



Green Engineering and Sustainability for the Pharmaceutical Industry:

IPAC

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Green Engineering Goals and Activities

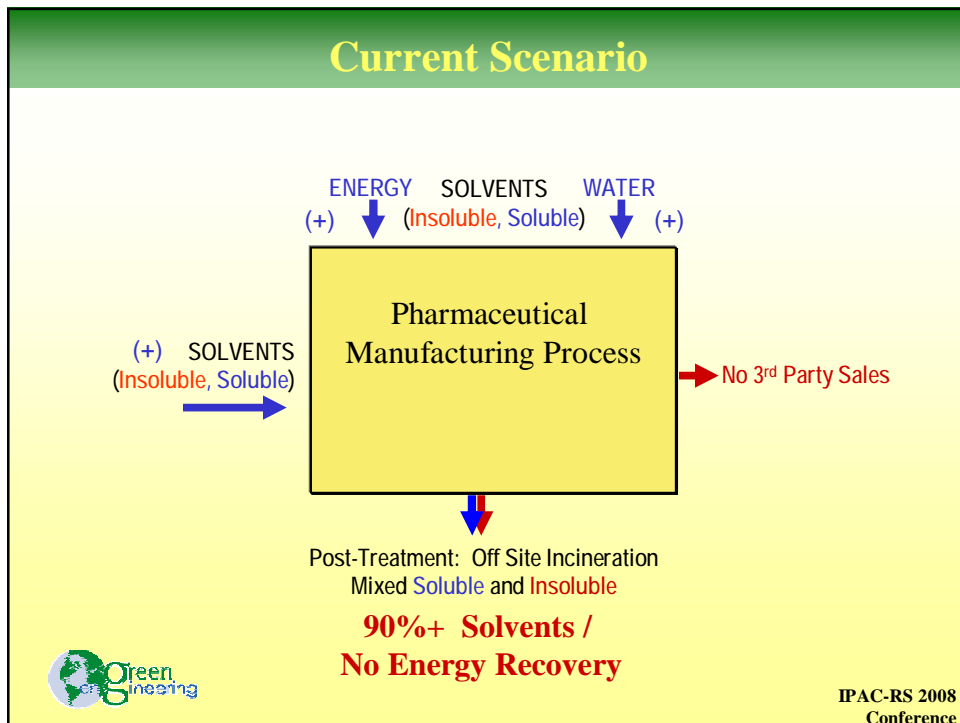
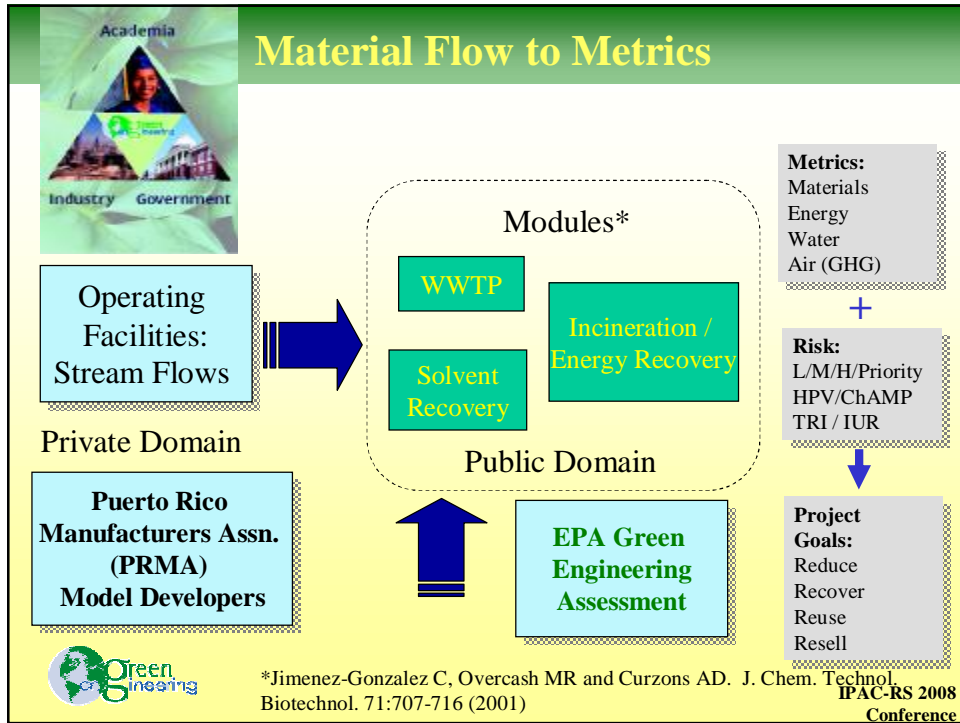
- Drive towards sustainability
- Systematic tiered assessment process
- Create awareness and innovative use of resources and technologies already currently available

Which will...

... Dispel the myth that environmental projects cost money



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National Releases & Environmental Footprint

2006 TRI Releases

- 122 million pounds of spent solvents **incinerated off site** in 2006
- 50% of the releases are soluble (50% solvent, 50% water), with methanol being the top solvent
- 50% of releases are insoluble, with dichloromethane being the top solvent

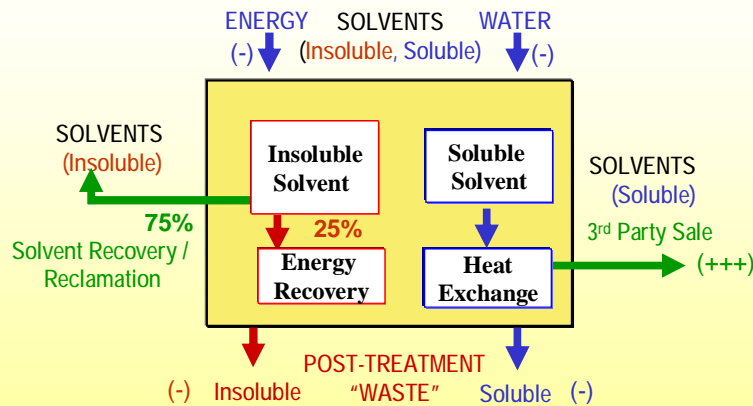
Environmental Impact of Off Site Incineration

- **Energy:** 90 trillion BTUs
- **GHGs:** 140,000 metric tons
- **VOCs, SO_x, NO_x:** 1.5 million pounds
- **Water:** 4 million gallons
- No energy recovery
- Loss of materials



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Green Scenario



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Greening Use of Solvents

Insoluble (Dichloromethane)

- High-risk carcinogen: Find alternatives
- Isolate and recover (75%) in closed systems

Insoluble (e.g., Toluene)

- Isolate and recover solvent (75%)
- Incinerate / energy recovery
- DO NOT send to wastewater treatment*

Soluble (Methanol)

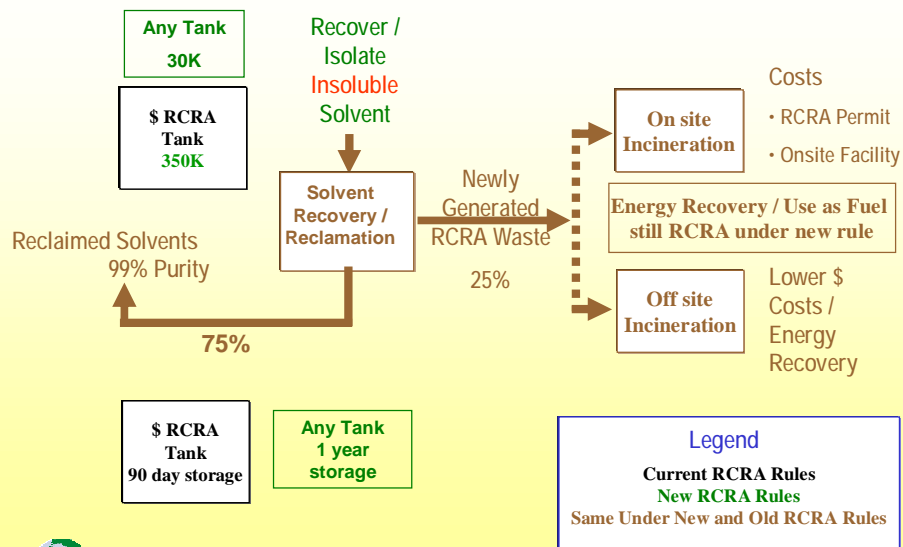
- Substitute with non-hazardous alternative
- Take advantage of water as heat sink: use in heat exchange
- Limit releases with leak detection and repair
- DO NOT incinerate
- Avoid / minimize sending to wastewater treatment*
- Recover solvent for resale (3rd party markets)



* Primary energy use in wastewater treatment is for moving chemical and aeration

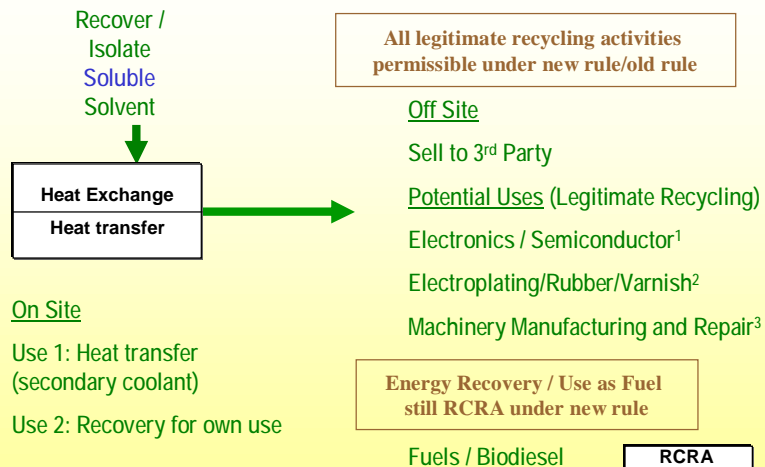
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The new RCRA Rule and Insoluble Solvents



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The New RCRA Rule and Soluble Solvents



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Eco-Industrial Park: Kalundborg, Denmark*

- Material and energy flows (e.g., solvents, acids, water, energy) are used in a wide variety of sectors.
- Design industrial networks to foster byproduct synergy.
- Kalundborg example: **Pharmaceutical manufacturer** exchanging flows of energy and mass with:
 - Oil refinery
 - Sulfuric acid plant
 - Coal burning power plant
 - Fish farm
 - Gypsum board manufacturer

* Excerpt from GE textbook, Chapter 14, pg 468. Allen/Shonnard, 2001



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Industrial Clusters – Puerto Rico Manufacturers Association (PRMA)

- Interrelated group of companies that either compete or work together, including:
 - Supply chain participants
 - Incubators
 - Research centers on related technologies
 - Design units
 - Core manufacturing companies
 - Services
 - Learning centers
 - Administrative units
 - Warehouses
 - Distribution systems

- Criteria which the products of the clusters must comply:
 - High technological content
 - High added value
 - Relatively small size
 - Immediate or short- time consumption



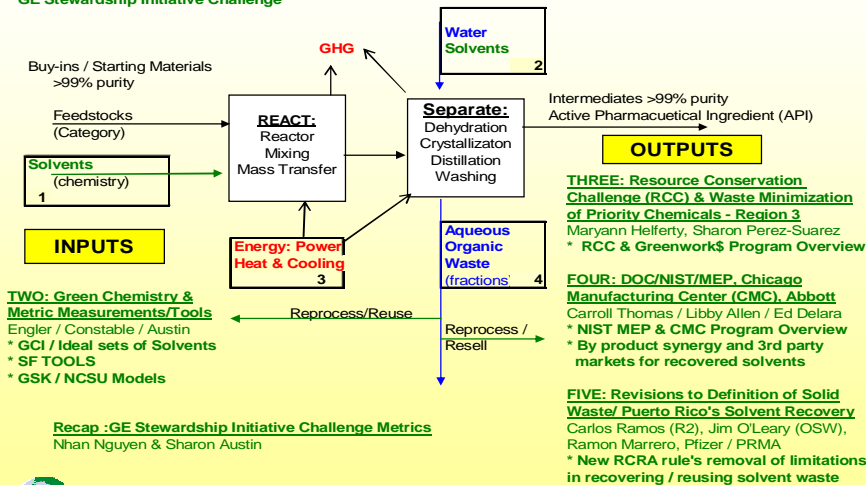
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November AIChE Meeting – GE Topical Conference

GE and Sustainability in Pharmaceutical Industry - Government Programs and Partnerships

ONE: Introduction to Green Engineering (GE), Nhan Nguyen

* GE Stewardship Initiative Challenge



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