Energy Challenges, Nanotech Solutions? Forum

Contact person: Brad Herring

Contact information: bradh@ncmls.org

General Description

Summary:

This forum puts the participants in the role of a governmental funding agency and asks them to consider and recommend how nanotechnology should fit into the timeline and scope of future national energy policy.

A scientific expert begins the forum by providing a brief introduction to the emerging field of nanotechnology and by describing some of its potential benefits as well as points of possible concern and uncertainty. A short video is then shown which delivers three perspectives from experts who discuss the potential benefits and tradeoffs around three possible energy funding strategies:

- *Nanotechnology-dependent energy technologies,*
- *Existing alternative energy technologies,*
- *Conservation and energy efficiency.*

The participants are then asked to consider how they would allocate $100 million of hypothetical research and implementation funding between the options presented above. After sharing their own individual ideas, the participants will work in small groups to form a group recommendation.
Discussion cards describing various hypothetical scenarios are then presented to the groups, and the groups are asked to consider whether and how these scenarios might change their funding allocations.

Finally, each group will make a brief report to everyone on the group's final funding allocations, and describe how the points of discussions helped to shape the recommendations of the group.

Big idea:

Given the potential energy benefits as well as the unknown environmental and health risks and the uncertainties associated with nanotechnology, how should nanotechnology research fit into domestic energy policies in the near future?

NISE Network Main Messages:

[X] 1. Nanoscale effects occur in many places. Some are natural, everyday occurrences; others are the result of cutting-edge research.
[X] 2. Many materials exhibit startling properties at the nanoscale.
[X] 3. Nanotechnology means working at small size scales, manipulating materials to exhibit new properties and create new devices.
[X] 4. Nanoscale research is a people story.
[X] 5. No one knows what nanoscale research may discover, or how it may be applied.
[X] 6. How will nano affect you?

Forums Overview

Introduction: The NISE Network:

The Nanoscale Informal Science Education Network (NISE Net) is a national infrastructure comprised of science museums and university based research centers collaborating to foster public awareness, engagement, and understanding of nanoscale science, engineering, and technology through establishment of a network that links science

museums and other informal science education organizations with nanoscale science and engineering research organizations. It is funded by a five-year cooperative agreement between the National Science Foundation and the Museum of Science – Boston and its core partners: the Exploratorium and the Science Museum of Minnesota.

Other subawardees have included: Oregon Museum of Science and Industry, Museum of Life and Science – Durham, New York Hall of Science, Sciencenter in Ithaca, Fort Worth Museum of Science and History, Cornell University, University of Wisconsin – Madison, the Materials Research Society, the Association of Science-Technology Centers, Inverness Research Associates, and Multimedia Research.

The goals for the NISE Net are to:

1. Engage the public with nanoscale science, engineering and technology through exhibits, programs, media, forums and other kinds of informal educational products;

2. Build a professional network of relationships, alliances, and professional development opportunities between museums and the research community; and

3. Generate essential new knowledge for learning about nanoscale science and engineering.

One of the primary goals is to engage the museum going public and other partner stakeholder groups by helping to bring nanoscale exhibits, programs, and media to as many informal science education venues as possible, with a specific target of 100 venues over the course of the grant. The NISE Net plans to reach this goal by building a network of relationships between informal science education organizations, nanoscience researchers, and professional associations that can work together to accomplish more than any single institution could do on their own.

Nano Public Forums Overview:

One focus of NISE Net's activity is the creation of nanoscale science, engineering and technology public forums that offer participants the opportunity to engage in thoughtful conversations about important issues regarding the potential societal, environmental and ethical implications of nanotechnology. They provide a vehicle for people of diverse views and backgrounds to deliberate on difficult issues and to seek a more comprehensive understanding of the topic.

The overall charge to the NISE Net Forums Team is to develop, test, and disseminate program models aimed at engaging adults and teenagers with informal educational experiences that incorporate discussion, dialogue, and deliberation around societal implications of nanoscale science, engineering and technology. The purpose of this manual is to provide information on how to engage members of the public in thoughtful conversations about important issues in nanotechnology.

The Forums Team (Figure 1) collectively has presented more than 30 forum programs and developed two program models (with different formats and topics) that have been tested at all five institutions, as well as a number of other forum program models implemented at only one or two sites. Going forward, the Forums Team plans to develop one more program model and to create dissemination packages for all three developed and tested programs. These program packages will be made available on nisenet.org along with information about other program models.

In addition to creating additional program models and distilling and posting the relevant knowledge about producing forum programs, work will be done in the

remaining three years of the grant to expand the number of institutions with experience in presenting such programs.

Figure 1. Museum Collaborators in NISE Net's Forums Team

Museum	Contact
Exploratorium	Veronica Garcia-Luis
Museum of Science	David Sittenfeld
Museum of Life + Science	Brad Herring
Science Museum of Minnesota	Dave Chittenden
Oregon Museum of Science and Industry	Amanda Thomas
Evaluation Coordinator	
Museum of Science	Christine Reich

NOTICE: You're welcome to alter this program to suit your needs. In fact, we encourage it! Change it around, and if you find something that works let us know. Post your revisions on www.nisenet.org. You may also find it helpful to refer to the Forums Manual for more detailed information on hosting a forum.

Program Delivery

Agenda:

* Pre-survey (before the start of the forum) - *If the forum will be evaluated, have the participants fill out the pre-forum evaluation while they are waiting for the forum to begin.*

1. *Welcome/Introduction* - 10 minutes

    a. Have the moderator of your forum give an introduction to your museum/institution and to the format of the forum.
    b. Introduction to the NISE Net and your role with the network if applicable.
    c. The various funding options to be considered and the role of the participants as policymakers will be introduced.
    d. Introduce speaker, obtain presenter biography beforehand to use for this introduction.

2. *Nanotechnology Overview from Guest Speaker* - 20 minutes

a. The speaker should give a general overview and introduction to nanoscale science, engineering, and technology, and provide examples of applications either currently available or in the research and design phase.

3. *Video presentations* - 20 minutes

    a. Three prerecorded perspective interviews featuring experts in the field of energy are shown to the participants. The experts discuss the tradeoffs and potential benefits of the three options which will be presented to the participants: existing alternative energy technologies, conservation and energy efficiency, and nanotechnology-dependent energy technologies. The videos can either be shown using a DVD or using a quicktime or other video player from a computer.

4. *Questions and answers* - 10 minutes

5. *Instructions for small group discussions* - 10 minutes

    a. The moderator will introduce the scenario to be considered by the participant groups, and give instructions on how to use the materials presented and to record the funding allocations.

6. *Introductions and individual reactions* - 10 minutes

    a. During this section, the small groups at the tables will first read the background information and the discussion scenario (this can be done either individually or aloud).
    b. The participants will then each take the opportunity to introduce him/herself, and describe how he or she would allocate the $100 million of research and implementation funding between the three options described in the video. The discussion scenario sheet provides a place for participants to record their recommendations.

7. *Discussion Cards* - 20 minutes total

    a. The group will first recommend and record a funding allocation based on the participants' individual responses and on a group discussion. *(5 minutes)*
    b. Discussion card describing a hypothetical scenarios will then be taken from envelopes one at a time and considered by the group. The funding allocations recommended by the group will be recorded after each deliberation period (5 minutes per card, 3 cards overall).

8. *Report out from tables* - 15 minutes total

a. The tables will have a maximum of 3 minutes each to identify the reasons for their final allocations, based upon the various points of discussion as they considered the hypothetical decisions posed by the discussion cards.

9. *Farewell/wrap up* - 5 minutes

* Post-survey (after the conclusion of the forum) - *If the forum is being evaluated, have the participants fill out the post-forum evaluation at this time.*

Program Length:

2:00 Hours

Cleanup:

Taking down the A/V equipment, bidding guests and speakers farewell, and cleaning up the space can take up to an hour. Satisfied speakers and participants tend to linger and continue to discuss the topic. This is to be expected with a forum. It is helpful to have someone cleaning up while at least one other person plays genial host.

Background Information for Speaker:

The following is a brief list of basic nanoscale science talking points intended to help presenters think about the kind of information they should include in their presentations. For information regarding societal and ethical implications of new and emerging nanotechnologies, please see the article Nanotechnology & Society: Ideas for Education and Public Engagement located in the appendix section of the Forums Manual.

- Nanoscale science is an emerging area of scientific research that encompasses many areas of study, including chemistry, biology, engineering, physics, and medicine.
- Nanotechnology will enable new advances in fields such as medicine, computing, and consumer products, and will likely have an effect on much of everyday life.
- Nanotechnology has to do with very small things, smaller than you can see with an ordinary microscope.
- A nanometer is very small, a billionth of a meter or 10^{-9} (for example, approximately 80,000 nanometers = width of human hair).

- Materials can have different characteristics at the nano scale (for example, gold particles change color the smaller they become).
- Along with the new benefits of nanotechnology may come risks that are currently unknown to our health, environment, and society.

Participant Materials

The following materials (except the DVD) should be placed at each table before the forum gets underway. You may wish to highlight the overarching question by having it on its own sheet of paper and in the center of the table for everyone to refer to throughout the forum. Items 2-5 are located at the end of this document.

1. *Energy interviews with experts (video on DVD)*
2. *Discussion cards (1 envelope per table)*
3. *Personal allocation sheet/Scenario (2 pages, 1 for each participant)*
4. *Instructions and Group Worksheet (2 pages, 1 per table)*
5. *Background information (2 pages, 1 for each participant)*

Overarching Question:

Given the potential energy benefits as well as the unknown environmental and health risks and the uncertainties associated with nanotechnology, how should nanotechnology research fit into domestic energy policies in the near future?

Universal Design

The following features of the program's design make it accessible:

1. Repeat and reinforce main ideas and concepts.
2. Provide multiple entry points and multiple ways of engagement
3. Provide physical and sensory access to all aspects of the program. Visitors can touch, see and hear different elements of the program.

Credits

The speakers on the video are:

- **Existing alternative energy technology**: Stephen R. Connors, AGREA – Analysis Group for Regional Energy Alternatives, MIT Laboratory for Energy and the Environment
- **Conservation and Education**: J. Drake Hamilton, Science Policy Director, Fresh Energy
- **Nanotechnology**: Dr. Jim Hutchison, Professor, Organic, Organometallic, and Materials Chemistry, University of Oregon

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Instructions and Group Worksheet

Thank you for being part of our discussion! It may be helpful to have someone read these instructions out loud to all the participants at your table.

Take time to hear how each of the individual members of your group would choose to allocate the research funding and **why**.

It is time for you to act as the NSF Board and come to a consensus about the allocation of energy funding for the coming year. This will require you to consider the points made by the speakers as well as the other members of your group. Be sure to consider and discuss the potential **benefits** and **drawbacks** of all of the options presented before making your final decision as a group.

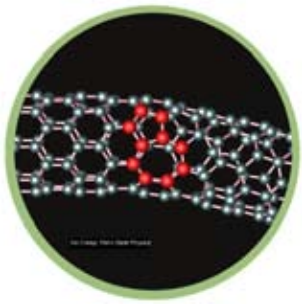
Please elect one person to record the allocations decided on by your group.

1. Use the time allotted to make a group funding decision, and **record your funding allocations** on the **Initial Group Consensus Allocations Line** of the chart.

2. After making this decision, we ask your group to take a **discussion card** out of the envelope. Please read the card and as a group, discuss how, if at all, the information on the card changes your energy funding allocations. You will have five minutes to decide what your new allocation should be. After this time, record the new allocation on this sheet, making sure to record the card number in the left hand column.

3. Repeat step 2 and continue onto the next card (6 cards total).

ALLOCATIONS

PERSONAL ALLOCATIONS			
Names of Group Members	**Nanotechnology-Dependent Energy**	**Conservation and Energy Efficiency**	**Existing Alternative Energies**
			
Initial Group Consensus Allocation	**$**	**$**	**$**

GROUP ALLOCATIONS			
Card Number	**Nanotechnology-Dependent Energy**	**Conservation and Energy Efficiency**	**Existing Alternative Energies**
	$	**$**	**$**
	$	**$**	**$**
	$	**$**	**$**
	$	**$**	**$**
	$	**$**	**$**
	$	**$**	**$**

What were the reasons for your final funding decisions? You may include as many discussion points as you wish: feel free to include those at the bottom of this sheet.

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Background Information

We will be discussing energy issues and the emerging field of nanotechnology throughout this forum. The information below provides a brief introduction to the potential benefits and drawbacks of nanotechnology, and to how nanotechnology might address current and future energy concerns.

Rising energy costs, dwindling natural resources, pollution, and climate change concerns have drawn increasing attention to the relationship between human activity and the earth's environment. Alternative and renewable energy sources and efforts towards conservation are in the public eye and in the priorities of public service officials and industry leaders as never before.

Policymakers face difficult choices when deciding how to allocate funding for energy and the environment. Should the bulk of research funding be dedicated to the implementation of existing technologies, or should more effort be dedicated to designing new technologies that could be of greater long-term impact?

The field of nanotechnology presents special considerations. Nanoparticles could allow us to build ultra-efficient transmission lines for electricity[1], produce far more effective and inexpensive solar cells[2], make cheaper and more efficient biofuels from a wide variety of sources[3], improve hydrogen storage options[4] and performance of hydrogen fuel cells, and improve the safety and efficiency of existing nuclear reactors[5]. Nanoparticles have also demonstrated the ability to pull chemical pollutants out of the ground. These and other developments which could be made possible by nanotechnology might one day do far more to lessen human impact upon the environment than current alternative and renewable energy options. Despite its immense promise in the area of alternative and renewable energies, nanotechnology presents at least two points of major concern:

1. The scope and timetable of nanotechnology's contribution to alternative and renewable energies is uncertain. In a time when immediate action to address increasing energy costs and global climate change may be necessary, the ultimate benefit and risks and short-term promise of nanotechnology is still unknown.

2. Nanotechnology may adversely effect the environment and human health on its own. The toxicity of nanoparticles is not yet fully understood. For example, in some studies, nanoparticles have shown the capability to reduce pollutants in groundwater, but there is concern that they may end up in the groundwater themselves. Nanoparticles may also have as-yet unknown effects upon the health of humans and other animal and plant life. Buckyballs, which are one type of nanoparticle, have caused brain damage in fish, according to research done at Southern Methodist University, and carbon nanotubes have caused respiratory disease in mice and rats in several studies in recent years.

REFERENCES

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2. http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2005/07/11/BUG7IDL1AF1.DTL
3. http://www.physorg.com/news69944274.html
4. http://www.nist.gov/public_affairs/techbeat/tb2005_1201.htm#cages
5. http://web.mit.edu/newsoffice/2006/reactors-0920.html

MISSION STATEMENT OF THE NATIONAL SCIENCE FOUNDATION

NSF's continuing mission is set out in the preamble to the National Science Foundation Act of 1950 (Public Law 810507):

TO PROMOTE THE PROGRESS OF SCIENCE; TO ADVANCE THE NATIONAL HEALTH, PROSPERITY, AND WELFARE; TO SECURE THE NATIONAL DEFENSE; AND FOR OTHER PURPOSES

The Act authorizes and directs NSF to initiate and support:

- Basic scientific research and research fundamental to the engineering process,
- Programs to strengthen scientific and engineering research potential,
- Science and engineering education programs at all levels and in all fields of science and engineering, and
- An information base on science and engineering appropriate for development of national and international policy.

Over time, the following additional responsibilities were added to the agency's mission: (1) foster the interchange of scientific and engineering information nationally and internationally; (2) support the development of computer and other methodologies; (3) maintain facilities in the Antarctic and promote the U.S. presence through research conducted there; and (4) address issues of equal opportunity in science and engineering.

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Personal Sheet/Scenario

Please take a few minutes to read this scenario, and then record your reactions.

Imagine you are a member of the board of the National Science Foundation (NSF), the largest federal funding agency for energy research in the United States. How much funding would you provide to nanotechnology-dependent energy versus other existing alternative energies, versus conservation and energy efficiency?

$100 million is available for funding energy-related research and implementation in the coming year. These funds could be used to research new technologies, implement existing ones, or learn more about the potential hazards that these technologies present. The board must decide how it wants these resources allocated. You can decide to fund all, some, or none of the options below with the funding available to you, but you must decide how much money to spend on each and give reasons for your recommendations.

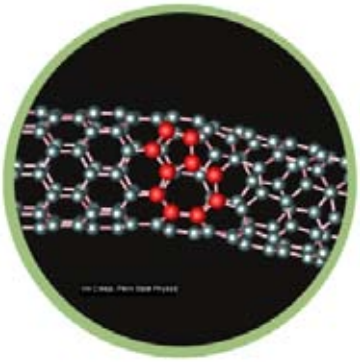
1. **Allocate funding towards existing alternative energies.** Wind and hydroelectric energy, nuclear energy, silicon-based photovoltaic cells, solar hot water systems, biofuels, and many other technologies exist today without the use of nanotechnology. Putting research into expanding and improving these areas might produce a faster impact upon the environment compared with research into nanotechnology. The long-term effects of these more conventional alternative and renewable energy sources might be less than nanotechnology can deliver… or they might be greater.

2. **Allocate funding towards conservation and energy efficiency by improving existing conventional technologies.** According to the EPA, the fuel economy of the average passenger vehicle is the same in 2007 as it was twenty years ago. People across the world are using more energy for their appliances and household electricity each year. Many advocates recommend that the greatest impact would

involve putting research into improving existing technologies such as the gasoline internal combustion engine, and educating the public on ways to cut their own electricity and fuel usage whenever possible.

3. **Allocate funding towards nanotechnology-dependent energy.** The field of nanotechnology could deliver world-altering changes in the ways we create, transmit, store, and use energy. Nanotechnology could produce super-efficient batteries, low-resistance transmission lines, clean up water, or make solar cells far more efficient and less expensive than they are today. However, the likelihood and time frame of these developments is unknown. In addition, the toxicity and regulation of nanotechnology is not well understood.

BEFORE discussing with the other members of your group, please write how much of the **$100 million** YOU would choose to allocate towards each of the following research options.

Nanotechnology-Dependent Energy	Conservation and Energy Efficiency	Existing Alternative Energies
		
$	$	$

After the members of your group have had time to record their personal allocations, you will have time to share and discuss your decisions with the others at your table.

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1 Nanotechnology-Dependent Energy

THE SITUATION:

India, a growing competitor with American industry, starts building a factory that they claim will make affordable nanotechnology-based solar cells within two years.

QUESTION FOR DISCUSSION:

Nanotechnology could help make solar energy a more efficient and affordable solution to the world's energy needs. But if a non-American company is developing a potentially profitable nanotech energy product that could be sold around the world, would that change your support for American nanotechnology research?

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2 Conservation and Energy Efficiency

THE SITUATION:

A new poll suggests that Americans who do not currently recycle are not likely to recycle in the future.

QUESTION FOR DISCUSSION:

If you learn that getting more people to recycle may be difficult, does this make you want to support energy alternatives that don't depend on individual behavior (like nanotechnology, wind, or nuclear), or should money be spent to change the way people think and act about recycling?

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3 Nanotechnology-Dependent Energy

THE SITUATION:

Researchers find nanoscale particles in the groundwater near a site where nanotechnology-based solar cells are tested.

QUESTION FOR DISCUSSION:

Nanotechnology-enabled solar cells have the potential to fulfill major energy needs, but weighing the environmental risks of a new technology is difficult. How would your support for nanotech research change if its byproducts might contaminate water sources?

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4 Existing Alternative Energies

THE SITUATION:

A nuclear reactor melts down, putting people and the environment at risk.

QUESTION FOR DISCUSSION:

With more than 100 nuclear plants, the US currently gets about 20% of its energy from nuclear power. However, despite a relatively safe operating history, concerns remain about the dangers of radioactive materials. Should we devote more future funding to developing safer nuclear processes or to researching new non-nuclear, nanotechnology-based energy solutions?

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5 Existing Alternative Energies

THE SITUATION:

Researchers develop a method of creating biofuel from wastewater residue.

QUESTION FOR DISCUSSION:

Today's biofuels are often made from crops like corn or soy, but using these crops to make fuel instead of food could lead to global food shortages. If other biological sources—like the sludge left over after treating wastewater—could be used for producing biofuel, should more research dollars be put towards finding non-food biofuel sources, or should we keep funding food-crop-based biofuels?

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6 Conservation and Energy Efficiency

THE SITUATION:

A new law makes public charging stations for electric cars mandatory in the parking lots of federal buildings.

QUESTION FOR DISCUSSION:

Electric vehicles produce little or no harmful emissions, but many people won't drive them due to a lack of places to recharge the cars' batteries. Building more charging stations would lead to more people driving electric cars, making us less dependent on petroleum. Should more funding be devoted to educating the public about alternatives to driving, or should funding focus on designing better nanotech-based batteries to increase the range of electric cars?