

# Identifying the Life Cycle Issues for Nanotechnologies

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EPA Pollution Prevention through  
Nanotechnology Conference



# Why Bother “Greening” Nano?\*

- Facing an uninformed and skeptical public
- Uncertain regulatory frameworks
- Contentious and highly competitive markets
- Brand equity and firm reputation at stake

\* View from the strategic planning department, not engineering.

# The Big Question



**Asset or Liability?**

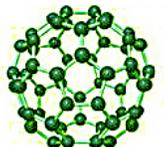
# Minimize Risks with LCA and DfE

## Large Potential Benefits, Minimal Downsides

**Dark Green:** Nanotechnology is applied directly to solve environmental problems.

**Light Green:** Nanotechnology provides environmental benefits for other applications.

**Right Green:** Nano-based processes and products are designed to be environmentally low-impact.



# Then Sell Benefits

*“Companies rarely, if ever, take the trouble to communicate to prospective customers all the economic, technical, service, and social benefits they provide.”*

**Tangible Financial Benefits:** Performance that sellers and customers can verify (energy saved, longer life, avoided costs, etc.)

**Nontangible Financial Benefits:** Sellers can convey but buyers cannot easily validate (safety, environmental compatibility, reductions in long-term liability).

**Tangible Nonfinancial Benefits:** Difficult for sellers to quantify but buyers perceive and react positively to it (service).

**Nontangible Nonfinancial Benefits:** Buyers and sellers cannot quantify, but often key to customer retention (environmental commitment).

# Position Products and Company

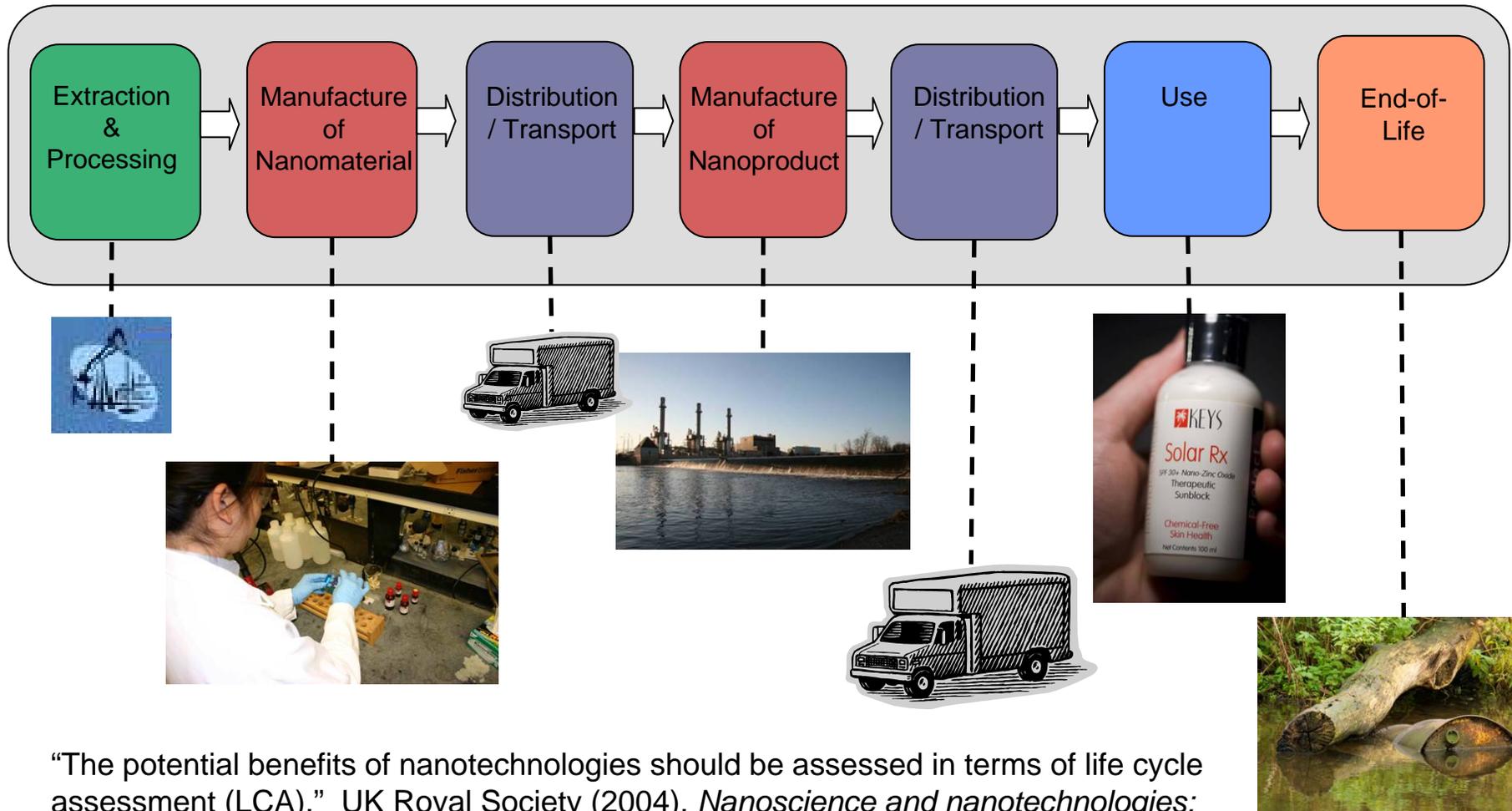


- Over 550 manufacturer-identified “nano” consumer products are commercially available from 22 countries.

**Large opportunity to position products and company as low-impact, green, etc. But claims will need to be backed up.**

“Differentiation is one of the most important strategic and tactical activities in which companies must constantly engage.” Theodore Levitt (1991): *Thinking About Management*.

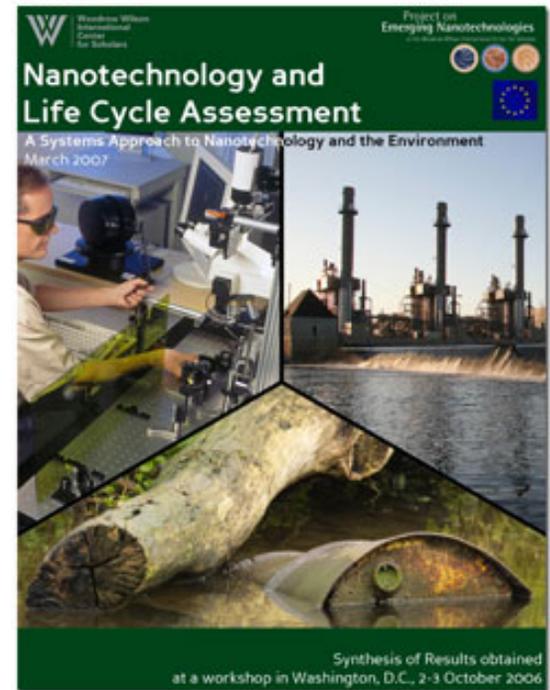
# It Won't Be Easy



“The potential benefits of nanotechnologies should be assessed in terms of life cycle assessment (LCA).” UK Royal Society (2004), *Nanoscience and nanotechnologies: opportunities and uncertainties*.

# Nano LCA Workshop

- Convened in **October 2006** by:
  - The European Commission's Nano & Converging Science and Technologies Unit
  - EPA's Office of Research & Development, and
  - The Project on Emerging Nanotechnologies
- Involved international LCA and nano experts
- **Purpose:** determine whether existing LCA tools and methods are adequate to use on a new technology
- **Key Conclusions:**
  - **Use a case-study approach**
  - **Do not wait to have near-perfect data (won't exist anyway).**
  - **Be modest and open about uncertainties.**
  - **Use a critical and independent review to ensure credibility.**
  - **Build the knowledge base with an international inventory of evolving nano LCA's.**
  - **Use the LCA results to improve the design of products and processes.**
  - **Promote best practices and successes.**

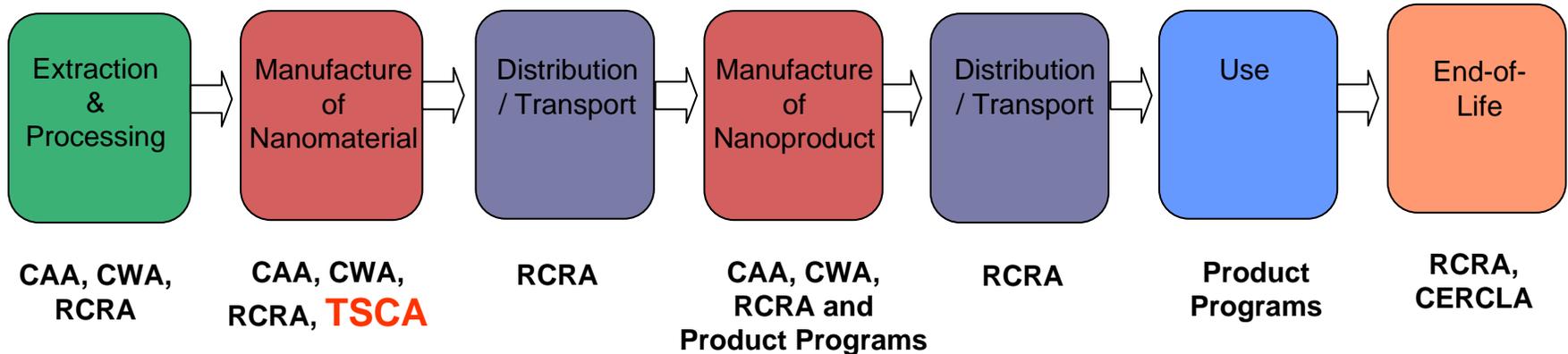


# Nano LCA Findings



Study Reference	Sector - Nano Product	Extraction	Manufacture	Distribution Transport	Use	End-of-Life
Lloyd and Lave 2003, <i>ES&amp;T</i>	<i>Auto</i> - clay polypropylene nanocomposite in light duty vehicle body panels (vs. steel)	↓ fuel, ore, and water	↑ cost ↓ CO <sub>2</sub> emissions ↓ haz waste for upper bound performance nanocomposite	not studied	↑ fuel economy ↓ petroleum ↓ CO <sub>2</sub> emissions	not studied
Lloyd et al. 2005, <i>ES&amp;T</i>	<i>Auto</i> - nanoscale platinum group metal (PGM) particles in auto catalysts	↓ PGM, fuel, ore, inert rock, and water	↓ haz waste and toxic releases and transfers	not studied	↑ fuel economy ↓ petroleum ↓ CO <sub>2</sub> and criteria pollutant emissions	not studied
Steinfeldt et al. 2004, <i>Nanotechnology &amp; Sustainability</i>	<i>Paint</i> - nano-varnishes (vs. water, solvent, and powder varnishes)	not discussed	↓ VOC and GHG emissions ↓ acidification potential	not studied	↓ varnish ↓ VOC and GHG emissions ↓ acid. potential	not discussed
	<i>Chemical/Plastics</i> - nanotube catalytic converter to produce styrene	↓ heavy metals	↓ energy use	not discussed	↑ potential risks from nanotubes	↓ heavy metals
	<i>Electronics/Displays</i> - OLEDs and CNT-FED flat displays (vs. CRT, LCD, and plasma displays)	comparable	↓ energy use	not studied	↓ energy use ↑ energy efficiency	not studied
	<i>Lighting</i> - White LEDs and quantum dots (vs. conventional and energy saving bulbs)	not discussed	not discussed	not discussed	↑ energy efficiency for white LEDs vs. conventional bulb, and ↓ vs. energy saving bulb	not discussed

# Regulatory Environment Undefined



**CAA** = Clean Air Act

**CERCLA** = Comprehensive Environmental Response, Compensation, and Liability Act

**CWA** = Clean Water Act

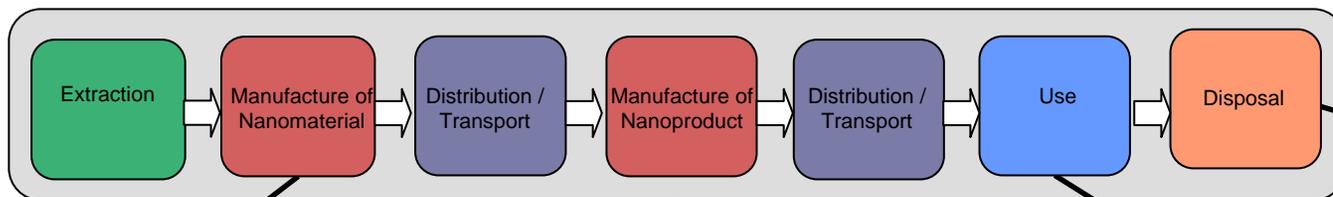
**FIFRA** = Federal Insecticide, Fungicide, and Rodenticide Act

**RCRA** = Resource, Conservation and Recovery Act

**TSCA** = Toxic Substances Control Act

**Product Programs** in this context refer to FIFRA, TSCA, and CAA §211.

# NGO Activities



**Protest at Molecular Foundry opening, Lawrence Berkeley National Lab**

**NANO Risk Framework**

**Environmental Defense**

**(with DuPont)**

<http://www.nanoriskframework.org>

**NRDC: Supermodel Angela Lindvall talks nanotechnology**

<http://www.itsyournature.org/video/Tips/183>

**THONG: Protesting Nanotex outside Eddie Bauer, Chicago**

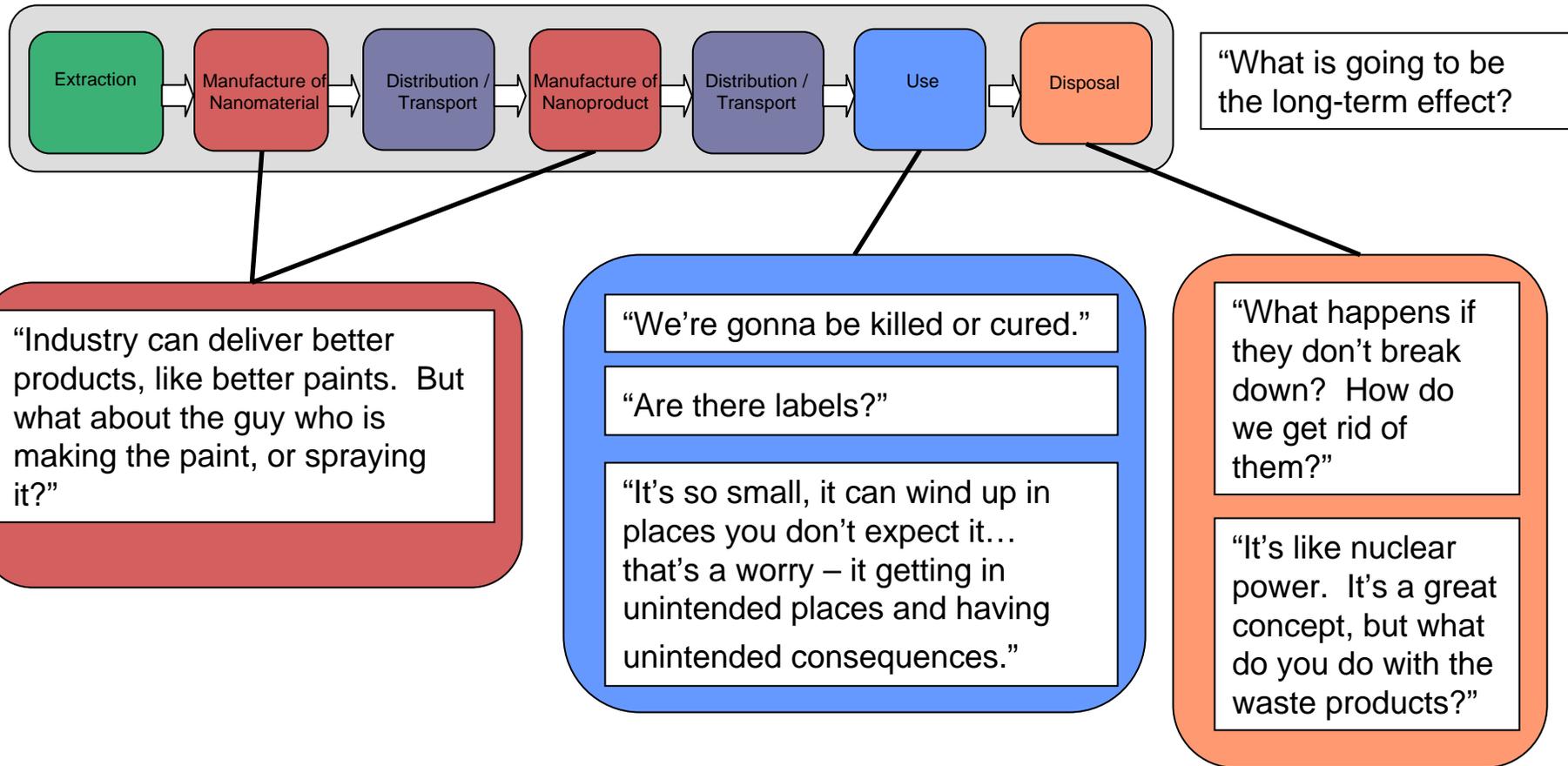
[http://www.treehugger.com/files/2005/05/nanotech\\_street\\_1.php](http://www.treehugger.com/files/2005/05/nanotech_street_1.php)

**ETC Group: Nano-Hazard Symbol Competition**

[http://www.etcgroup.org/en/materials/publications.html?pub\\_id=604](http://www.etcgroup.org/en/materials/publications.html?pub_id=604)

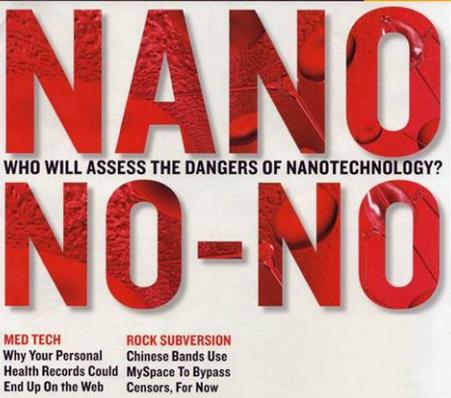
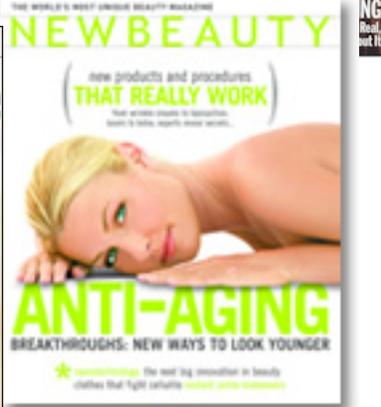
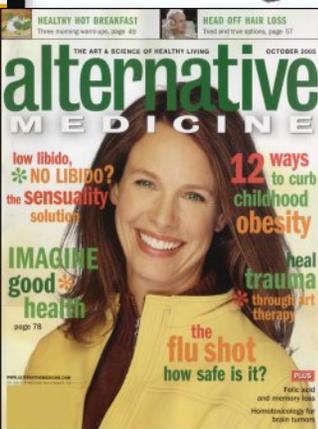
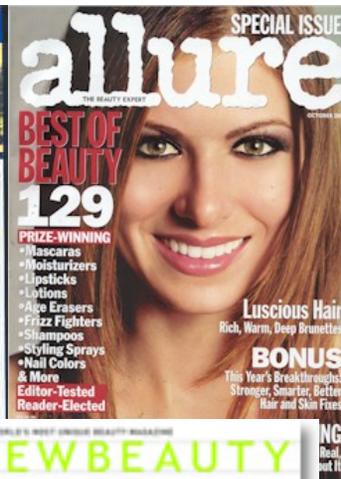
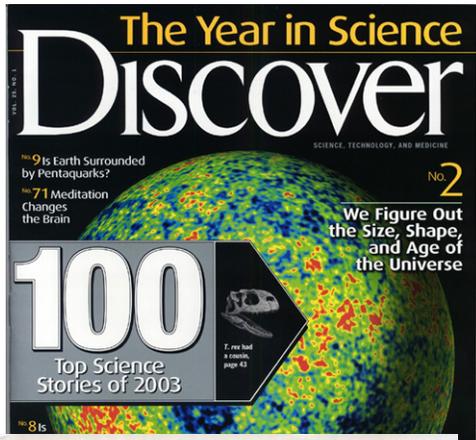
**Tri-TAC: Letters to EPA and CA DPR on Samsung Silver Wash**

# Public Perception Concerns



Quotes from: Macoubrie, Jane. (2005) “Informed Public Perceptions of Nanotechnology and Trust in Government,” January. and Francesconi, Robert. (2005) “Facilitator’s Report of Findings: Nanotechnology Experimental Issue Groups,” July.

# Media Coverage Remains A Wildcard



2005 Popular Press articles about...	in US	in UK
Potential health risks related to nanotechnology	30	8
Potential environmental risks related to nanotechnology	26	9
Regulation of nano risks	14	25

From: Friedman, Sharon. (2006) "Reporting the Risks of Nanotechnology in the Media 2000-2005." Presentation given at Wilson Center, December.

# Next Steps for EPA

- Increase funding for development, application, and evaluation of LCA's (including risk assessments).
- Encourage life cycle thinking in nano product design and development through DfE program.
- Reward success (Green Nano Award and Low Life-Cycle Impact (LLI) Award).
- Continue building a community of researchers and practitioners committed to nanotech pollution prevention (use conferences, website, publications, etc.).

# For More Information

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