

Framework for Estimating the Environmental Impact of Nanotechnology

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Background

By reducing the energy and materials required to provide goods and services, nanotechnology has the potential to improve economic efficiency while improving environmental performance and sustainability. The potential commercial and social benefits of nanotechnology have led to rapid increases in government and private R&D spending.

All technologies and products developed thus far have had some impact on the environment. Some much larger than what was expected – CFC's for example. Nanotechnology is unlikely to be the first entirely environmentally benign technology advance.

Statement Of Work

Our research objective is to develop a framework that can be used by policy makers and industry during various research and development stages to estimate the potential environmental implications of future nanotechnology-based products.

Realizing environmental improvements from nanotechnology depends on phrasing the right R&D questions and pursuing commercialization intelligently. The vast majority of the life cycle costs and environmental impact of a product are set in the early stages of product development. Changing a product to reduce its environmental impact after the product has been developed can cost more than 1000 times the cost of making the same change in earlier stages of research and development. Now, while government and the private sector ramp up R&D investing, is the critical time to focus on nanotechnology's ability to improve environmental quality and sustainability.

Approach

We estimate the environmental impact of several predicted industrial applications in which nanotechnology is used to produce a

consumer good. The nanotechnology may be used either in an industrial process to produce the consumer good or in the manufactured product itself.

For each application, we identify the key potential environmental impacts. We then use the appropriate analytical models and equations to provide first approximations of the direct environmental impacts. Here, our analysis focuses on the direct changes in fuel consumption, material consumption, and environmental discharges that could be realized by widescale commercialization of the nanotechnology-based product. We then use the Economic Input-Output Life Cycle Assessment (EIO-LCA) model developed at Carnegie Mellon to estimate the indirect environmental effects across the entire supply chain.

We also consider the feasibility of widescale commercialization based on other design requirements, estimate the value to producers and consumers of the nanotechnology innovation, and estimate the value to society of the nanotechnology innovation.

Based on the results of these studies, we will develop a framework that can be used by public and private R&D policy makers to estimate the potential environmental implications of future nanotechnology-based products. We will then evaluate the general applicability of the framework and evaluate how it can be used in R&D decisions and in establishing R&D policy.

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