



Global Health,  
Safety, **and** Environment

# Green Chemistry

## Building HSE Performance into Products

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Partners for Pollution Prevention, 2 December 2009

Answers That Matter.

# What is Green Chemistry?

## *Green Chemistry*

The design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances

Green Chemistry moves our consideration of how to deal with environmental, health and safety problems from the ***circumstantial*** to the ***intrinsic***.

## We take a “simple” approach

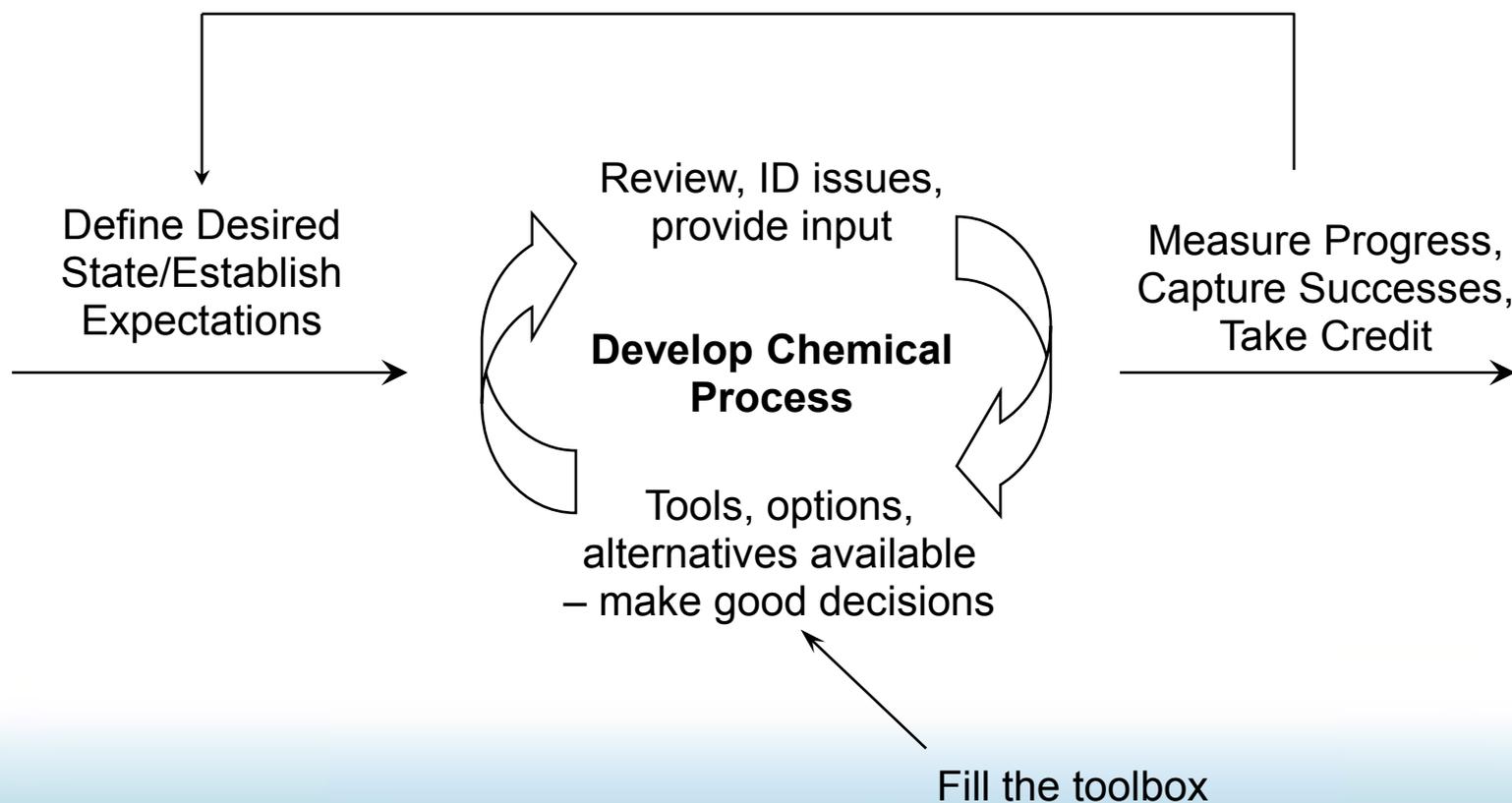
### **Incremental Improvements**

- 1) Stay away from the really “bad” stuff
- 2) Reduce material use per output  
(increase efficiency)
- 3) Evaluate chemical/chemistry alternatives

### **Step Improvements**

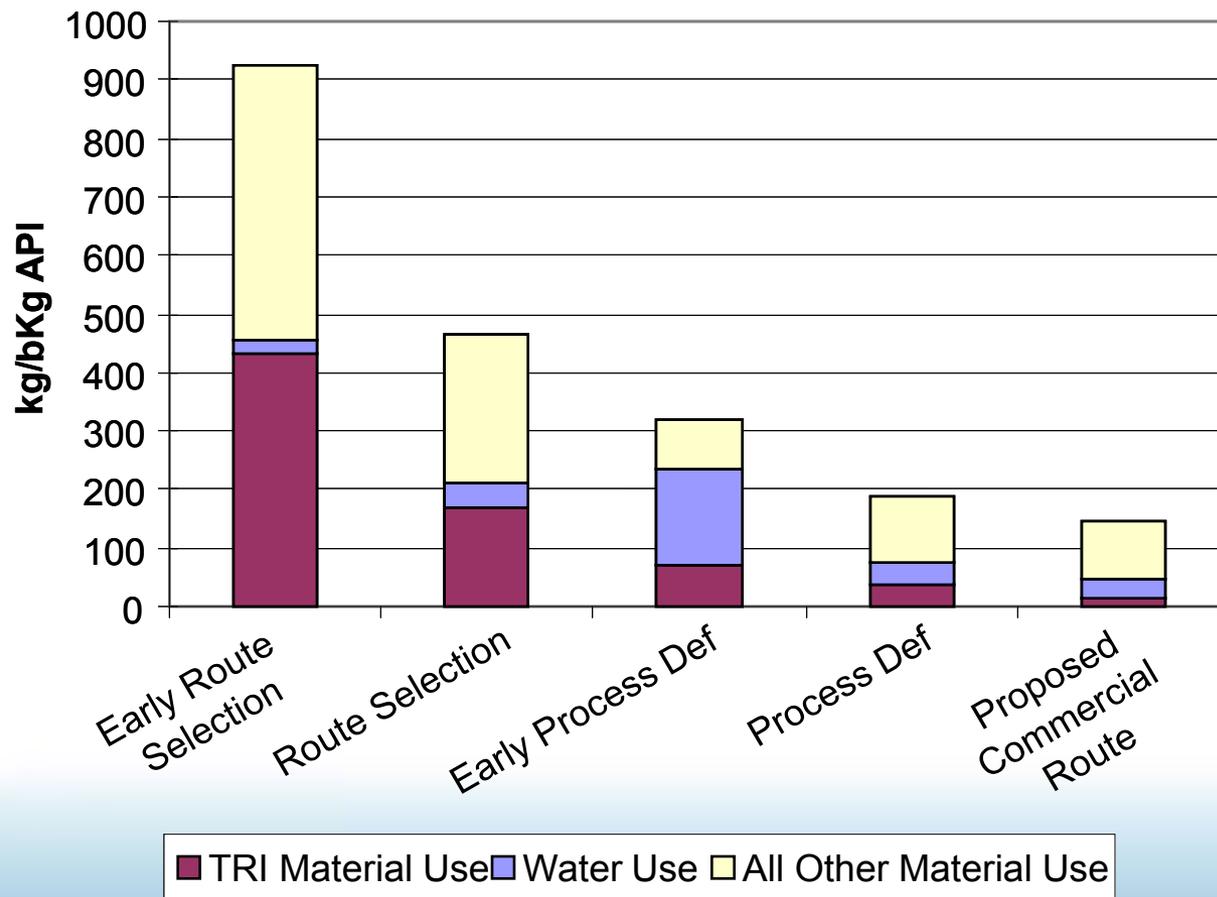
- 1) Move the state of the art for chemistry
- 2) Develop and implement practical alternative reactor technology

## Strategic Elements of our Process



# Example of material efficiency improvement

## Synthetic Route Material Use Comparison



Annual raw material requirements dropped by over 30,000,000 kg due to green chemistry efforts.

TRI - US EPA Toxic Release Inventory Listed Chemical

## Alternative Reactor Technology



New process technology such as these coiled tube reactors, being used by members of Lilly's Alternative Reactor Technology (ART) team makes a big impact.

Example –

Conventional process:  
154 kg material use/kg out

Continuous process:  
1.7 kg material use/kg out

## Part of the Routine

- Green chemistry expectations are built into our development objectives right along with other important criteria such as cost and quality
- Development teams are accountable for process efficiency and inherent safety from candidate selection through the development of a manufacturable process
- Electronic lab notebooks, used by all chemists, include efficiency, solvent selection, and materials of concern tools to assist chemists in making good decisions when designing synthetic pathways and processes
- Progress and determination of “success” is measured and is part of the overall evaluation process which occurs at major development milestones

## Conclusions

- We already use state of the art chemistry. Improvement means moving the science forward. This is hard, time intensive, and expensive – and worthwhile in reducing material use and safety risks
- Internal and partnership resources are active on creative chemistries as well as alternative reactor technologies
- We leverage our efforts to improve problem chemistries through active participation in the pre-competitive efforts of collaborative groups, particularly ACS's Green Chemistry Institute Pharmaceutical Roundtable
- Efforts to reduce use of raw materials (such as solvents) in traditional chemistries gives incremental improvements.
- Progress at applying alternative reactor technology gives step change in material use and safety.
- Inherent safety is aligned with green chemistry progress

**Break and Networking –  
Reconvene at 11:15**