PROJECT FINAL REPORT

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EURO-INDO FORUM ON ENERGY

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4.1 Final publishable summary report

Executive summary

The EICOON project entitled "Euro-Indo forum for Nanomaterials research coordination & cooperation of researchers in sustainable energy technologies - Coordination and Support Action" is about the strategic assessment of mutual EU-India Nanomaterials research needs in sustainable energy technologies and of Nanomaterials researchers training needs in the field. This included the organization of an assessment workshop as well as of scientific seminars and Summer Schools to provide for a forum to researchers and students to be informed of the regions' funding opportunities and competencies and to exchange ideas for research including future projects and joint training initiatives of mutual interest.

Research topics and training initiatives in the area of Nanomaterials in sustainable energy technologies are identified and suggested for future Joint Call for Proposals to be coordinated by DG RTD[1] and DST[2] to sponsor on a cost-sharing basis joint RTD (research and technological development) projects according to the EU-India S&T Agreement of 2002.[3] Upon publication of the anticipated coordinated call for proposals, the suggested research topics and joint training initiatives will provide for a solid base to advance by means of coordination of joint research project the better and more effective use of Nanomaterials in sustainable energy technologies both in Europe and in India. It will also lead to better educated and trained young researchers and scientists able to undertake the execution and management of research projects in either region. Moreover, the suggestions of research topics of mutual interest by this project for a coordinated call for proposals will also result when implemented in the stipulation and further enhancement of research collaborations between scientists and institutions of the two regions in research whether on Nanomaterials, sustainable energy technologies or beyond.

The assessment has been achieved by information gathering through screening of open scientific literature and websites of academic institutions and by communication to other researchers in the field as well as by relying on the knowledge of the partners active in field. This was followed by a synergy (gap & overlap) analysis, drafting and review of the two reports upon which the assessment workshop was organized and held in New Delhi (India). Here, the invited stakeholders had the opportunity to express their views on the research and training needs. Their comments and suggestions have been incorporated into the final version of the two reports. The assessment resulted in recommended future collaborations between research organizations (universities, research centres and industry) in EU and India on nanomaterials for the investigated thematic areas of Advanced coal combustion and gasification combined with CCS, Batteries and supercapacitors, Fuel cells including hydrogen production & storage, and Solar & Photovoltaic.

The thematic area research in Europe and India show some overlap especially in CO_2 capture (nano-structured membranes, metal-organic frameworks), hydrogen & fuel cells (novel nanomaterials for SOFC, nanomaterials for electrodes, nano-catalysts and carbon support including CNT mainly for PEMFC and conductive polymers) and solar & PV (thin films, DSSC, silicon based cells).

[1] Directorate-General for Research & Innovation of the European Commission
[2] Department of Science and Technology of the Ministry of Science & Technology, Government of India
[3] Agreement renewing the Agreement for scientific and technological cooperation between the European Community and the Government of the Republic of India, OJ 2002 L 213, 30-37.

The thematic area research in Europe and India show some overlap, therefore, suggested topics for coordinated joint RTD-DST calls for research proposals are:

- Nanomaterials in sustainable energy technologies such as energy conversion (Clean coal including carbon capture & CO_2 sequestration (CCS), fuel cells including H_2 production and storage, and solar & PV) as well as energy storage (CNT[4], hydrides, batteries & supercapacitors) covering aspects of materials synthesis, manufacture, processing, characterization, processing-structure-properties relations, and modelling & simulations;
- Mapping of competences of research expertise and research infrastructure in EU and India particularly of CoE (centres of excellence) in synthesis, manufacture, processing, characterization of Nanomaterials and of their modelling & simulation at the nano scale in India and EU including gap analysis;
- Establishment of standardized methods to assess and validate effects at the nano scale in materials by means of inter-laboratory comparison;
- Development of schemes for access to research infrastructures (synthesis & manufacture, characterisation tools, software codes, databases, etc);
- Socio-economic studies on the use and effectiveness of Nanomaterials for energy and other applications (i.e. cross fertilization potentials) including future research spending required and societal benefits and impacts.

Furthermore, the suggested topics for future joint training initiatives as part of Joint Calls are:

- Organization of joint workshop(s) on EU and India energy context and issues (energy & research policies including funding, research landscape and competencies, etc) including dissemination of the regions research "acquis" targeting policy & decision makers, regulators, researchers, students, and young professionals alike;
- Development of common training materials suitable for short courses Summer/Winter Schools on energy applications and Nanomaterials as well as on aspects of career development for PhD students, junior researchers and young professionals;
- Organization of series of joint training events such as short courses and Summer / Winter Schools on Nanomaterials in energy applications including synthesis, manufacture, processing, and characterisation methods and tools with a balance of teaching and practice opportunities for research students, fellows and young professionals; and
- Establishment of staff exchange programme between the regions' energy and materials research institutions whether academia or industry to further foster research collaborations and to provide on-the-job training and career development opportunities.

Project context and objectives

In a globalized world, energy is a decisive factor for the further development and economic and social well being of the nations and stability in the different world regions. Materials science and research has in the past significantly contributed to solving issues in sustainable energy technologies for the safe, reliable and efficient use of energy and that of the available natural resources. With the advent of nano-materials, materials research is thought to play an increasing role in sustainable energy technologies; particularly, energy conversion, storage and savings. The technologies meant are primarily the following: coal combustion and gasification combined with carbon capture & CO_2 sequestration, solar, photovoltaic, batteries and super capacitors, fuel cells including hydrogen production and storage, renewable energy technologies.

These technologies must address among other issues

- Security of supply,
- Sustainability

[4] Carbon nano tubes

- Economic growth
- Industry competitiveness
- Climate change
- Efficiency improvements and
- Globalization & citizen concerns (safety, labour, affordability, availability etc).

In Europe, the challenges faced in sustainable energy and the interdependencies are readily visualized in the so-called Kyoto-Lisbon-Moscow triangle. The Kyoto corner of this intimately linked triangle represents sustainability including energy efficiency, technologies, research & innovation, climate change, GHG emissions and CO_2 reductions. The Lisbon corner stands for the new start of the EU Lisbon Strategy "Working together for growth and jobs" and represents growth, internal energy market, jobs creation and world-wide competitiveness. The Moscow corner is associated with the security of energy supply, energy storage, diversification in energy sources and international dialogue.

The EU has developed a number of key policies. To name a few, these include policies on energy[5] including energy technology[6] and efficiency,[7] research including energy research,[8] new and emerging technologies including nano-sciences & nanotechnologies (N&N),[9] climate change[10] including CO_2 reductions[11] and security of energy supply.[12] The instruments to implement these policies are for example the SET-Plan,[13] the Action Plan for Energy Efficiency,[14] the Renewable Energy Roadmap[15] and the N&N Action Plan for Europe 2005-2009.[16]

However, the aforementioned challenges and issues are not pertinent to Europe alone but of equal importance to other industrialised nations as well as developing countries including the emerging power centres in the major world regions such as India.[17] In respect to India, only the names of two corners of the triangle may change but not their very scope and content.

To bring about advancement and improvements in energy technologies and to address sustainability,[18] materials research in nano-materials and nano-structured materials including nano-coatings & films and nano-composites are expected to contribute significantly to solutions in a highly competitive and increasingly globalized world. Such research will inevitably have to be coordinated not only at European level but also internationally by participation of ICPC's research organizations.

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[5] Communication from the Commission, An energy policy for Europe, COM(2007) 1.
[6] Communication from the Commission, Supporting Early Demonstration of Sustainable Power Generation from Fossil Fuels, COM(2008) 13.
[7] Communication from the Commission, First assessment of national energy efficiency action plans: moving forward together on energy efficiency, COM(2008) 11.
[8] European Commission, Green paper: European Research Area New Perspectives – energy dimension, COM(2007) 161 final.
[9] Commission Communication Towards a European Strategy for Nanotechnology, COM(2004) 338.
[10] Communication from the Commission COM(2008) 30, 2020 by 2020 - Europe's climate change opportunity.
[11] Communication from the Commission - Sustainable power generation from fossil fuels: aiming for near-zero emissions from coal after 2020, COM(2006)843.
[12] Communication from the Commission, Green Paper: Towards a European strategy for the security of energy supply, COM(2000) 769 final.
[13] Communication from the Commission, Towards a European strategic energy technology plan, COM(2006) 847 final.
[14] Communication from the Commission, Action Plan for Energy Efficiency: Realising the Potential - Saving 20% by 2020, COM(2006) 545 final.
[15] Communication from the Commission to the Council and the European Parliament - Renewable energy road map - Renewable energies in the 21st century: building a more sustainable future, COM(2006) 848 final.
[16] Communication from the Commission, Nanosciences and nanotechnologies: An action plan for Europe 2005-2009, COM(2005) 243.
[17] See for example, the reviews in: Varun, S.K. Singal, Review of augmentation of energy needs using renewable energy sources in India, Renewable Sustainable Energy Reviews 11 (2007) 1607–1615 & M. Asif, T. Muneer, Energy supply, its demand and security issues for developed and emerging economies, Renew. Sustain. Energy Rev. 11 (2007) 1388–1413.
[18] L. A. Dobrzański, Significance of materials science for the future development of societies, J. Mater. Process. Technol. 175 (2006) 133–148.

Funding bodies and decision & policy makers need to be well informed about the future needs in nano-materials research as to provide the necessary funding, to select the proper research policy mechanisms and instruments and to facilitate their use as well as to plan ahead for required research infrastructure, educational and skills & labour needs.

In Europe, materials researchers already cooperate increasingly under the framework of EU funded projects and projects at intergovernmental level and bilaterally with non-European countries. The EU has meanwhile concluded with ICPC including India S&T agreements and implementation arrangements thereto. Usually, these instruments foresee the execution of joint projects and the coordination of projects and other initiatives.

In both regions, the brain drain of researchers including those active in materials research and nano-materials is a phenomena not only occurring in Europe but occurs to a greater extent and more rapid pace in India. This can certainly harm economic growth and competitiveness but will also hinder the development and the deployment of technologies as vital as sustainable energy technologies in both regions.

The EICOON project focuses on a clear strategic position of the two regions, the identification and analysis of their mutual interest and eventually an increased cooperation and coordination of their common energy research efforts. This will eventually bring materials science and research including nano-materials more forward for the development and application of sustainable energy technologies for the benefit of both regions.

This project provided an assessment including synergy analysis by means of identifying gaps and overlaps of the nano-materials research and training needs in sustainable energy technologies in the EU and India. It established and communicated to the Directorate-General Research (DG RTD) of the European Commission (EC) and the Department of Science and Technology (DST) of the Government of India the mutual interests and the topics and subject areas for future coordinated calls and other initiatives as to enable these decision & policy makers and funding bodies to make better informed decisions and to better select the implementation mechanisms and instruments.

The assessment of the needs and identification of the topics have been made in phases of

- Gathering information by means of existent surveys and reports and by a technical workshop on
  - each others research and training[19] landscapes in nano-materials for sustainable energy technologies focusing on the region's centres of excellence (CoE),
  - their respective nano-materials research needs and
  - their researchers training[20] needs in the field,
- Synergies (gap & overlap) analysis of the needs to identify mutual interests
- Brainstorming on identification of topics for future coordinated calls in the field and on ideas for joint research projects and joint training initiatives in dedicated sessions of the workshop and
- Reporting to DG RTD and DST.

[19] For a summary on Europe see, for example, I. Malsch, Nano-education from a European perspective, J. Phys.: Conf. Ser. 100 (2008) 032001 & nanoforum.org, European Nanotechnology Education Catalogue, March 2005.

[20] For a general survey on required skills in nanotechnology see, for example, L. Abicht, H. Freikamp, U. Schumann, Identification of skill needs in nanotechnology, Institute for structural policies and economic development (isw), edited by M. Tessaring, O. Strietska-Ilina,.A. Zukersteinova, European Centre for the Development of Vocational Training, Cedefop Panorama Ser. 120, Office for Official Publications of the European Communities, Luxembourg, 2006.

Also, the project has disseminated the "research acquis" of the two regions in the field, enhanced and facilitated information exchange of nano-materials researchers and established a forum for increased research cooperation and coordination through the organization of

- Scientific seminars & symposia addressed to the scientific community and decision & policy makers of the regions and
- Thematic Summer Schools addressed to interested students and young researchers active in the field
- Information days on upfront knowledge such as energy, energy research and international research cooperation policies, research funding and training opportunities, public funded research projects and core competencies & expertise of the research (centres of excellence) organizations of both regions in the field.

The overall objectives of the project are

- The assessment (synergy analysis and establishment) of nano-materials research needs in sustainable energy technologies and the researchers training needs in the field, the definition of research topics and subject areas to be addressed in future coordinated calls, ideas of joint project proposals and of joint training initiatives and their dissemination as reports to the decision & policy makers of both regions.
- The dissemination of the nano-materials "research acquis" in the technologies and of the upfront knowledge to enable researcher cooperation and research coordination in the regions.
- The bringing together of the regions' researchers for future collaboration and to eventually form strategic research partnerships.

By achieving these objectives, the project as proposed aimed at the generation and enhancement of knowledge in and understanding of materials science and research especially nano-materials applied to sustainable energy technologies. The aim is also to benefit the application by an increased deployment of these materials in the technologies in both regions. The use of improved and more advanced materials served to address the various concerns in the regions' energy policies and industry sectors.

Project results/foregrounds

The EICOON project (http://www.eicoon.eu) entitled "Euro-Indo forum for Nanomaterials research coordination & cooperation of researchers in sustainable energy technologies - Coordination and Support Action" is about the strategic assessment of mutual EU-India Nanomaterials research needs in sustainable energy technologies and of Nanomaterials researchers training needs in the field.

This includes the organization of an assessment workshop as well as of scientific seminars and Summer Schools to provide for a forum to researchers and students to be informed of the regions' funding opportunities and competencies and to exchange ideas for research including future projects and joint training initiatives of mutual interest.

Research topics and training initiatives in the area of Nanomaterials in sustainable energy technologies are identified and suggested for future Joint Call for Proposals to be coordinated by DG RTD and DST to sponsor on a cost-sharing basis joint RTD (research and technological development) projects according to the EU-India S&T Agreement of 2002.[21]

Upon publication of the anticipated coordinated call for proposals, the suggested research topics and joint training initiatives will provide for a solid base to advance by means of coordination of joint

[21] Agreement renewing the Agreement for scientific and technological cooperation between the European Community and the Government of the Republic of India, OJ 2002 L 213, 30-37.

research project the better and more effective use of Nanomaterials in sustainable energy technologies both in Europe and in India.

It may also lead to better educated and train young researchers and scientists able to undertake the execution and management of research projects in either region.

Moreover, the suggestions of research topics of mutual interest by this project for a coordinated call for proposals will also result when implemented in the stipulation and further enhancement of research collaborations between scientists and institutions of the two regions in research whether on Nanomaterials, sustainable energy technologies or beyond.

The EICOON project is structured into three main work packages (WP) as follows:

- WP1 - **Strategic assessment of mutual EU & India's nano-materials research needs in sustainable energy technologies and nano-materials researchers training needs in the field**
  - Strategic assessment of mutual EU-India nano-materials research needs in sustainable energy technologies and of nano-materials researchers training needs in the field including synergy (gap & overlap) analysis by means of partners' knowledge, existent information & reports through an assessment workshops, and
  - Identification of topics for future coordinated calls.

- WP2 - **Events organization**
  - Organization of a workshop to support strategic assessment of the regions' nano-materials research and researchers training needs in the field.
  - Organization of one scientific seminar to disseminate the field's "research acquis" of the regions.
  - Organization of one thematic Summer Schools to educate interested students and to train young researchers, engineers and decision & policy makers.
  - Organization of an information day in India in connection with the aforesaid events on
    - Policies for energy, energy research and international research cooperation, and
    - European funding opportunities including training, fellowships and grants.

- WP3 - **Communications & strategic dissemination**
  - Regular contacts and dissemination to EU's and India's decision & policy makers, and project coordinators and other relevant bodies.
  - Creation of website tool and collection, preparation and distribution of PR materials.

During part of the project the focus was to draft two reports on the assessment of mutual EU-India nano-materials research needs in sustainable energy technologies and of nano-materials researchers training needs in the field as well as to list topics for future coordinated calls.

This has been achieved by way of information gathering through screening of open scientific literature and websites of academic institutions and by way communication to other researchers in the field as well as by relying on the knowledge of the partners active in field. This was followed by a synergy (gap & overlap) analysis and drafting and review of the two reports upon which the assessment workshop was organized and held. During the assessment workshop held in New Delhi, India the invited stakeholders had the opportunity to express their views on the research and training needs. Their comments and suggestions have been incorporated into the final version of the two reports.

The assessment resulted in the following recommendations:

- Collaborations between research organizations (universities, research centres and industry) in EU and India on Nanomaterials for the investigated thematic areas of
  - Advanced coal combustion and gasification combined with CCS,
  - Batteries and supercapacitors,
  - Fuel cells including hydrogen production & storage, and

- Solar & PV

is rather limited but has great potential for future enhancement of mutual benefits;

- o Thematic area research in Europe and India show some overlap especially in CO_2 capture (nano-structured membranes, metal-organic frameworks), hydrogen & fuel cells (novel Nanomaterials for SOFC, Nanomaterials for electrodes, nano-catalysts and carbon support including CNT mainly for PEMFC and conductive polymers) and solar & PV (thin films, DSSC, silicon based cells);
- o Collaboration between academia and industry is well developed in Europe but appears to be lacking in India;
- o Academia and industry collaborations as well as an interdisciplinary approach to research on Nanomaterials should be mandatory for coordinated joint calls for research proposals;
- o An interdisciplinary approach to research on Nanomaterials in sustainable energy technologies is only partly developed in both regions but is utterly required since the structure-property relationship in these materials depend heavily on the methods and techniques of their synthesis, manufacture and processing involving different disciplines; similarly the vast varieties of the different post- or in-situ characterization techniques require such an approach;
- o Large number of youth especially in India provide for immense opportunity for scientific excellence;
- o Nanomaterials research especially in energy applications is judged as having great economic potential and contributes to meet climate policy goals;
- o Both regions have steadily increased investment in Nanomaterials research by providing more funds and improving infrastructures;
- o Research collaboration should address IPR issues, accountability for funds provided and research conducted, affordability of energy supply going beyond mere cost reduction, relevance for society and scientific excellence
- o Desire for up-scaling of laboratory devices and production routes to industry scale and volumes; and
- o The exchange of researchers in the field between both regions exists but is capable of development to enhance mutual benefit in terms of exchange of knowledge and re-search results, allow testing of novel ideas & concepts and to obviate duplication of re-search including streamlining of available resources.

Then, suggested topics for coordinated joint RTD-DST calls for research proposals are:

- o Nanomaterials in sustainable energy technologies such as energy conversion (Clean coal including carbon capture & CO_2 sequestration (CCS), fuel cells including H_2 production and storage, and solar & PV) as well as energy storage (CNT, hydrides, batteries & supercapacitors) covering aspects of materials synthesis, manufacture, processing, characterization, processing-structure-properties relations, and modelling & simulations;
- o Mapping of competences of research expertise particularly of CoE (centres of excellence) in synthesis, manufacture, processing, characterization of Nanomaterials and of their modelling & simulation at the nano scale in India and EU including gap analysis;
- o Mapping of available research infrastructure in EU and India for use in the synthesis, manufacture, processing, characterization and modelling & simulation of Nanomaterials in India and EU including gap analysis;
- o Establishment of standardized methods to assess and validate effects at the nano scale in materials by means of inter-laboratory comparison;
- o Development of schemes for access to research infrastructures (synthesis & manufacture, characterisation tools, software codes, databases, etc);
- o Socio-economic studies on the use and effectiveness of Nanomaterials for energy and other applications (i.e. cross fertilization potentials) including future research spending required and societal benefits and impacts.

The suggested areas for joint research projects are:

- o Development of (high temperature) and nano-structured membranes whether composites or hybrids for CO_2 separation and fuel conversion (reforming, fuel cells, electrolyser);

- Development of improved and low (production) cost solar cells (thin films, DSSC, Si based, organic) with increased light harvesting capabilities and reduced degradation;
- Development of novel nano-catalysts and carbon supports including functionalized (carbon) nanostructures for electrodes with no or reduced noble metal content/loading;
- Development of new (multifunctional) Nanomaterials for solid oxide electrodes and electrolytes; and
- Development of Nanomaterials and nano-structures for batteries including carbon, polymers and catalysts to optimize power density of batteries, capacitors, and hybrids and to allow for new battery concepts.

Regarding the training needs in general, the following is concluded from the assessment:

- Given the highly interdisciplinary nature of these areas students (master and PhD) and (junior) researchers should be well educated on the essential basics, e. g. nucleation and growth, materials property-structure & processing relationships, characterisation methods & tools, etc. to gain an understanding of Nanomaterials;
- They should broaden their horizon to understand the underlying facts and the context of their studies and research especially when pursuing an international career or taking part in international collaboration;
- Their institutions whether academia or industry should provide for appropriate opportunities to acquire such knowledge by teaching and/or practice as to better pursue their studies and research as well as to better target the most appropriate funding sources in the course of their career development;
- The training of students and junior researchers should include, as part of career development aspects, acquisition of funds including effective proposal writing and efficient project coordination and management;
- "Nano-education" including Nanomaterials teaching and practising should form part of interdisciplinary Master courses (or PhD studies), for example, in natural sciences or engineering and technology rather than specialized Master courses, for example, in nanotechnology or Nanomaterials;
- On-the-job-training of junior researchers whether in academia or industry is advantageous for Nanomaterials research given its strong interdisciplinary character and the need to combine various tools and methods to gain insight into the processing-property-structure relationship of the materials at nano scale;
- International exchange of personnel such as PhD students and junior researchers as well as senior scientists is commonly seen as an appropriate and effective means to provide on-the-job training and to stipulate further research collaboration for all assessed areas; and
- Joint EU-India training events such as short courses and Summer/Winter Schools are virtually non-existent for these areas though benefits of jointly organizing such events are clearly appreciated.

The suggested topics for future joint training initiatives as part of Joint Calls are:

- Organization of joint workshop(s) on EU and India energy context and issues (energy & research policies including funding, research landscape and competencies, etc) including dissemination of the regions research "acquis" targeting policy & decision makers, regulators, researchers, students, and young professionals alike;
- Development of common training materials suitable for short courses Summer/Winter Schools on energy applications and Nanomaterials as well as on aspects of career development for PhD students, junior researchers and young professionals;
- Organization of series of joint training events such as short courses and Summer / Winter Schools on Nanomaterials in energy applications including synthesis, manufacture, processing, and characterisation methods and tools with a balance of teaching and practice opportunities for research students, fellows and young professionals; and
- Establishment of staff exchange programme between the regions' energy and materials research institutions whether academia or industry to further foster research collaborations and to provide on-the-job training and career development opportunities.

Furthermore, besides the assessment workshop/summerschool in New Delhi (India) two events were organized in Espoo (Finland) and Kolkata (India), in which a combination of a seminar/workshop, summer school and information day was organized involving an extensive number of attendees from research institutes, universities, industry and government. All events were well received and much appreciated by the attendees. The participants were provided with an overview of both the regions' energy and research policies in general as well as on research in Nanomaterials and sustainable energy technologies in particular.

Also, by bringing together Nanomaterials researchers, students and policy makers from India and the EU in a unique setting of the second and third project event (seminar/workshop, summer school) allowed them to discuss the involved issues and to exchange views on energy research in general as well as to breed ideas for possible future collaboration especially in Nanomaterials research. Furthermore, the information day organized in parallel to these events provided a unique opportunity not only for the attending researchers but foremost for the students to be better informed about ongoing European Nanomaterials and energy research including available funding opportunities.

It is concluded that these events contributed much to the far better and improved understanding of each regions' policies, research needs and competencies to both policy makers and researchers in the field. Also students had the opportunity of gathering a wealth of information useful in the comprehensive understanding of the regions' energy and research policies, the involved technologies, the on-going research and the underlying materials issues. At the same time, the students could start to realize career opportunities.

For the first time the mutual EU-India research needs of both regions on Nanomaterials in sustainable energy technologies were assessed by European and Indian researchers which has resulted in the aforementioned suggestions for topics of future Joint Calls and possible joint projects. The same applies to the assessed mutual EU-India training needs of Nanomaterials researchers and for the suggested for joint training initiatives.

Apparently such assessments and topic suggestions were not made before and it is now for DG RTD and DST, the two executive agents named in the S&T cooperation agreement to prepare the follow up in the form of Joint Calls considering their respective energy and research cooperation policy contexts. The exploitation of the main project results, the two assessment reports along with the suggestions for Joint Call topics and possible joint projects and training initiatives have also been disseminated through the project website at http://www.eicoon.eu to reach many more of the identified stakeholders.

Potential impact

The expected societal impact of the results of this CSA-CA project are

- To better inform DG RTD and DST through the identification of topics of synergy and mutual benefit allowing the more efficient preparation of joint coordinated calls,
- An increased awareness of the EU and India's decision & policy makers, funding bodies and the regions' researchers on the respective policies (energy, energy research and international S&T collaboration), through a strategic events and dissemination plan incorporated excellent links with existing effective mechanisms in both regions such as Nanoforum, SciDev, ICPCNanoNet, AsiaNanoForum,
- To better and comprehensively inform the regions' researchers on the other regions' research & training landscape including the Centres of Excellence research capabilities and researchers complementary & supplementary skills, on relevant international, national and regional research projects and their results, and on funding opportunities in the regions for research & researchers training at first hand through the information days and event annexes,
- To strengthen links between researchers and industry in the two regions increasing industry awareness of research activities in the other region, providing information and opportunities of

networking useful for the establishment of collaboration (see Table for benefits of specific activities),

- Euro-Indo research cooperation including the exchange of researchers facilitated by the forum of this project contributes to slow down the brain drain of researchers to other major world regions and contributes to penetration of the knowledge and know how of the researchers into the other region.

Project Activity	**Benefit to industry**
WP1 Strategic assessment of mutual EU & India's nano-materials research needs in sustainable energy technologies and nano-materials researchers training needs in the field	Dissemination of industry views on priorities for research/training to research/education community such that researchers are aware of industry needs (input from Confederation of India Industry (a project partner) and EU Technology Platforms). Information for industry about the mutual EU and India's needs in sustainable energy technologies and nano-materials for research and training (output to EU and Indian Industry) to be aware of areas of research in the corresponding region in which expertise exists for collaborative activities.
WP2 Events organization	Participation in events will provide industry with contact with researchers and industry in a region with which they might not normally have contact and information about the areas of activity of these individuals or organizations, which can be useful for identifying expertise for the establishment of collaborative activities.
WP3 Communications & strategic dissemination	Receipt of information about the project's activities provides information that can be used for the establishment of future collaborative activities between the EU and India.

The impact of the project results are multi fold. For example, they will result in an increased coordination & cooperation of regions' nano-materials research, and of the training of the regions' researchers. This will benefit the development and the deployment of the technologies eventually to better address the energy issues, energy & research policy support and citizen concerns. An increased and better Euro-Indo coordination of the research and the training of the researchers are likely to save resources and cut costs in a highly competitive globalized world with increased energy demand.
The project events have constituted an exchange forum for interested students, young researchers, and senior scientists for a lively and lasting discussion on ideas for future joint research projects in nano-materials in the field, training initiatives for researchers.
Also, the project results will serve the New Approach to international S&T collaboration of the EU; for example, to provide access to and information about the research projects with public funding of the other region.

The dissemination efforts have been optimized in terms of time and costs as the communication with stakeholders was mainly via emails. For detailed explanation, joint meetings were held as far as

possible by teleconferences and video links in close interaction with the project coordinator and the other WP leaders. Where the dissemination concerns, for example, projects results, event announcements and outcome of events which target an audience outside the project consortium, have been made available on the project's website www.eicoon.eu as well as on other public websites, especially http://nanoforum.org, and EC services at http://cordis.europa.eu, http://www.scidev.net/, and http://www.asia-nano.org.

This was divided in two parts. First a project website was created for data exchange and information dissemination, which concerned the setup and maintenance of a website comprising publicly available information and a restricted-access area, for enabling an effective exchange of information within the project consortium. This tool was based on existing software to provide the coordinator and the WP leaders with effective means to manage the individual project tasks, to allow partners to be kept well informed and timely updated on the project developments, to facilitate remote data exchange and to make the project reports accessible (according to defined user rights). This tool was used in the management of the events including announcements and attendees registration. It also provided a link portal for the addressees of this WP.

The recorded website statistics show a steady increasing trend since the outset, culminating in some 15,000 hits per month on the EICOON website, for example the month of January 2011 had 14,778 hits, 3,974 page views, 1,901 visitor sessions and 616 unique visitors. However, the peak was observed in the month of October 2010 leading to the assessment workshop in New Delhi (India) with 25,936 hits, 5946 page views, 2,114 visitor sessions and 838 unique visitors, closely connected to the event promotion.

Secondly, the project results have been disseminated to the stakeholders including regional and national research policy & funding agencies (e.g. DG RTD, MEP, ESF, COST, DFG, DAAD, PTJ, KoWi, DTI, Tekes, UK ERC, NOW, EOS, FFG, FWF), research organizations including academia across Europe (e.g. CEA, CNRS, CNR, SinTeF, EMPA, EPFL, TKK, Helmholtz, etc), European Technology Platforms and Joint Initiatives (i.e. ELSF, FCH JU, NERGHY, PV ETP, RHC ETP, NOW), and research & industry associations (e.g. e-MRS, Fuel Cell Europe, SuSChem, RSC, DWV, H2IT, VDMA) as well as program managers and coordinators of relevant European projects and DST and CSIR in India.

In this way, these stakeholders were informed about the project in general and the obtained assessment results as well as the organized workshops and summerschools: scope, objectives and programme (speakers, schedule, etc) and targeted audience. In addition to these numerous invitations, the events were advertised not only on the project website (http://www.eicoon.eu) but also on several conference announcement web portals well known to the community, e.g. www.allconferences.com, www.nanopaprika.eu, www.nano.org.uk, http://biomedikal.in, www.nanoforum.org and http://www.conference-service.com.

As a result, the scientific counsel of the EU delegation to India attended the assessment workshop in New Delhi (India) along with a limited number of academics from Europe. While understandably European attendees were fewer in numbers, the events were well attended and much appreciated by the numerous Indian participants including the DST Secretary and other high ranking ministerial officials as well as CSIR program managers and scientists. Also, during the events held in Delhi information was directly communicated to DST, CSIR and other ministerial officials present at the events. The two assessment reports and the event outcome reports were eventually distributed to stakeholders for collection of their comments & suggestions to finalize these reports.

The workshops and summer schools in Espoo (Finland) and Kolkata (India) were combined with Information days during for which PR materials were collected from several agencies and research bodies of the Member States (e.g. DAAD, DFG, UKERC, CEA, RSC) were about funding opportunities in Europe and its competencies in research whether specific to the field of Nanomaterials in sustainable energy technologies or more in general about European (materials & energy) research.

The DG RTD as well as several agencies provided materials, brochures and booklets. These materials were displayed at the events and were collected by the interested attendees, which found it useful for additional information as orally communicated during the four days of the individual events.

Relevant contact details

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