Assessing the Economic Impact of Nanotechnology: an OECD Perspective

Dr. Françoise ROURE
Chair, Committee « Technologies and Society »
French High Council of Economy (CGE)

SNO Conference
Santa Barbara (CA), 3 November 2013
The origin of the OECD dates back to 1960, when 18 European countries plus the United States and Canada joined forces to create an organisation dedicated to global development.

Today, the 34 OECD member countries span the globe, and include advanced and emerging countries.

OECD also has advisory committees from Business and Industry (BIAC) and Trade Unions (TUAC)
The OECD also works closely with emerging giants like China, India and Brazil and developing economies in Africa, Asia, Latin America and the Caribbean.

The OECD’s focus has broadened and it now maintains co-operative relations with more than 70 non-member economies. The OECD had regional initiatives covering Europe, the Caucasus and Central Asia; Asia; Latin America; the Middle East and North Africa (MENA). The Sahel and West Africa Club creates, promotes and facilitates links between OECD countries and West Africa.

The OECD also works with International Organizations including - International Labour Organization, Food and Agriculture Organization, International Monetary Fund, World Bank, International Atomic Energy Agency, and many other United Nations bodies, the International Transport Forum.
Summary of the Presentation

Introduction: Stakes and Outcomes of the NNI-OECD Symposium

1. Setting the Nano-Economics Scene at Global Scale
   - Indicators and methodologies
   - The Innovation Eco-System for Nanotechnology, a Platform Technology
   - Specific Issues from the Nanotechnology Roadmap towards Converging Technologies

2. Sustainable Nanotechnology and LCA of manufactured goods: the OECD case of the Tyres industry

3. Pathway for Economic Impact: Stakeholders Initiatives
   - From experimental Indicators to a full set of homogeneous Economic Data
   - Back to fundamentals: a universal description system for the nanoscale
   - A Sustainability Assessment Impact (SIA) mechanism for opening up the markets

Conclusion: Two priorities for action at the international level
Introduction

OECD : towards New Approaches of Economic Challenges

The Systemic Economic Crisis and the « Smiling Curve »
1970s – 2010s
Where will your next Business Opportunities stand?

Source: Based on Shih (1992), Dedrick and Kraemer (1999), and Baldwin (2012).
The objectives of the OECD –NNI Symposium on Assessing the Economic Impact of Nanotechnology

- Since its creation in 2007, the OECD WP on Nanotechnology had proposed to address the economic, legal and societal frameworks of Nanosciences and Nanotechnologies in order to provide Governments the right guidance towards a Responsible, Sustainable Development.

- The 27th and 28th of February 2012, a symposium hosted by AAAS in Washington DC, « systematically explored the need for, and development of methodology to assess the economic impact of nanotechnology across whole economies »

- Many sectors and types of impact;
- New and replacement products and materials;
- Markets for raw material, intermediate and final goods;
- Employment and other economic impacts
How much Private Stakeholders are ready to spend in Nanotechnology? *Comparatively Weak Venture Capital.*
1. Setting the Nano-Economics Scene at Global Scale

a) Indicators and methodologies

**Input indicators** (and the global Value-Chain)
- R&D public and private funding
- Investments at large

**Output indicators** and the nanotechnology-induced changes
- Knowledge creation, publications and patents
- Advances in Science and technology
- Production and Commerce

**Impact indicators** for an informed decision making
- Jobs, meeting grand social and environmental challenges
- Framework indicators (on public opinion...)

b) The innovation eco-system: towards a new paradigm

- Nanotechnology as a **key enabling, platform technology**
- **Open innovation**: the difference between be or not to be for Business

c) Specific issues related to the nanotechnology roadmap towards Converging Technologies at the nanoscale

- **The IPR issue** in a brave new world of convergence at the nanoscale
- **Can you measure, integrate, guaranty, insure it?** Nanometrology contribution to the added-value of nanomanufacturing.
Indicator System *(qualitative and quantitative)* for Measuring Nanotechnology Economic Impact.
Nanotechnology Governance Continuum:
How can Economic Knowledge can help Bridging the Gaps

FD Roure, 4 Nov. 2013
OECD Proposed Key Nanotechnology Indicators (KNI) 2013 rely on robust definitions, not yet available

• NANOTECHNOLOGY FIRMS
  – KNI 1 Number of nanotechnology firms (production and/or R&D firms)
  – KNI 2 Percentage of nanotechnology firms with fewer than 50 employees (production and/or R&D firms)

• 2. NANOTECHNOLOGY R&D IN THE ENTERPRISE SECTOR
  – •KNI 3 Nanotechnology R&D expenditures in the business sector
  – •KNI 4 Nanotechnology R&D intensity in the business sector
  – •KNI 5 Percentage of nanotechnology R&D expenditure by dedicated nanotechnology R&D firms in the services sector
  – •KNI 6 Percentage of nanotechnology R&D expenditure performed by small nanotechnology R&D firms

• 3. NANOTECHNOLOGY R&D IN THE PUBLIC SECTOR (GOVERNMENT + HIGHER EDUCATION SECTOR)
  – KNI 7 Intramural nanotechnology R&D expenditures in the public sector
  – KNI 8: Nanotechnology R&D expenditures in the public sector as a percentage of total R&D expenditure in the public sector
  – Possibility to look at firms by application – to be explored

• 4. NANOTECHNOLOGY PATENTS (from existing OECD data)
  – KNI 10 Share of countries in nanotechnology patents filed under PCT (calculated by OECD Secretariat using OECD Patent Database)
  – KNI 11 Revealed technological advantage in nanotechnology (calculated by OECD Secretariat using OECD Patent Database)
### Addressing the limits: Availability of DATA (2013)

<table>
<thead>
<tr>
<th>Country</th>
<th>Nanotech data availability</th>
<th>Nanotech data availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>No</td>
<td>Korea</td>
</tr>
<tr>
<td>Austria</td>
<td>No</td>
<td>Luxembourg</td>
</tr>
<tr>
<td>Belgium</td>
<td>Yes</td>
<td>Mexico</td>
</tr>
<tr>
<td>Canada</td>
<td>Yes*</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Chile</td>
<td>No</td>
<td>New Zealand</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Yes</td>
<td>Norway</td>
</tr>
<tr>
<td>Denmark</td>
<td>Yes</td>
<td>Poland</td>
</tr>
<tr>
<td>Estonia</td>
<td>No</td>
<td>Portugal</td>
</tr>
<tr>
<td>Finland</td>
<td>No</td>
<td>Russian Federation</td>
</tr>
<tr>
<td>France</td>
<td>Yes</td>
<td>Slovak Republic</td>
</tr>
<tr>
<td>Germany</td>
<td>Yes*</td>
<td>Slovenia</td>
</tr>
<tr>
<td>Greece</td>
<td>No</td>
<td>South Africa</td>
</tr>
<tr>
<td>Hungary</td>
<td>No</td>
<td>Spain</td>
</tr>
<tr>
<td>Iceland</td>
<td>No</td>
<td>Sweden</td>
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<tr>
<td>Ireland</td>
<td>Yes</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Israel</td>
<td>No</td>
<td>Turkey</td>
</tr>
<tr>
<td>Italy</td>
<td>Yes</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Japan</td>
<td>Yes</td>
<td>United States</td>
</tr>
</tbody>
</table>
OECD Indicators for Nanotechnology online.

But Very Few Economic Indicators available.

1. Nanotechnology firms
   KNI 1 Number of firms active in nanotechnology, 2011 or latest available year
   KNI 2 Percentage of small nanotechnology firms, 2011 or latest available year

2. Nanotechnology R&D
   KNI 3 Nanotechnology R&D expenditures in the business sector, 2011 or latest available year
   KNI 4 Nanotechnology R&D intensity in the business sector, 2011 or latest available year
   KNI 5 Percentage of nanotechnology R&D expenditure by dedicated nanotechnology R&D firms in the services sectors, 2011 or latest available year
   KNI 6 Percentage of nanotechnology R&D expenditure performed by small nanotechnology R&D firms, 2011 or latest available year

3. Public-sector nanotechnology R&D
   KNI 7 Intramural nanotechnology R&D expenditures in the government and higher education sectors, millions of USD PPP, 2011 or latest available year
   KNI 8 Intramural nanotechnology R&D expenditures in the government and higher education sectors as a percentage of total government and higher education sectors R&D expenditures, 2011 or latest available year

4. Nanotechnology patents
   KNI 9 Share of countries in nanotechnology patents filed under PCT, 2008-10
   KNI 10 Revealed technological advantage in nanotechnologies, 1998-2000 and 2008-10

Nanotechnology statistics: Methodology 2013 (xls)
STI Scoreboard 2013 indicators on nanotechnology

http://www.oecd.org/sti/ nanotechnology-indicators.htm

Nanotechnology Impact Assessment, Amplifiers and Multipliers

IN VOLVING ECONOMISTS!

Micro
- Global Industrial Forum on nanotechnology-induced changes
- Potential role of OECD

Meso
- CONVERGENCE
- Understanding Multipliers
- Value Chains

Macro
- Productivity
- Contribution to Growth
- Contribution to Jobs
- Contribution to Quality of Life
Assessing Public/Private Spending in Nanotechnology: Elements of International Benchmark

Source: PCAST, 2012
Accountability for Public Spending in Nanotechnology towards a Responsible R&D Scheme.

<table>
<thead>
<tr>
<th>Country</th>
<th>Funding programmes</th>
<th>Nano-specific?</th>
<th>Period</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>Ministry for Science &amp; Technology</td>
<td>no</td>
<td>Annual estimate</td>
<td>R$11.87 million (€4.9 million)</td>
</tr>
<tr>
<td>China</td>
<td>Medium &amp; Long Term Development Plan</td>
<td>yes</td>
<td>2006-2008</td>
<td>US$38.2 million (€29.1 million)</td>
</tr>
<tr>
<td>European Union</td>
<td>Framework Programme 7</td>
<td>no</td>
<td>2007-2013</td>
<td>€3.5 billion²³</td>
</tr>
<tr>
<td>France</td>
<td>Nano 2012 Programme</td>
<td>yes</td>
<td>2008-2012</td>
<td>€500 million²⁴</td>
</tr>
<tr>
<td>Germany</td>
<td>Nano Initiative – Action Plan 2010</td>
<td>yes</td>
<td>2008-2013</td>
<td>€370 million²⁵</td>
</tr>
<tr>
<td>India</td>
<td>Nano Mission</td>
<td>yes</td>
<td>2007-2012</td>
<td>Rs. 1000 crore (€144.8 million)</td>
</tr>
<tr>
<td>Japan</td>
<td>MEXT</td>
<td>no</td>
<td>Annual estimate</td>
<td>€470 million²⁷</td>
</tr>
<tr>
<td>Russia</td>
<td>Development of nanotechnology infrastructure in the Russian Federation for 2008 - 2011</td>
<td>yes</td>
<td>2008-2011</td>
<td>€693.3 million²⁸</td>
</tr>
<tr>
<td>UK</td>
<td>Research Councils UK/Technology Strategy Board</td>
<td>no</td>
<td>Annual estimate</td>
<td>€256 million²⁹</td>
</tr>
<tr>
<td>USA</td>
<td>National Nanotechnology Initiative</td>
<td>yes</td>
<td>2012</td>
<td>$2.1 billion (€1.6 billion)</td>
</tr>
</tbody>
</table>

Source: OECD 2012

VAT/Customs/Official Census/Registries Declarations

Investment
Production
Commerce
Jobs

5 to 9 digit Statistical Nomenclatures

CPC/Eurostat NACE Nat. « Census « Bodies

OECD NESTI + WPN

FD Roure, 4 Nov. 2013
Impact Metrics for a Nanotechnology Innovation cluster model. The Multiplier Effect.

<table>
<thead>
<tr>
<th>Year of Initial Commercialization</th>
<th>Short-Term</th>
<th>Medium-Term</th>
<th>Long-Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5</td>
<td>Partnership structures &amp; strategic alliances organized</td>
<td>Supply-chain structure established</td>
<td>Broad industry and national economic benefits</td>
</tr>
<tr>
<td>-4</td>
<td>New research facilities and instrumentation in place</td>
<td>New-skilled graduates produced</td>
<td>➢ Return on investment</td>
</tr>
<tr>
<td>-3</td>
<td>New firm formation</td>
<td>Compression of R&amp;D cycle</td>
<td>➢ GDP impacts</td>
</tr>
<tr>
<td>-2</td>
<td>Initial research objectives met/increased stock of technical knowledge</td>
<td>New technology platforms &amp; infratechnologies produced</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>Commercialization</td>
<td>Commercialization</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>➢ New products</td>
<td>➢ New processes</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>➢ Licensing</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>8</td>
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</tbody>
</table>

Nanomaterials are Advanced Materials Designed for purpose, with specific nanoscale properties

Materials are KNOWLEDGEmediaries (intermediaries of knowledge).

They contribute, with nano-systems, to the Multiplier Effect.

Materials embed and «transfer» the new knowledge into new products and processes, therefore we hear of «(re)active» or «intelligent» materials, materials that «perform a work»

New knowledge — New materials — New products & processes — Growth & Jobs

new atomic, time and scale precision industry

Adapted from EU/Renzo Tomellini
Ex. of a Value Chain: *nano-battery in a green car*

Potential economic impacts:
- Low cost, high availability of material, safety
- Increased energy and power density, reduced costs, non-toxic
- Skilled job creation, high value industry expansion, other applications
- Market growth expected, job creation, displacement of fossil fuels

Challenges for economic assessment:
- Key indicators are patents and publications - issue of definition
- Key indicators are patents and publications - issue of definition
- Data reliant on surveys of manufacturers
- Battery is only one part - also light-weighting, tyres, energy scavenging, etc

Challenges in evaluating Return on Investment in Nanotechnology and its Broader Economic Impact

- The OECD-NNI Symposium took stock of the fact that there are no accepted definitions of nanotechnology products, processes and companies, yet they are essential for collecting data and comparing countries.

« The fact that nanotechnology can have an impact along the value chain highlights the need for those collecting economic data to understand fully the impact of nanotechnology:

- at each stage of the value chain and across the multi-disciplinary/multi-application value chains that can arise from the enabling nature of nanotechnology,
- and its potential to contribute to solutions for many global challenges »
Global Investment for Leadership in Global Markets: Where does the Added-Value stand in NanoManufacturing

Estimated Value of *Advanced Materials* (VAM) H2050 (Unit: Billion €)

<table>
<thead>
<tr>
<th>Table 1: VAMs market share by sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
</tr>
<tr>
<td>Energy</td>
</tr>
<tr>
<td>Transport</td>
</tr>
<tr>
<td>Environment</td>
</tr>
<tr>
<td>Health</td>
</tr>
<tr>
<td>ICT</td>
</tr>
<tr>
<td>Others / Cross-cutting</td>
</tr>
<tr>
<td><strong>Total projected value of identified VAMs markets</strong></td>
</tr>
</tbody>
</table>

Source: Oxford Research AS. Unit: billion euro.
**VALUE CHAIN 1: Lightweight multifunctional materials and sustainable composites**

1. Nano-enabled Multilayer barrier materials, Y1, Pilot lines up to TRL 7
2. Cost effective industrial scale technologies for synthesis and technologies for dispersion/exfoliation (extrusion), Y1, Open access pilot lines, up to TRL 6
3. Synthesis and functionalization of particles for functional nano-inks used in flexible and rigid electronics, Y1, Pilot lines up to TRL 7
4. Integration of novel nano materials into existing production and assembly lines, Y2, Pilot lines up to TRL 8
5. High performance nano composites, Y2, Pilot lines up to TRL 8
6. Analysis and process control of dispersion of nanofillers into polymers, Y2, Metrology R&D up to TRL 6
7. Precise control of morphology in nanoporous materials, Y2, Metrology and process development up to TRL 6
8. Cost effective industrial scale synthesis and technologies for nanofibers, Y3, Pilot lines up to TRL 7
Quality Control of Surfaces at the nanoscale: an Added Value of Nano Systems.

Quality Control of a Coin’s surface
(20 cents (€))

Source: ZYGO
Rugosité, Planéité
Symposium Outcome: Nanotechnology as a Platform Technology, and adapting IPR models for Innovation.

• For Platform, Enabling Technologies like Converging Technologies, industrial challenges come from economies of scope more than economies of scale to serve a heterogeneous set of submarkets with a generic production system.

• Comparative Advantages come from the Management of the Whole Technology Life Cycle

• The « Missing Middle » between TRL 4 to 7 is where investment is so crucial to capture added value (Tech. translation, Tech. transfer to manufacturing)

• IPR must be protected indeed, and adequately...
  • ...BUT traditional IPR models will fail to provide innovation at the right pace.

• In Emerging Technologies, Innovation comes from:
  • Societal needs and expectations more than from technology push;
  • Aggregation of existing Patents in affordable economic conditions
  • A stable and incitative legal and economic framework
  • Compliance to Sustainability and Accountability on Corporate Societal Responsibility
2. Sustainable Nanotechnology and LCA of manufactured good: *the OECD ongoing case of the Tyres industry (2012-2014)*

a) **What’s in, why choosing this industry? An OECD template.**
   - Intentionally manufactured nanomaterials: the list
   - Economic impact of nano-enabled tyres

b) **Sustainability, LCA and socio-economic responsibility**
   - Protecting occupational health in the nanomanufacturing of tyres
   - Protecting the environment along the tyres whole life-cycle

c) **The contribution of standards in tyre nanomanufacturing development and beyond**
   - Definitions, characterization and reproducible EHS tests for manufactured nanomaterials: voluntary contribution. ISO+OECD
   - Adapting the industrial process to the societal and regulatory requirements: a pre-competitive issue.
Project components

Tyres case study

- Joint project between WPMN and WPN, supported by the Tyre Industry Project of the World Business Council for Sustainable Development

- The case study will consider many issues arising from the use of nanotechnology and nanomaterials in the tyre industry including:
  - Status of the technology
  - Societal impacts;
  - Positive & negative environmental impacts through LCA;
  - Environmental Health and Safety risks & best practices; and
  - Knowledge & best practice transfer
Sustainable development of Nanomaterials in Tyres an *ongoing* OECD Case Study
## Tyres: What’s in It?

<table>
<thead>
<tr>
<th>Technology</th>
<th>Example trade names</th>
<th>Loading</th>
<th>Technology Readiness</th>
<th>Application</th>
<th>Developers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon black</td>
<td>Corax, Ecorax (Evonik) Vulcan (Cabot)</td>
<td>50-100 phr</td>
<td>Mature</td>
<td>Improve mechanical properties</td>
<td>Prell, Nanotek Instruments Inc. Princeton University</td>
</tr>
<tr>
<td>Silica + Silane</td>
<td>Ultrasil (Degussa) Zeosil (Rhodia); HiSil (PPG Industries)</td>
<td>30-80 phr</td>
<td>Mature</td>
<td>Lower rolling resistance with compromising performance</td>
<td>Lanxess, Rhein Chemie; Toyo Tire</td>
</tr>
<tr>
<td>Montmorillonite Clay (MMT)</td>
<td>Delite (Laviosa Chimica Mineraria S.p.A); Closite (Southern Clays); Bentonite AG/3 (Dal Cin S.p.A); Nanofil (Sud Chemie)</td>
<td>1-10phr</td>
<td>Market entry / Prototype</td>
<td>Decrease gas permeability, better trade-off between hair and comfort, better thermoplastic stability and reduced decay. Sealing inside of tyres; pot decreasing amount of rubber making tyres lighter and cox running (lowering rolling resistance).</td>
<td>ExxonMobil</td>
</tr>
<tr>
<td>Core/shell Polymer nanoparticles</td>
<td>NanoProTech: Core Composition 66% styrene / 14% divinylbenzene</td>
<td>&lt;20phr</td>
<td>Market entry</td>
<td>Improvement in cornering, steering response; reduced generation. Weight reduction since the core-shell particle; significantly less dense than carbon black or silica fillers.</td>
<td>Kumho; Cabot; ExxonMobil (&quot;silica gels&quot;); Nissan; Hankook</td>
</tr>
<tr>
<td>Carbon Nanotubes (Multi-wall)</td>
<td>Baytubes (Bayer) Fibril (Hyperion Catalysis)</td>
<td>1-10phr</td>
<td>Basic research / Applied Research</td>
<td>Reduce rolling resistance in reduced heat generation. Increased durability – possibly even peak life of the car itself. Improved tensile strength, tear strength and hardness of the composites, by almost 600%, 250% and 70% respectively compared to pure styrene-butadiene rubber</td>
<td>Nexen, Sumitomo, Lanxess, Goodyear</td>
</tr>
</tbody>
</table>

**Notes:** phr = parts per hundred (rubber)
OECD Template for Sustainability of Nanotechnology in the Tyre Industry: elements of methodology

- **Life Cycle Inventory (LCI):** examines the sequence of steps in the life cycle boundaries of the product system, beginning with raw material extraction and continuing on through material production, product fabrication, use, and reuse or recycling where applicable, and final disposition. For each life cycle step, the inventory identifies and quantifies the material inputs, energy consumption, and environmental emissions (atmospheric emissions, waterborne wastes, and solid wastes). In other words, the LCI is the quantitative environmental profile of a product system. Substances from the LCI are organised into air, soil, and water emissions or solid waste.

- **Life Cycle Impact Assessment (LCIA):** characterises the results of the LCI into categories of environmental problems or damages based on the substance’s relative strength of impact. Characterisation models are applied to convert masses of substances from the LCI results into common equivalents of one category indicator.

- **Interpretation:** uses the information from the LCI and LCIA to compare product systems, rank processes, and/or pinpoint areas (e.g. material components or processes) where changes would be most beneficial in terms of reduced environmental impacts. The information from this type of assessment is increasingly used as a decision-support tool.

Nano-enabled tyres will be evaluated relative to reference tyres (i.e. tyres that do not contain nano-materials) and the associated difference in life cycle impacts quantified for each life cycle phase: 1) nanomaterial production, 2) tyre production, 3) use, and 4) end-of-life.

The study will comply with the following voluntary international standards for LCAs:

- **ISO 14040:** 2006, Environmental management – Life cycle assessment – Principles and framework
- **ISO 14044:** 2006, Environmental management – Life cycle assessment – Requirements and guidelines
OECD Template Meeting SNO expectations? More initiatives welcomed from Industries which would wish to use it! *PoW 2015-2016 in preparation now...*

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**Develop a Life-Cycle Assessment Appropriate for Green Nanoproducts.** Before a product or production process can be considered green, the product’s EHS implications must be assessed using an appropriately tailored life-cycle assessment (LCA) that is capable of identifying and quantifying nanotechnology EHS implications and gauging the trade-offs that arise in the context of their applications. An LCA is a comprehensive management tool that is used to evaluate how a material and/or a product, from the status of production through end-of-life, affects ecosystems and human health.

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**Source:**

*Sustainable Nanomaterials: Emerging Governance Systems*

Lynn L. Bergeson*

Bergeson & Campbell, P.C., 2200 Pennsylvania Avenue NW Suite 100W, Washington, District of Columbia 20037

a) From **experimental indicators to a full set of homogeneous economic data**
   - Still under construction at OECD level but in progress *
   - Qualitative indicators may help mapping out potential users requirements and avoid stranded investments
   - A certain sense of urgency as regards accountability of public policies and spending in nanotechnologies (US GAO...)

b) Back to fundamentals: a **universal description system to support responsible development of nanotechnology and its economic assessment** is needed
   - The “logic cascade” (from 3D representation to robust ontology supporting Information Systems)
   - The traceability issue (citizens, consumers, public stakeholders requirements) and ISO TG2 CASD (consumers and societal dimension of standards) potential contribution

c) Opening up the nano-related markets with a **Sustainability Impact Assessment (SIA)**
Indicator of Revealed Comparative Advantage for Nanotechnology (*share of nano patents in the total of patents*)

Oct. 2013
Nanotechnology in the Business Sector (USD PPP \( (\text{left}) \) and % of Total Business expenditure on R&D \( (\text{right}) \)). OECD 2013

Note: This is an experimental indicator. International comparability may be limited.
Comparing an input and an output indicator to measure an impact: *Investment/Patents by subsets of nano-applications in Japan*

(Source: OECD/NNI Symposium on Assessing the Economic Impact of Nanotechnology, 27-28 March 2012, Presentation by Mr. Kaneko, Fellow, Centre for R&D Strategy, Japan Science and Technology Agency, Japan.)
NanoMaterial Traceability: if and when technically feasible (radioactive and non-radioactive methods) ... then expected by regulators and society at large.

- **Science**
  - Representation
  - « metrics »

- **Industry**
  - Presence / detection
  - Characterisation

- **Society**
  - Quantity/properties and Impact
  - Risk Assessment

- **Ontologies**
  - Describing, Naming, Defining and Ontologies

- **Value Chain**
  - Producing and The Value Chain and LCA until final waste management

- **Legal Framework**
  - Governance Continuum and The Cascade of Responsibilities

FD Roure, 4 Nov. 2013
Is « Free Text » appropriate and sustainable for IUCLID/REACH Nano-Substance declaration?

- General information/Reference substance name: the label for the nanoform is given here “nano [substance] 1”
- EC inventory: the EC entry of the bulk substance may be included here (note that following this manual will not validate any decision on the substance identity made by a registrant)
- CAS information: the CAS number of the bulk substance may be included here if one for the nanoform is not available
- IUPAC name: as there is no current IUPAC name or similar international nomenclature, a descriptive commonly used name for the nanomaterial can be given
- Description: a description of the nanoform can be inserted here as free text
- Synonyms: the other names of the nanoform can be inserted here as free text

NanoMaterials in IUCLID 5
Feb. 2013, Guide for Users
Converging Technologies at the Nanoscale raise Dual Use Research Concerns (DURC)

Addressing Risks and Responses at a Global Level

The project aimed to scan the horizon for developments in the technology fields of synthetic biology and nanobiotechnology that may – depending on their current or future ease of use and access – place potentially dangerous capabilities at the disposal of groups or individuals that are bent on causing harm to society.

A Sustainability Impact Assessment (SIA) mechanism in the coming T-TIP: An opportunity to open up global nanotechnology markets.

Trade Sustainability Impact Assessments are a policy tool for the prior assessment of the economic, social and environmental implications of a trade negotiation. They are carried out during the underlying negotiation, and helps integrate sustainability into trade policy.

These assessments were first developed in 1999 for WTO negotiations.

These assessments help to integrate sustainability into trade policy: by analysing the issues covered by a trade negotiation from a sustainable development perspective,

- by informing negotiators of the possible social, environmental and economic consequences of a trade agreement;
- by providing guidelines for the design of possible flanking (complementary) measures, the scope of which can extend beyond trade policy (eg, internal policy, capacity building, international regulation), and which are intended to maximise the positive impacts and reduce any negative impacts of the trade negotiations in question.
Conclusion – General Remarks
Addressing global Economic issues (public and private)

- If economic assessment may require adaptation for nanotechnology and its converging technologies future, **homogeneous economic indicators shall require extensive and long lasting international cooperation** intergovernemental and non governmental).

- **Sustainability of nanotechnology may be challenged in the future by the molecular nanotechnology, synthetic biology applications and converging technology applications**, which raises the levels of complexity and uncertainty including for economic impact assessment models.

- As regards Converging Technologies, OECD provided guidance at ministerial level in 2012 for sustainable bio-sourced products supporting the path towards Bioeconomy.

- But **a huge effort in standard setting** is required for terminology, characterization and EHS reproducible and affordable tests, inclusive of Consumers and Citizens requirements.
Nanotechnology Impact Assessment: THREE Areas for International, Intergovernmental Cooperation

- Description
- Counts and Statistics
- Impact Assessment

Bridging Governance Gaps

FD Roure, 4 Nov. 2013
A Universal System of Description for nano-objects and manufactured nanomaterial: *pre-requisite*

- **Metrology**
  - BIPM
  - VAMAS, ICSU

- **Standards**
  - ISO, IEC, IEEE
  - Nat. Stand. Bodies

**KNOWLEDGE DATABASES**

**LINKING DEFINITION TO SCIENCE-BASED, STANDARDIZED DESCRIPTIONS**

Towards a ICSU-CODATA/OECD guidance?

FD Roure, 4 Nov. 2013
An International Initiative towards a Unified System to Describe Nano-Objects/Nanomaterials

ICSU/CODATA and OECD WPN initiative:

« An international, pre-standardization project is needed to develop multi-disciplinary, multi-use requirements of the data necessary to describe materials at the nanoscale » Open access, open source, well curated meta database. »

- Next Step 2013:
Since the workshop, a joint CODATA/VAMAS (Versailles Project on Advanced Materials and Standards) working group has been established with the objective of developing a pre-normative White Paper setting out the requirements for a description system for materials at the nanoscale. and multi-lingual basis.

Expected Impacts: Metrology, Scale-Up, Innovation, Quality, Traceability, IP revenues, Fair International Trade, Security, Safety to increase Investors, Citizens and Consumers trust; Convergence of Regulatory Frameworks
Conclusion –

Two Priorities for Action at International Level

In the short run, two actions are proposed:

- Engaging an international cooperation aiming at a universal system of description/descriptors at the nanoscale, well curated and its corresponding meta-database available (accessible): a prerequisite for improving any kind of assessments (technology, safety, security, EHS, economic, industrial, commercial, IPR, regulatory). Cf. On going ICSU-VAMAS White Paper.

- An opportunity from 2013 to 2015 to go beyond the “precautionary principle” traditional commercial disputes: the SIA (Sustainable Impact Assessment) T-TIP mechanism, which could be “powered” by the “RRII” concept “engine”, then disseminated at a global scale. Economic impact: lowering non tariffs, technical barriers to trade (TBT), lowering cost production and avoiding dumpings of any sort (economic, environmental and societal). Cf. CETA/ Canada-EU Trade Agreement SIA available report.

- SNO Members Initiatives are most welcomed at OECD Level via US Delegation to OECD and BIAC (OECD Industrial Advisors)
A European Perspective to Nanotechnology: The Invisible GIANT
Tackling Europe’s Futur Challenges
Assessing the Economic Impact of Nanotechnology: an OECD Perspective

Thank You for Your Attention

Dr. Françoise ROURE
Chair, Committee « Technologies and Society »
French High Council of Economy

SNO Conference
Santa Barbara (CA), 4 November 2013