Paper 1: Challenges for Governments in Evaluating Return on Investment from Nanotechnology and its broader Economic Impact

Eleanor O'Rourke and Mark Morrison

Institute of Nanotechnology

Registered Scottish Charity, No. SC025709

Scope of this paper:

- Key Challenges for Governments in Assessing Nanotechnology Value
- Nanotechnology Investment Policy Landscape - Government
- Currently Available Data and Needs for Successful Future Investment
- Defining the Economic Impact of Nanotechnology
- Conclusions

Public investment in nanotechnology

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

Focus differs:

- Most countries now focus more on improving links between innovation and value chains for nanotechnology, rather than purely fundamental research
- However, some no longer have nano-specific programmes: UK and Japan in particular instead favour focusing on challenge rather than technology driven research

Key challenges:

- Nanotechnology is one of many options (technological and otherwise) available to governments – how to disentangle these?
- Definition of nanotechnology can affect data collection and interpretation
- The impact of nanotechnology can be direct or indirect (both on a micro and macro-economic level)

‘Nano’ is one of several tools available to effect socio-economic change:

- It is one of several Key Enabling Technologies and there are many overlaps
- These are heavily invested in with the purpose of transforming industry and creating new products and services
- As a result these address Societal Grand Challenges
- However they are not the only solution ...

Disentangling ‘nano’ from everything else:

- Other KETs – poorly defined boundaries, many research programmes include more than one
- Fiscal and legislative policies – can drive new technology development, but also hinder it
- Communication and education – not all solutions are technology based, engaging with and educating society can have the desired effect

Direct and indirect economic impacts of technologies also cloud the picture

Direct	vs	Indirect
• Increased market share • Growth of new companies • Job creation • New products • Wealth creation		• More difficult to define, and depends on the nature of the technology development

Examples of indirect economic impacts following a technology development:

Technology development leads to ...	Indirect economic impacts
Reduced deaths from cancer through earlier detection	• Fewer hospitalisations and deaths • Lower treatment costs • Lower state benefit payments • Freeing resources to address other diseases
Improved lithium ion batteries for electric vehicles	• Energy security • Lower pollution
Novel display technologies	• Replacement of rare or toxic materials • Lower energy usage

May not always be positive, e.g. displacement of industry and jobs, requirement for additional investment

Where does nanotechnology 'fit in' to product development?

Direct	vs	Indirect
• Nanomaterials included within the value chain • Nanoscale features fundamental to the functionality of components • Nanoscale features inherent in the final product • Final product functionality and novelty strongly dependent on nanotechnology		• Nanomaterials anciliary to the value chain – affecting processes • Nanoscale features not necessarily present in components • Nanoscale features not necessarily evident in the final product • Final product functionality and novelty independent of nanotechnology

Is the problem definition?

- Everyone from ISO to Patent Offices to National and International funding bodies to Industrial Associations has presented definitions of nanotechnology
- While broadly similar they can vary in certain key respects
- Exemplified by the European Commission vs the International Council of Chemical Associations:

EC: nanomaterial contains 50% or more particles with nanoscale features

ICCA: nanomaterial contains a certain percentage weight of particles with nanoscale features

How does this affect data collection?

Data collection to measure nanotechnology

- **Input indicators**, e.g. public investment, infrastructure, number of graduates
- **Output indicators**, e.g. publications, patents, product sales
- **Impact indicators**, e.g. number of companies, number of jobs, growth of market or volume share

Data collection issues

- Do companies see themselves as nanotech companies?
- If they do, how do they dissect and attribute parts of the business to nano?
- From the perspective of government funding, how to identify what funding is ‘nano’ and the influence it has?
- How to measure the worth of patents (and publications)?

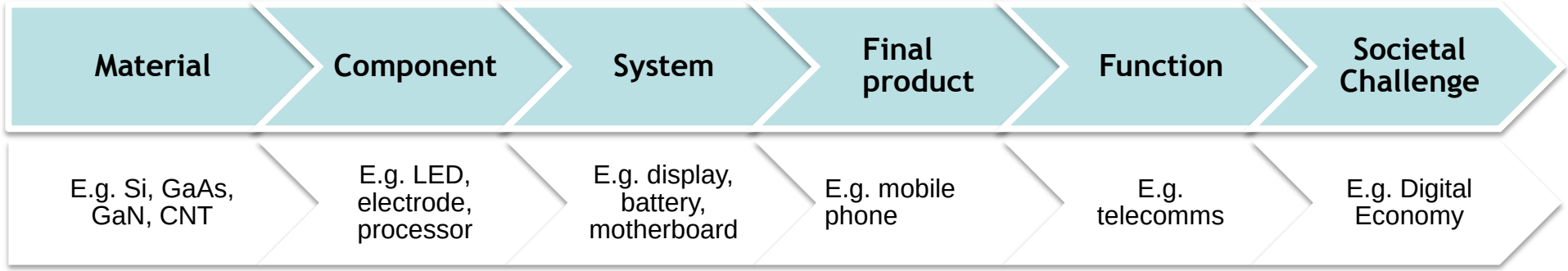
Mapping companies:

- The ObservatoryNANO FP7 project began a mapping exercise of European companies manufacturing products or delivering services utilising nanotechnology
- It used FP7 NMP funding for nanotechnology, publications and patents to identify companies
- However, of over 1540 companies identified only 100 were willing to participate, with the food industry particularly reluctant
- How to ensure a better take-up?

Defining the economic impact of nanotechnology

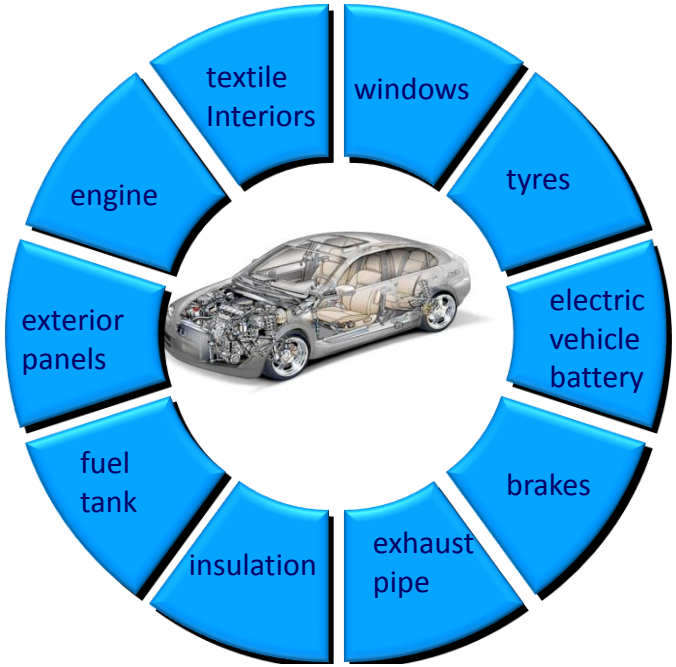
- **Nanotechnology product** – nanotechnology is fundamental to functionality
- **Nano-enabled product** – nanotechnology provides functionality, but final product may contain few nanomaterials
- **Products that utilise nanotechnology** – nanotechnology impacts the production process, the final product may contain no nanomaterials and its functionality may not have been altered by nanotechnology

Value chains for assessing the impact of nanotechnology:



Value chains for assessing the impact of nanotechnology:

Material → Component → System → Final product

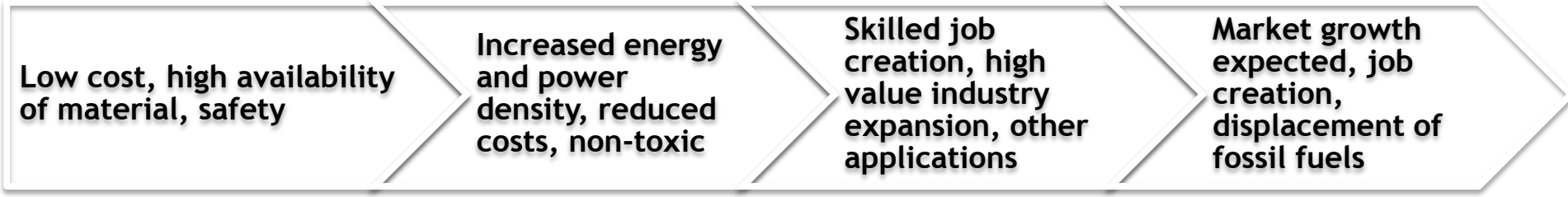


Green Car

Jam

The Green Car:

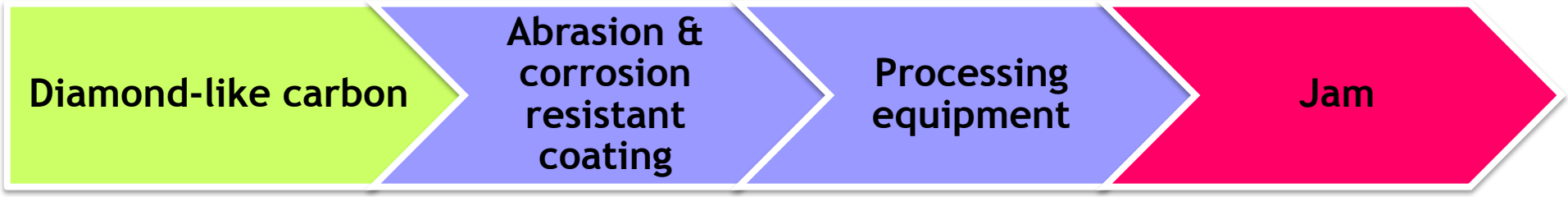
Potential economic impacts



Challenges for economic assessment

Overall issues – disentanglement in what is a complex multi-value chain product

Jam:



Potential economic impacts

Challenges for economic assessment

Overall issues - determining impact when final product is not nano

Conclusions:

- Nanotechnology operates alongside other interventions – it is necessary to understand the contribution each makes, when attributing value and impact
- The nanotechnology policy landscape is evolving, as countries employ more challenge and manufacturing focused policies and strategies
- Agreed international definitions of nanotechnology and nanotechnology products will assist data collection and comparison between countries
- Improvement to survey collection, as these are the means to capture data for key indicators
- Assessment of the whole value chain (rather than final product) to measure the full impact of nanotechnology

Acknowledgements:

- OECD for supporting this paper
- ObservatoryNANO and NMP Scoreboard for value chain analysis, mapping the European landscape and developing indicators for the assessment of nanotechnology – both funded by the EC
- Eleanor O'Rourke (now at Swedish Meteorological and Hydrological Institute)

For more information: mark.morrison@nano.org.uk
+44 (0)141 303 8444