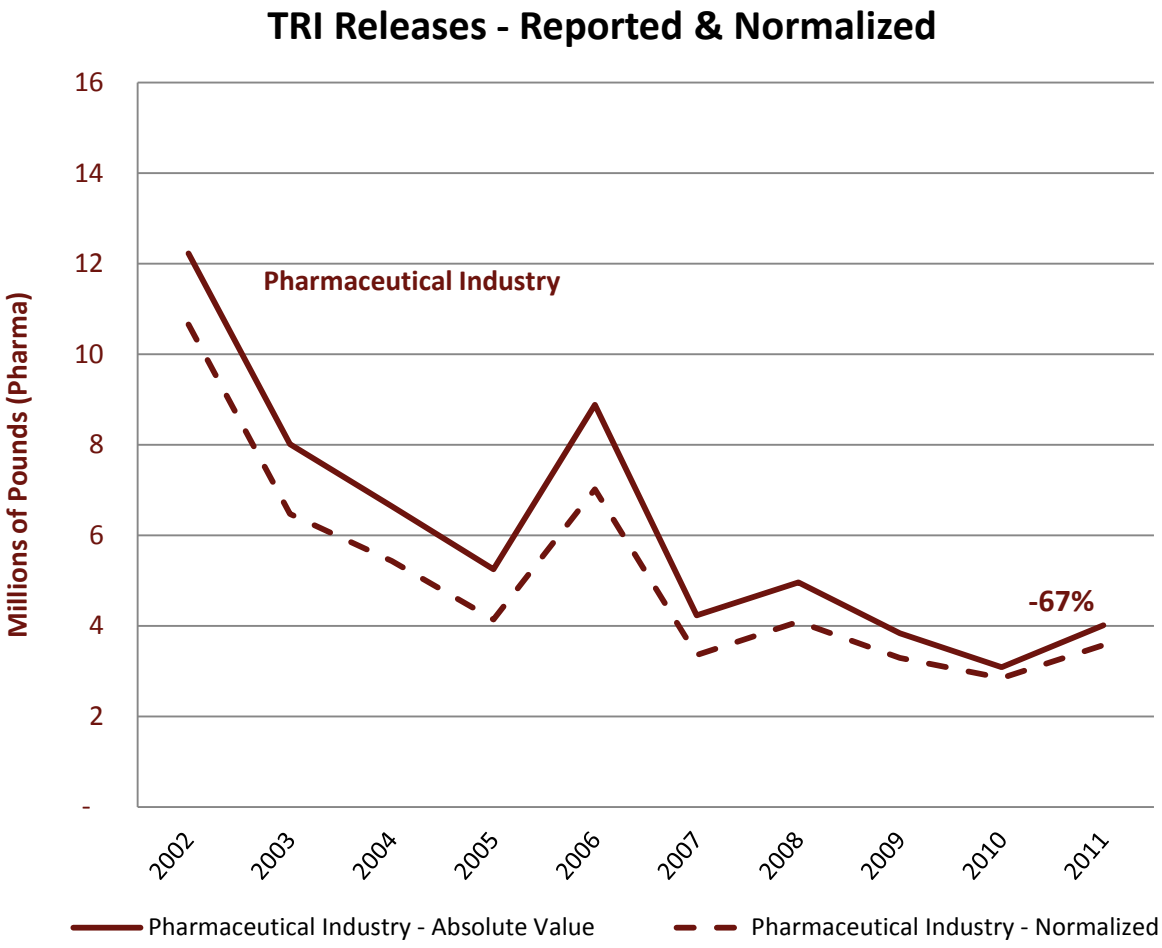
Does the trend reflect general improvements seen across sectors?

- The decline in releases for the pharmaceuticals industry is much greater than for the rest of manufacturing



Are reductions due to economic trends?

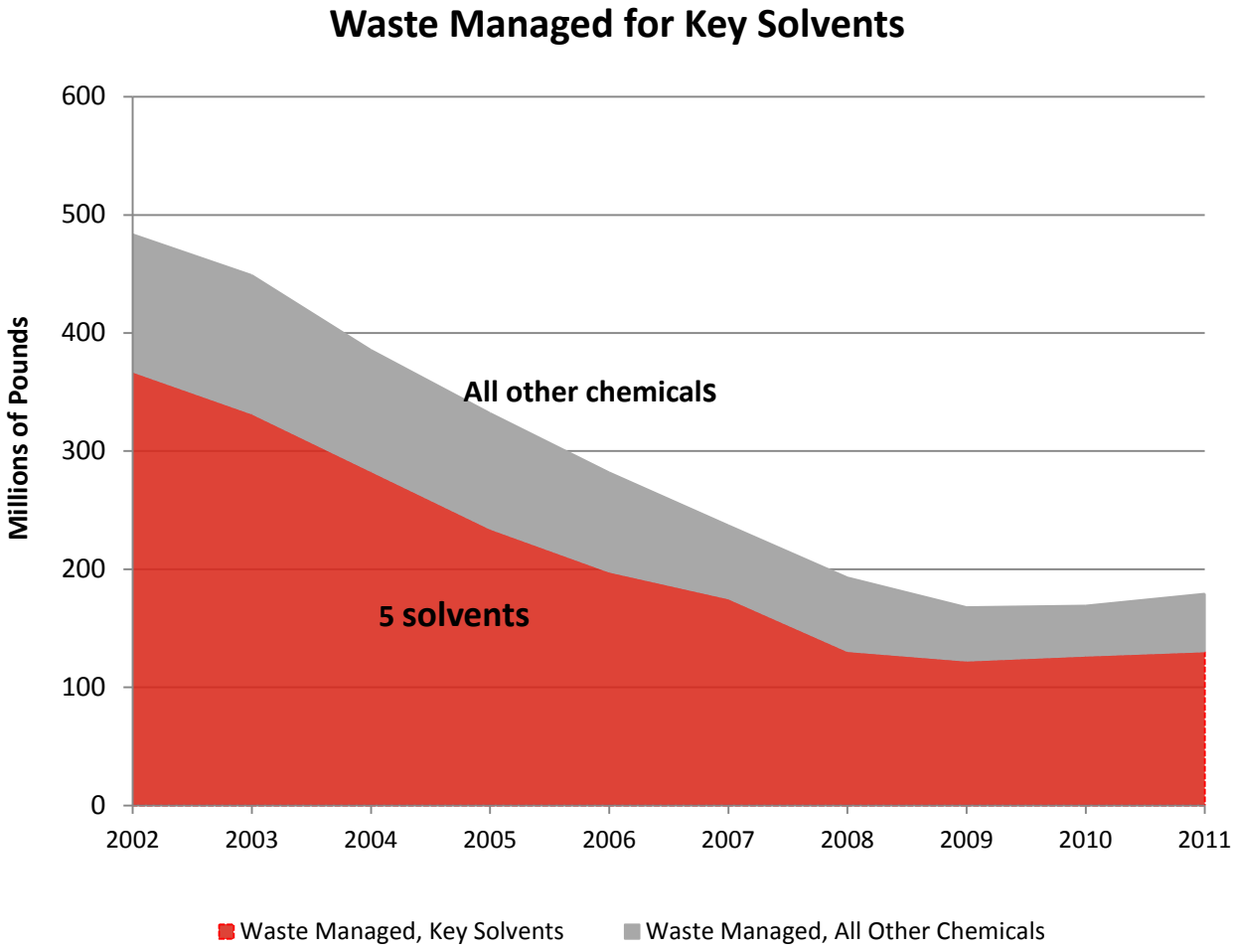
- Normalizing releases to annual value-added has little impact on the trend



Are the chemicals driving the trend associated with green chemistry?

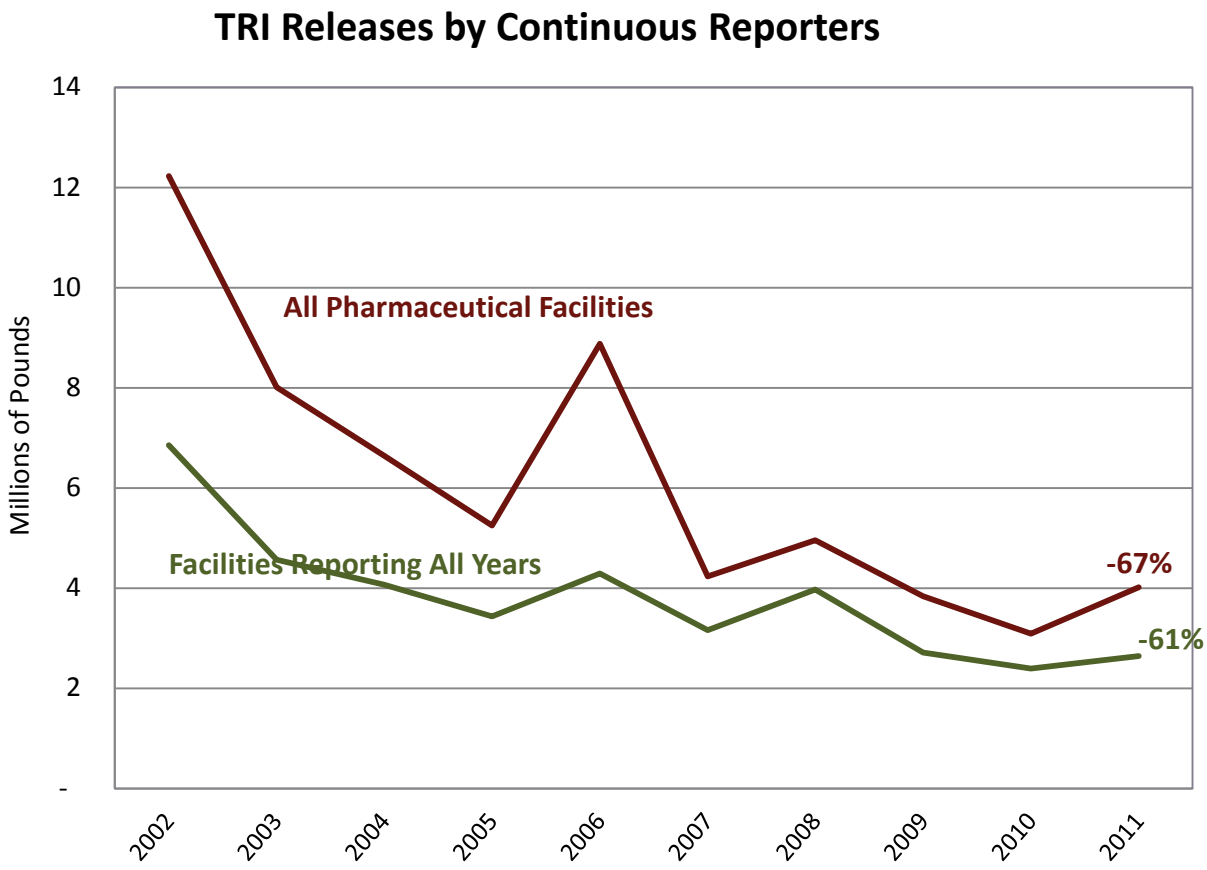
- Solvents driving the declining trends:

  Methanol
  Dichloromethane
  Toluene
  Dimethylformamide
  Acetonitrile



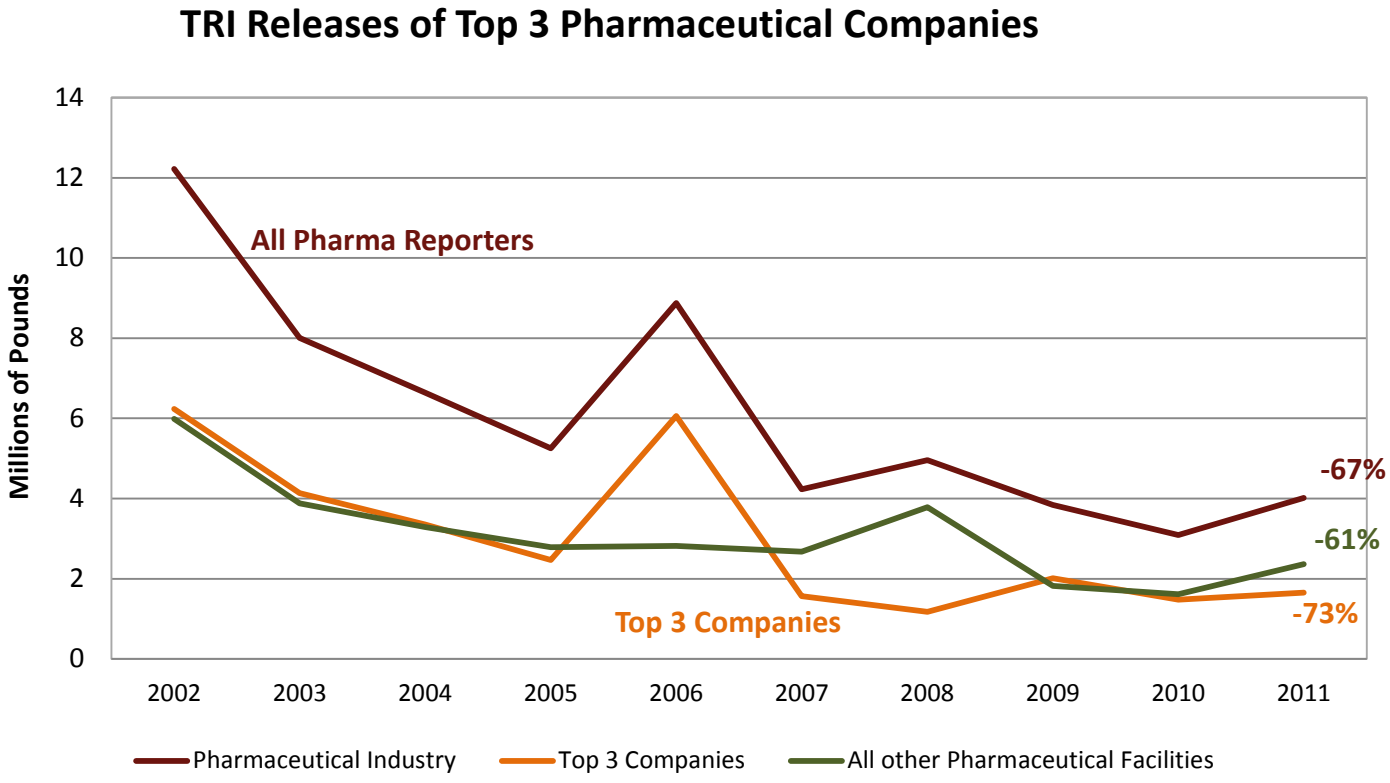
Are reductions a result of outsourcing?

- Facilities that reported over the whole 10-year period reduced releases as much as the entire sector



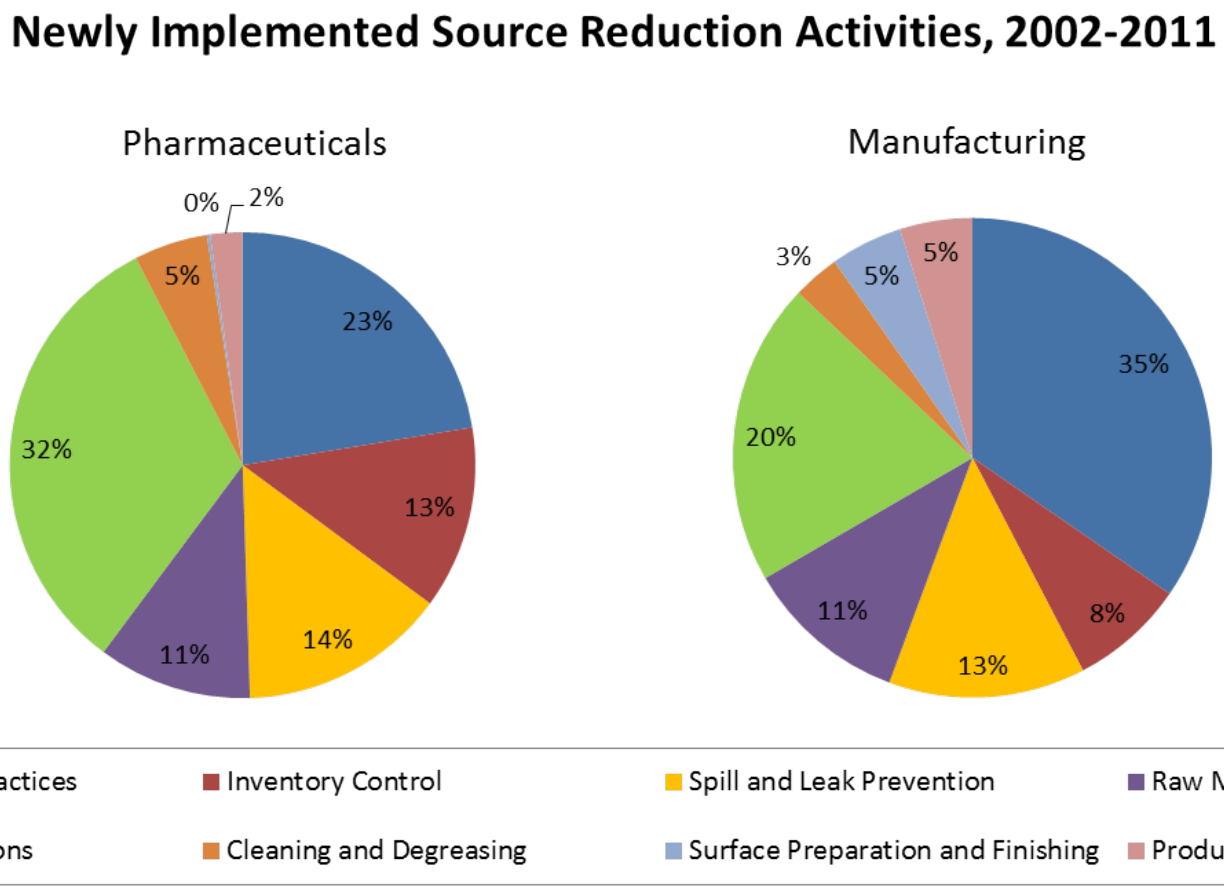
Are reductions sector-wide or driven by a few companies?

- Reductions are sector-wide



Pollution Prevention in TRI

- Pharmaceutical facilities report more process modifications than the rest of manufacturing



Wrap up

- Can TRI data be used to quantify environmental progress?
  - 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 tool to track sustainability progress