International Symposium on Assessing the Economic Impact of Nanotechnology
27-28 March 2012, Washington DC

Organised by

Organisation for Economic Co-operation and Development (OECD) and
U.S. National Nanotechnology Initiative

Hosted by

American Association for Advancement of Science

Conference Programme

27-28 March 2012,
AAAS Building, 1200 New York Avenue NW

Washington, DC

Background/Rationale for the symposium

It is widely accepted that national investments in science and technology produce significant long-term economic benefits, yet rigorous frameworks to estimate the return on investment (ROI) have been elusive. More recently, it has been recognized that technology-based economic growth depends on a broad variety of policies and resources, sometimes referred to as an innovation initiatives. Understanding more clearly the components and dynamics of such innovation initiatives would help nations improve investment strategies and policy decisions. Improved understanding of potential ROI from the outcomes of research, particularly for emerging technologies such as nanotechnology, would help inform both public and private investment strategies.

Significant investments have also been made in supporting infrastructure for both R&D and early stage commercialisation. Global annual R&D investment in nanotechnology from public and private sources has been estimated to be about US $15 billion in 2008, of which about US $3.7 billion were invested by the United States. Global venture capital investment in nanotechnology reached about 1.4 billion US dollars in 2008.[1]

Governments around the world have been steadily, and in some cases heavily, investing in nanotechnology R&D for well over a decade. R&D funding for nanotechnology – both public and private - grew about 35% between 2000 and 2008[2].

The strategies under which these investments have been made generally cite potential benefits to society and the economy as driving forces behind national investment in R&D and research oriented infrastructure. More recent strategic investments have included a focus on development of manufacturing capacity, commercialisation, job creation or public engagement and some consideration of the fields of industry where nanotechnologies may begin to deliver some of the envisaged potential benefits.

At the same time, with many economies struggling to emerge from the downturn initiated by the global finance crisis, governments are also looking to assess the economic returns from their significant investments in nanotechnology development. For example, in the United States, the most recent report to the President and Congress assessing the National Nanotechnology Initiative (NNI) strongly highlights the importance of measuring the value of "all products with nanotechnology components, as well as the value of those components".[3] This would help provide an estimate of the importance of nanotechnology in the economy today as well as of the ROI made or planned – for example in terms of job creation or social welfare.

Analysts and consultants have been making predications or forecasts of the potential economic impact and value of nanotechnology since the late 1990s[4][5]. Funding agencies are seeking metrics and ways to collect data on the economic impacts of nanotechnology and on the economic impacts of investments in the development of nanotechnology.

[1] National Science Foundation and the World Technology Evaluation Center, Nanotechnology Research Directions for Societal Needs in 2020, 2010, Springer, Boston.

[2] National Science Foundation and the World Technology Evaluation Center, Nanotechnology Research Directions for Societal Needs in 2020, 2010, Springer, Boston.

[3] President's Council of Advisors on Science and Technology (PCAST), 2010. Report to the President and Congress on the Third Assessment of the National Nanotechnology Initiative.

[4] Roco M.C., R.S. Williams, and P. Alivisatos, eds. 1999. *Nanotechnology research directions: Vision for the Next Decade.* Springer (formerly Kluwer Academic Publishers) IWGN Workshop Report 1999. Washington, DC: National Science and Technology Council. Also published in 2000 by Springer. Available online: http://www.wtec.org/loyola/nano/IWGN.Research.Directions/.

[5] Roco, M.C. and W. Bainbridge, eds., 2001, Societal implications of nanoscience and nanotechnology. Boston: Springer (formerly Kluwer Academic Publishers).

And to date there have been a number of government and academic projects which have been trying to estimate the value of nanotechnology. Several were studying the economic impact of nanotechnology for specific applications. For example, the EU's ObservatoryNano commissioned an economic analysis of nanotechnology specifically for Information and Communication Technologies (ICT) and for photovoltaics. Recently the United Kingdom Department of Environment, Food and Rural Affairs developed a much broader approach, which aimed to develop a methodology able to perform a comparative valuation of a nanotechnology-enabled material or product against an incumbent technology. Findings and methodologies were published early this year[6], however, there is little by way of definitive or generally accepted methodologies to identify or enumerate economic impact or value.

The objective of the symposium is to systematically explore the need for and development of a methodology to *assess the economic impact of nanotechnology* across whole economies, factoring in many sectors and types of impact, including new and replacement products and materials, markets for raw materials, intermediate and final goods and employment and other economic impacts.

Organizers: This symposium will be jointly sponsored by the Working Party on Nanotechnology (WPN) of the Organization for Economic Cooperation and Development (OECD), the U.S. National Nanotechnology Initiative (NNI), and the American Association for the Advancement of Science (AAAS).

Participants: Attendees will be invited from a broad spectrum of backgrounds and expertise, including scientists, engineers, and policy analysts from academia, industry, government, and business; private investors, technology leaders, key decision makers, and the general public.

Topics: Topics covered during the symposium will include economic metrics for other technological assessments and consideration of the appropriateness of these metrics for nanotechnology materials and products. The role of research funding portfolios, intellectual property frameworks, private sector and industry investments, patents and publications, venture capital, public-private partnerships, State and local initiatives, international cooperation, and development of a technologically-educated workforce as metrics for nanotechnology will be examined.

Venue and Timing: This symposium will be held in Washington, DC on March 27 – 28, 2012. This 2-day symposium will include topical presentations by subject matter experts, breakout panels, and networking opportunities.

[6] DEFRA, April 2011, Methodology for estimating, in monetary terms, the benefits of nanotechnology. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=17332

Tuesday March 27, 2012

Detailed timing 8.00-8.30	*Registration and Coffee*
8:30-9:00	*Opening Session* **Welcoming address** **Alan I. Leshner**, CEO, American Association for the Advancement of Science and Executive Publisher of *Science*, United States **Tom Kalil,** Deputy Director for Policy, OSTP, United States **Ken Guy**, Head of the Science and Technology Policy Division, OECD
	Session One: Setting the Scene This plenary session will introduce the conference themes, objectives and expected outputs. The session will provide an overview of the technologies and challenges that impact the assessment of the economic impact of nanotechnology and some indications of metrics being used to perform those assessments. ***Moderator: Robert Wells,*** Head of Unit, Science and Technology Policy Division, OECD
09.00 -09.20	**Presentation 1** **Françoise Roure,** OECD Working Party on Nanotechnology Chair, Head of the Technology and Society Section, Ministry of Economy, Finance and Industry, France
09.20-09.40	**Presentation 2** **Greg Tassey,** Chief economist, National Institute of Standards and Technology (NIST), United States
09.40-10.00	**Overview Background Paper 1** "***Challenges for Governments in Evaluating Return on Investment from Nanotechnology and its broader Economic Impact"*: Mark Morrison,** Chief Executive Officer, Institute for Nanotechnology, United Kingdom.
Coffee Break: 10.00-10.30	
	Session One con't: Government Panel Discussion This panel session will consider the issues raised in Session One, with a focus on the particularities of each country in addressing the challenges in assessing the economic impact of nanotechnology *Moderator:* **Françoise Roure,** OECD Working Party on Nanotechnology Chair, Head of the Technology and Society Section, Ministry of Economy, Finance and Industry, France

10.30 – 12.30	**The government panel will be composed of :** **Adalberto Fazzio**, Deputy Secretary and Coordinator of Nanoscience and Nanotechnology Secretariat for Technological Development and Innovation Ministry of Science, Technology and Innovation, Brazil **Herbert von Bose,** Director, "Industrial Technologies", DG Research, European Commission **G. V. Ramaraju**, Head of Nanotechnology Initiatives Division, Ministry of Communications and Information Technology, India **Kazunobu Tanaka,** Fellow, National Institute of Advanced Industrial Science and Technology, Japan **Joseph Molapisi,** Manager for Emerging Research Areas, Department of Science & Technology, South Africa **Altaf Carim,** Science Division Assistant Director, Nanotechnology, OSTP, United States Panel Participants will firstly provide brief responses to a set of prepared questions on the key issues in assessing the economic impact of nanotechnology for their country / region. This will be followed by an open discussion with the symposium audience.					
Lunch Break: 12:30-13:30						
	Session Two: Exploring the qualitative dimensions of the economic impact of nanotechnology **Assessing the breadth of the potential Economic Impact of Nanotechnology Applications** **Moderator**: **Steffi Friedrichs**, Director General, Nanotechnology Industries Association, Belgium					
13.30-13.50	**Overview of background paper 2 "*Finance and investor models in nanotechnology*": Pekka Koponen**, CEO, Spinverse, Finland**.**					
13.50-14.10	**Overview of background paper 3 "*Economic Contributions of Nanotechnology to Green and Sustainable Growth*": Philip Shapira,** Professor, Manchester Institute of Innovation Research, University of Manchester, United Kingdom, and School of Public Policy, Georgia Institute of Technology, United States.					
14.10-14.30	**Discussion with the Audience**					
14.30-14.45	**Introduction to the Parallel Breakout Sessions**					
14.45-16.45	**Breakout Sessions:** ***Exploring the qualitative dimensions of the economic impact of nanotechnology in the following sectors :*** Breakout groups will consider the scope and range of anticipated economic impacts of nanotechnology by sector					
	Transportation and Aerospace	*Nanomedicine*	*Electronics*	*Energy*	*Materials*	**Food & Food Packaging**

Coffee break incorporated into the session	*Chair and co-chair* **Michael Meador,** Chief, Polymers Branch, Glenn Research Center NASA, United States **Steffi Friedrichs**, Director General, Nanotechnology Industries Association, Belgium	*Chair and co-chair* **Piotr Grodzinski,** Director, Nanotechnology for Cancer programs, National Cancer Institute, United States **Alexander Pogany,** Federal Ministry for Transport, Innovation and Technology, Austria	*Chair and co-chair* **Mike Roco,** Senior Advisor for Nanotechnology, National Science Foundation, United States **Luis Melo,** Professor, Physics Department of Instituto Superior Tecnico (IST), Technical University of Lisbon, Portugal	*Chair and co-chair* **ARPA-E,** DOE, (TBA) **Ingo Höllein**, Deputy Director of New Materials, Nanotechnology, Federal Ministry of Education and Research, Germany (TBC)	*Chair and co-chair* **World Nieh,** Marketing Manager of Forests, United States National Forest Service , United States **Markku Lämsä, Senior Technology Adviser,** Tekes, Finnish Funding Agency for Technology, Finland	*Chair and co-chair* **Hongda Chen,** National Program Leader, Bioprocess Engineering and Nanotechnology USDA, NIFA, United States **WPN delegate –***(TBA)*
	Francis Peters, Materials and Raw Materials Projects Director-Worldwide Michelin **Travis Earles,** Advanced Materials and Nanotechnology Initiatives, Lockheed Martin, United States	**Lawrence Tamarkin,** President CEO, CytImmune, United States **Joerg Vienken,** Vice President BioSciences, Fresenius Medical Care, Germany	**Paulo Freitas,** Deputy Director General, International Iberian Nanotechnology Laboratory, Portugal **Michael Liehr,** Vice President for Research, SUNY, United States *Or* **Michael Fancher,** Vice President for Business Development & Economic Outreach; Director, New York State CATN2; Associate Professor of Nanoeconomics,	**Hilary Flynn**, Senior Analyst, Lux Research, United States **Seth Coe Sullivan,** Founder and Chief Technology Officer, QD Vision, United States	**Reinhold Crotogino,** President & CEO, ArboraNano, Canada **Peter Kruger,** Bayer & EU Working Group Nano-technology	**Kalpana Sastry,** Principal Scientist, Agricultural Research Systems Management and Policies Division, National Academy of Agricultural Research Management, India **Victor Bertucci Neto,** Embrapa Instrumentacao Agropecuria, Brazil

			SUNY, United States			
16:45 – 18.00	**Report Back and Synthesis Conversation**					
18:00	*Reception at AAAS*					

Wednesday March 28, 2012

8.00-8.30	**Coffee**
08:30-9.00	**Nanotechnology Research Directions for Societal Needs in 2020** **Mike Roco,** Senior Adviser for Nanotechnology, National Science Foundation, United States
	Session Three Nanotechnology, Economics, and Regulations This session will consider the impact of socioeconomic issues, evolving standards and regulatory frameworks on nanotechnology investments. **Moderator: Lynn Bergeson,** Bergeson & Campbell, P.C, Unites States.
09.00 - 09.20	**Presentation 1** *business to business & standards* **Ajit Jillavenkatesa,** Senior Standards Specialist, Global Standards and Information Group, National Institute of Standards and Technology, United States.
09.20 - 09.40	**Presentation 2** *socioeconomic issues* **Douglas Robinson,** Managing Director**,** teQnode, France
09.40 – 10.00	**Presentation 3** *regulatory impacts and uncertainty* **Diana Bowman,** Assistant Professor, Risk Science Center and the Department of Health Management and Policy, University of Michigan, United States
10.00 – 10.30	**Discussion with the Audience**
Coffee Break: 10.30 – 11.00	
	Session Four: Science of Science and Innovation Policies applied to nanotechnology This session will consider the links between policies for science and innovation and the economic priorities of governments, and explore systems through which governments currently track public investment and outputs. **Moderator: Sujai Shivakumar,** Deputy Director, Innovation Program, Board on Science, Technology, and Economic Policy, National Academy of Sciences, United States

11.00 - 11.20	**Presentation 1** *- the innovation process and economic value* **Tateo Arimoto** Director-General of Research Institute of Science and Technology for Society (RISTEX), and Deputy Director-General, Center for R&D Strategy (CRDS), Japan Science and Technology Agency (JST), Japan
11.20 – 11.40	**Presentation 2** Star Metrics Project in the U.S. **Julia Lane,** Program director, Science of Science & Innovation Policy, National Science Foundation, United States
11.40 – 12.00	**Presentation 3** Brazilian LATTES System in Brazil **Esper Cavalheiro,** Centre for Strategic Management and Studies in Science, Technology and Innovation
12.00 – 12.30	**Discussion with the Audience**
Lunch Break 12:30-13:30	
	Session Five: Approaches (new and established) to assess the effects of technology investment This would be an overview of approaches emphasizing what could be assessed to understand the impact of technologies and platforms, such as nanotechnology. **Moderator:** Phillip Singerman, Director, Associate Director for Innovation and Industry Services, NIST, United States
13.30 – 13.55	**Presentation 1** **Leonid Gokhberg,** First Vice-Rector, National Research University "Higher School of Economics" (HSE), and Director, HSE Institute for Statistical Studies and Economics of Knowledge, Russian Federation
13.55 – 14.15	**Overview of background paper 4** "***Tool and Metrics Available to Assess the Economic Impact of Nanotechnology, and models that have been applied to assess economic impact of other technologies"***: **Ben Walsh**, Senior Consultant, Oakdene Hollins, United Kingdom**.**
14.15-16:30	***Session Six: Exploring the quantitative dimensions of the economic impact of nanotechnology*** **Introduction and tasking questions:** *TBA* ***Targeted Questions to All Sessions*** • *Current metrics and economic impact?* • *What is not currently being captured with metrics that should be?*

<table>
<tr><td></td><td colspan="6">

- *How relevant are the models for ICT and Biotech to nanotech?*
- *What is a reasonable objective to set for the economic assessment of impact of nanotech in each sector in 3 or 5 years?*

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<tr><td rowspan="3">14.30-16.30

Coffee break incorporated into the session</td><td colspan="6">***Parallel Breakout Sessions: Exploring the quantitative dimensions of the economic impact of nanotechnology***
Same 'sector' breakout groups as day 1, to discuss available data relevant to nanotechnology by sector – availability, quality, sources and limitations</td></tr>
<tr><td>Transportation and Aerospace</td><td>Nanomedicine</td><td>Electronics</td><td>Energy</td><td>Materials</td><td>Food & Food Packaging</td></tr>
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<tr><td>Lance Criscuolo, President, Zyvex Technologies, United States

Speaker 2</td><td>Bertrand Loubaton, Director Pharm & Acad Collab, GE Healthcare & Chair of the European Technology Platform Nanomedicine</td><td>Eunmi Jung, Research Fellow, Korea Institute for Industrial Economics & Trade, Korea

Paolo Gargini , Technical Manager,</td><td>Oleg Karasev, Deputy Director, International Foresight Centre, HSE Institute for Statistical Studies and Economics of Knowledge, Russian Federation
Xing Zhu, Deputy</td><td>Seth Snyder, Section Leader, Process Technology Research, Energy Systems, Argonne National Laboratory, Lab Relationship Manager, DOE Office of the Biomass Program President, Council for</td><td>Lynn Bergeson, Bergeson & Campbell, P.C, Unites States

Rosalie Ruegg, Director, TIA Consulting, United States</td></tr>
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		(ETPN), France. **Richard Clinch,** Director of Economic Development, Jacob France Institute, University of Baltimore, United States	Intel and Director of the International Nanoelectronics Roadmap (*invited)*	Director of National Center for Nanoscience and Technology, China	Chemical Research , United States **Kristen Loughery,** Economist, Environmental Protection Agency, United States	
16.30-17.30	*Report back and Synthesis Conversation*					
17.30 – 18.00	*Symposium Conclusion and Close*					