User Needs for a Sustainable Nanotechnology Framework

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Presentation Outline

- Problem Formulation
- ✓ Industrial Sustainability
- ✓ Sustainable Nanotechnology

- SUN User Workshop Findings on user needs for sustainability assessment methods

- SUNDS Framework
- ✓ Tier 1
- ✓ Tier 2

- Conclusions

- Future Directions for SUNDS Development

Industrial Sustainability

- European Commission recommends addressing industrial sustainability through integrative environmental, climate, energy and industrial policies

- Literature approaches industrial sustainability at levels of product, production process, industry, supply chain, sector, and industrial policy

- Six Key Enabling Technologies (KETs) considered to have an important role toward achievement of industrial sustainability goals

✓ Micro and nanoelectronics
✓ Nanotechnology
✓ Industrial biotechnology
✓ Advanced materials
✓ Photonics
✓ Advanced manufacturing technologies

How can the impact of KETs on industrial sustainability be assessed?

Sustainable Nanotechnology

- Development of safe nano-enabled **products** is considered an important aspect of its sustainability at the current stage of its development

- Triple Bottom Line (TBL) approach comprising of environmental, economic and societal pillars has been adopted in the context of product sustainability

- Multi Criteria Decision Analysis (MCDA) can be used to integrate evaluative criteria for nano-enabled products within each TBL pillar, and also with stakeholder preferences

- Techniques like sensitivity analysis and uncertainty estimation can pinpoint sensitive and uncertain elements of a sustainable nanotechnology decision model

What criteria should be included in a sustainable nanotechnology decision model?

SUNDS User Workshop

- Held in Utrecht (NL) in October 2014 to understand needs of industry, regulatory and insurance sectors with respect to SUNDS design

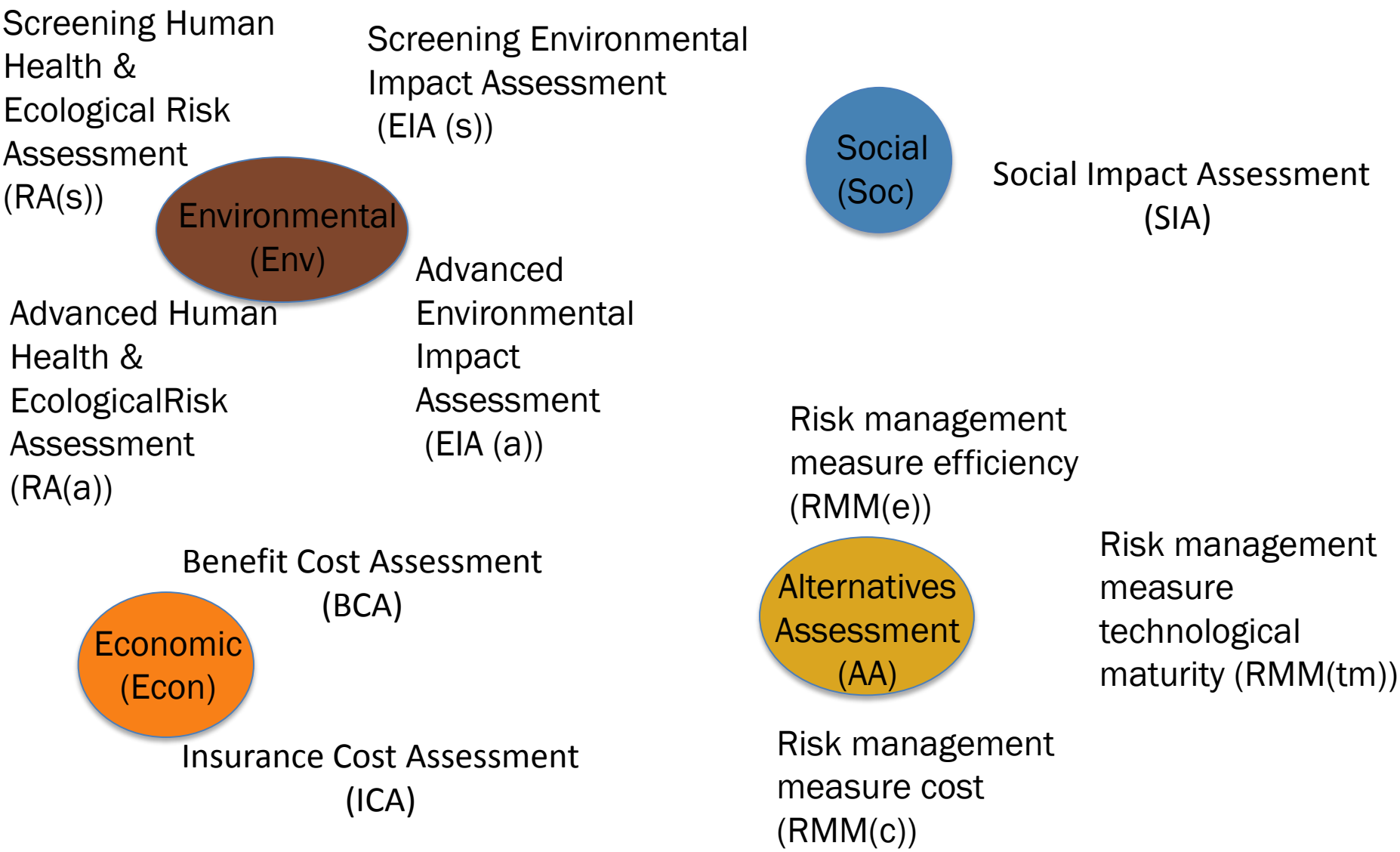
- Objective of workshop was to seek user feedback on:

✓ Ecological and human health risk assessment for nanomaterials

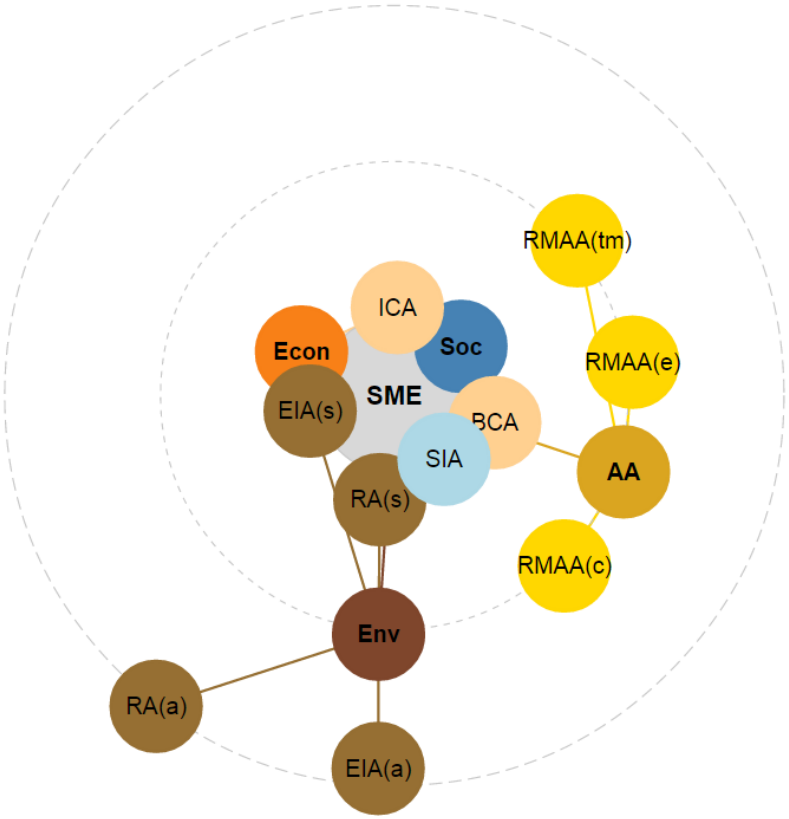
✓ Decision analytic framework for sustainable nanotechnology

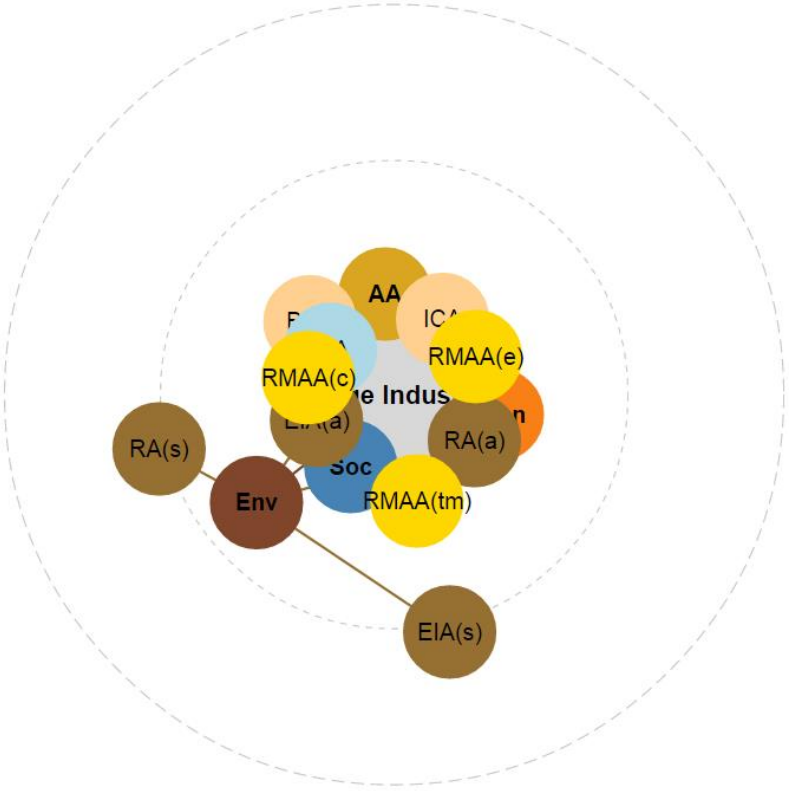
- Workshop findings available on SUN website

Sustainability Assessment Methods for SUNDS



User Needs for Industry

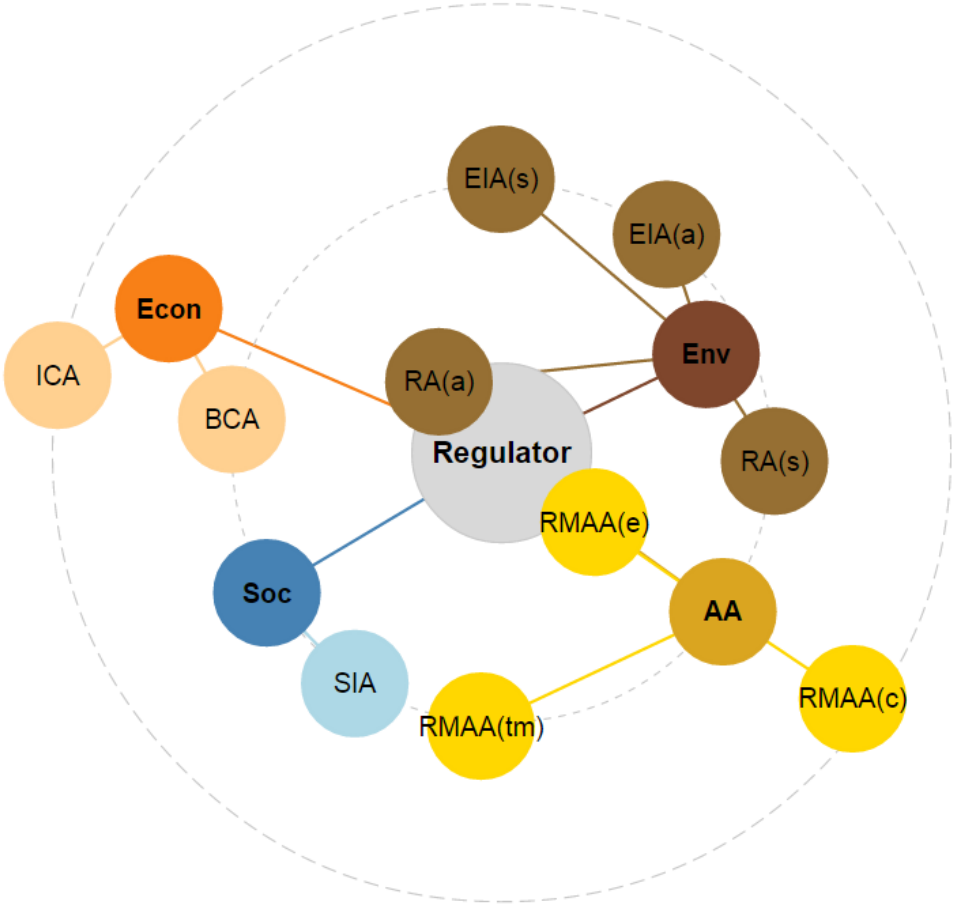


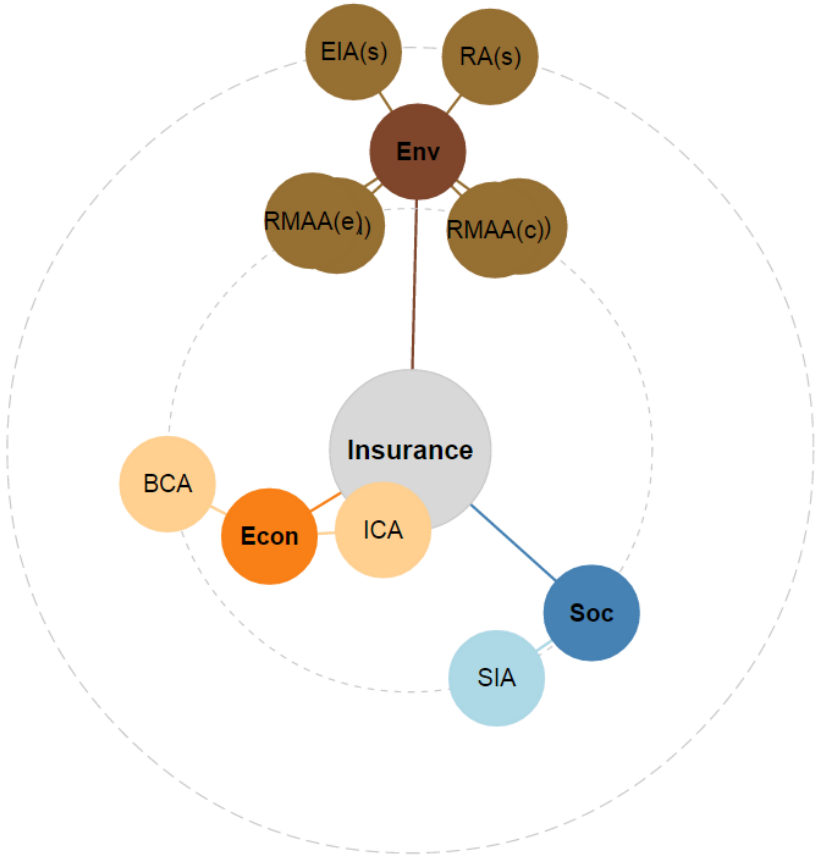


- SMEs are interested in sustainability, they are limited in capacity to handle complex analyses and data requirements

- Large Industry users are interested in proactively tailoring their products-in-development toward safety and sustainability, and have the capacity to use advanced tools

Regulator and Insurance User Needs





- Regulators are most interested in advanced risk assessment tools, and interested in other screening level tools for critical nano-enabled products
- Insurance sector is not a primary user of tool, but is willing to offer lower premiums if companies show due diligence in understanding and managing risks

Key Findings of User Workshop

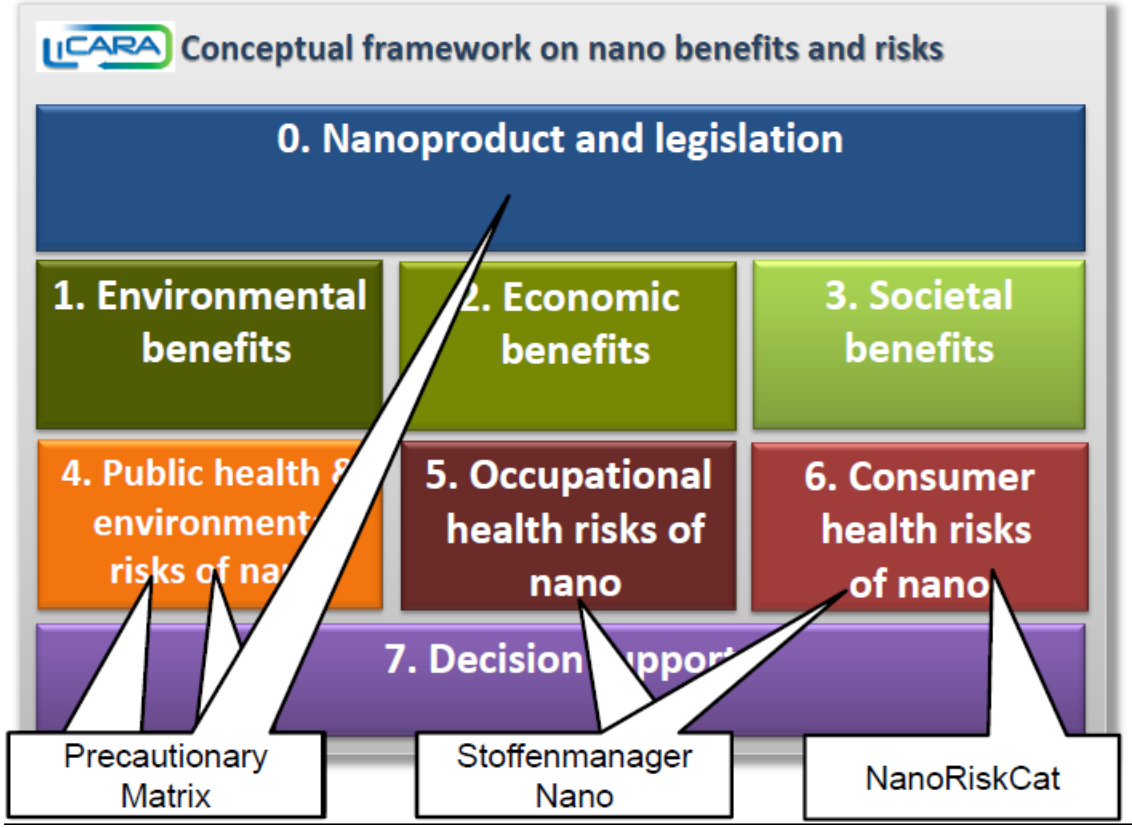
- Modular design of SUNDS was endorsed by all users
- ➢ Module outputs, user preferences and tier analyses to be presented in a disaggregated form

- A mid-level tier between Tier 1 and 2 based on read across and grouping approaches was suggested by risk assessors
- ➢ The decision support tool of EU FP7 GUIDENANO is addressing this need, and SUNDS will continue its development as proposed

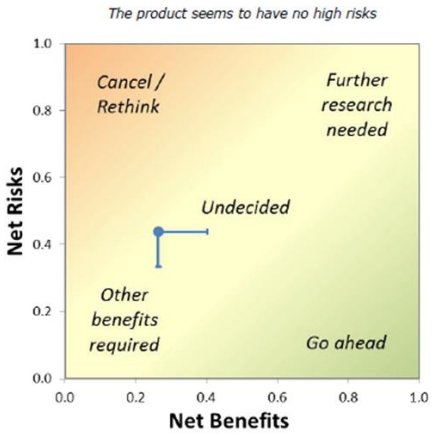
- SUNDS framework and tools to be tailored to REACH guidelines
- ➢ Two routes to REACH authorization translated into SUNDS modules:
- ✓ Demonstration of adequate control of risk due to a substance in a use context through risk management or substitution→Risk Control (RC) module
- ✓ Demonstration that benefits of using the substance significantly outweigh costs→ Socioeconomic Analysis (SEA) module
- ➢ Risk Assessment tools will be developed according to REACH guidelines

SUNDS Tier 1: LICARA Nanoscan

- Tool that provides a benefit-risk balance by integrating Risk Assessment and Life Cycle Assessment paradigms
- Developed for Small and Medium Enterprises
- Deterministic and has low data requirements
- RC and SEA paradigm incorporated



SUNDS Tier 1 Output



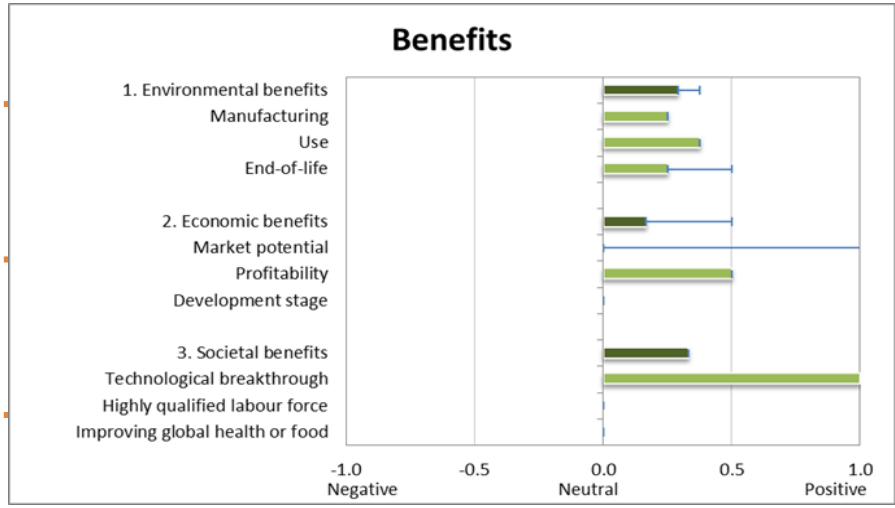
MCDA

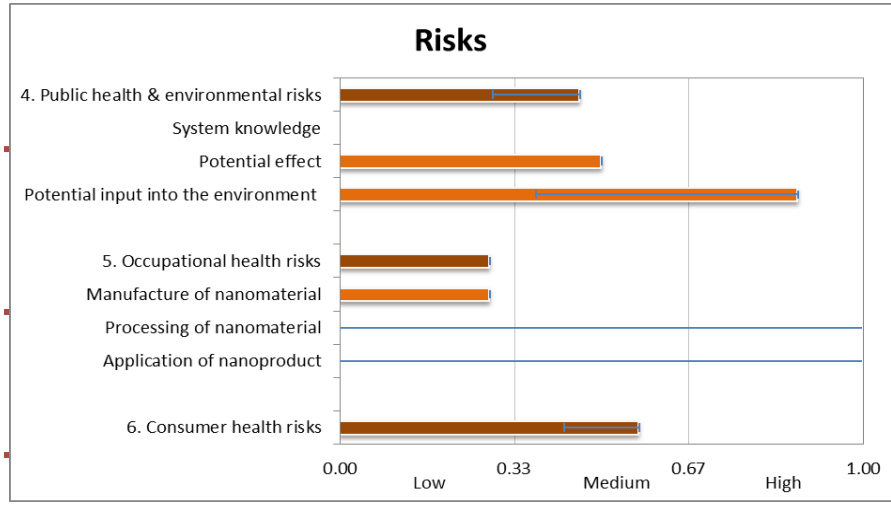
LCA

RA

nanoSCAN

- Benefits
  - Environmental
  - Economic
  - Societal
- Risks
  - Public health & environmental
  - Occupational health
  - Consumer health





RISK CONTROL

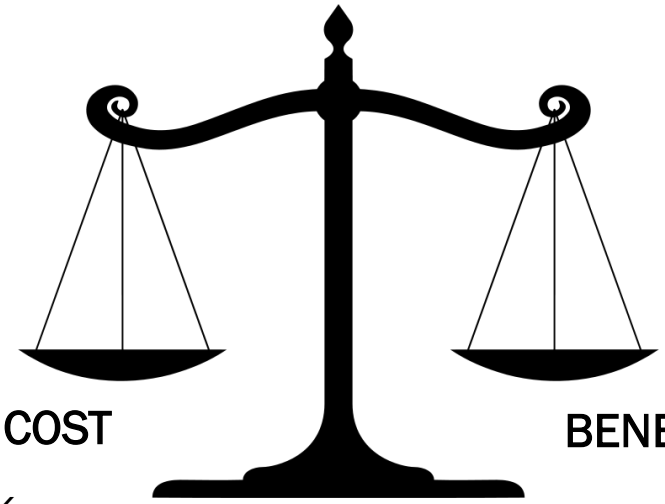
ADDITIONAL SUSTAINABILITY ASPECTS

RC Module in Tier 2

- MCDA will integrate ERA and HHRA (Public health, Occupational health and Consumer health) modules
- TARMM inventory will be used to choose risk reduction measures by efficiency, cost and technological maturity
- RC module based on thresholds

SEA Module in Tier 2

- ERA, HHRA, EIA, EA and SIA sub-modules, each classified by the user as benefit or cost, using various valuation techniques and MCDA
- SEA is comparitive (compares nano-enabled product to conventional counterpart or no product scenario)



Public Health Risk
Occupational Risk
Ecosystem Risk
Environmental Impacts
Manufacturing Cost

Functionality based Benefits
Better products (Lower price, higher quality)
Better Employment Conditions

Conclusions

How can the impact of KETs on industrial sustainability be assessed?

- SUNDS framework provides a clear role for nano-enabled products in industrial sustainability
- ✓ SEA module can be used to compare the benefits and costs of nano-enabled product with its conventional counterpart or even a scenario with no product
- ✓ TARMM inventory in the RC module will include alternatives for nano-enabled products with reduced environmental impacts like molecular and process safety by design strategies

What criteria should be included in a sustainable nanotechnology decision model?

- The SUNDS framework presents TBL and AA criteria to address sustainable nanotechnology decision making
- Economic and social pillars of sustainability assessment are limited in SUNDS due to state-of-art of nanotechnology assessment

Future Developments

- MCDA methodology for SUNDS is being developed to integrate tools and modules
- TARMM inventory being built through questionnaire and literature sources, and will facilitate risk management for entire lifecycle of nanomanufacturing
- SUNDS prototype will be ready in October 2015 and tested to relevant case studies

Nanomaterial	Product	Sector
Tungsten Carbide-Cobalt	Sintered wear resistant ceramics	Tools
Copper Oxide	Antimicrobial wood coating	Construction
Multi-Walled Carbon Nanotubes	Anti-fouling coatings Lightweight, conductive plastics	Transportation and energy
Silica	Food additives	Food
Titanium dioxide	Self-cleaning coatings for ceramic tiles	Construction
Organic red pigment	Coloured plastic composites	Transportation and Consumer equipment
Silver	Antibacterial polymer fibres in woven or non-woven textiles	Textiles

THANKS FOR YOUR ATTENTION

Feedback or Questions?