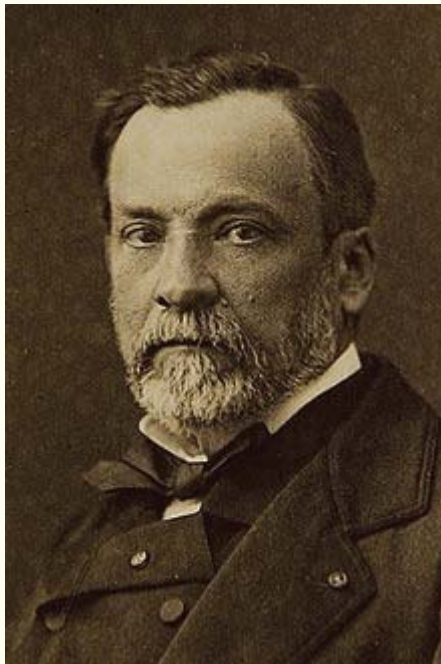


ANNUAL REPORT
2011



To enrich the nation with technology enabled policy options for equitable growth

Science knows no country because knowledge belongs to humanity and is the torch, which illuminates the world. Science is the highest personification of the nation because that nation will remain the first which carries the furthest the works of thought and intelligence.



Louis Pasteur
(1822-1892)



PREFACE

Greetings,

The year-end season is once again on us and we are tempted to look back on how this year has been at CSTEP, what have been the challenges we faced and of the opportunities we created at the Center.

To begin with, we have been busy with a number of interesting projects. All these projects had one thing in common. They are all technology enabled in some form or another reflecting our vision for the Center. The projects were diverse from managing large-scale accidents and catastrophes to discovering new materials from first principles that could replace energy critical elements. We continue to be actively involved in sustainable energy programmes. Our work in solar thermal systems, wind power and nuclear power is proceeding smoothly and a few results and recommendations are already published. More than studying problems in energy generation, we are also concerned with issues concerning efficient usage of energy. A detailed study in cement industry was completed and we are also looking at iron and steel industry which if left untouched, can grow into a major energy guzzler.

Our focus until now has been only on policy studies where technology is an enabler. We now have some plans to expand our scope to include areas where the national economy is intimately related to policy options. These fields can also benefit from in-depth analytical studies. Questions like the desirability of enhancing the manufacturing base for defence services and ensuring that financial institutions such as stock exchanges and mutual funds become fast, efficient, reliable and truthful are now being considered for study. We are preparing to foray into these areas with studies that will be strengthened when the Decision Theatre comes into being. We are already working closely with the Defence Research and Development Organisation (DRDO) conducting preliminary studies where modelling, simulation and analytical pursuits interact with one another.

All our work has been made possible by the munificence of a few charities and foundations who recognized our vision and commitment and came forward to support us even before we had received projects to work on. Sri. Shiv Nadar came forward to support us from the SSN Foundation closely followed by the Jamsetji Tata Trust. When we did not know how we could pay for the site the State Government offered us on sale, the Narottam Sekhsaria Foundation readily came forward and paid the bill. We now have the core support from the IDRC and the OAK Foundation. But we need more such grants for building the new campus. The site is all ready for the buildings to come up and our challenge for the coming year is to find the funds.

We are still a small group, just around fifty bringing in enviable competence and enthusiasm and I salute them for their commitment and output. They are making CSTEP an exciting place to work.

Dr. V. S. Arunachalam

Chairman

Dr. Anshu Bharadwaj

Executive Director

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CSTEP is a 'not for profit' research organization incorporated in 2005, under Section 25 of The Companies Act, 1956. The vision is "to enrich the nation with technology enabled policy options for equitable growth". Its mission is to impact policy with informed and objective analysis of science and technology enabled options for inclusive and equitable economic growth.

Professor V. S. Arunachalam, former Scientific Advisor to Defence Minister is CSTEP's Founder Chairman. The Board consists of distinguished scientists and professionals.

The organisation is interdisciplinary and has about 50 researchers with specialisation in science, engineering, economics and social science. CSTEP is recognised as a Scientific and Industrial Research Organisation by the Department of Scientific and Industrial Research, Government of India.

CSTEP presently operates from its main office at High Grounds, Bangalore and has an additional office located in Dollars Colony, Bangalore. CSTEP has acquired a 14-acre plot in north Bangalore to build a "green and smart" campus that minimizes energy and material flows.

We are supported by grants from national and international foundations, industry trusts and Government. It is registered under the Foreign Contribution (Regulation) Act, 1976. Grants and donations made to CSTEP are eligible for exemptions u/s 80(G) of the Income Tax Act, 1961.

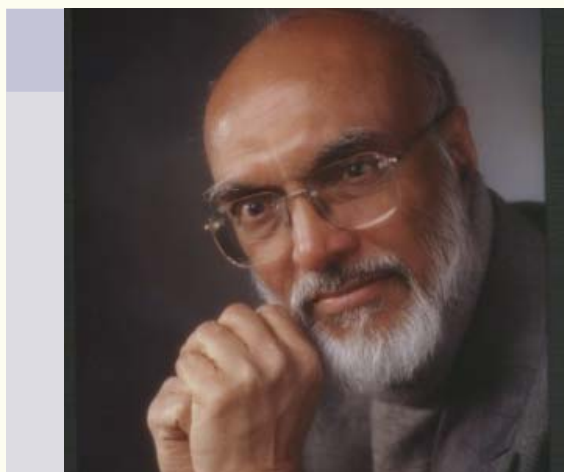


DR. V. S. ARUNACHALAM
Chairman and Founder, CSTEP

Dr. Arunachalam, a metallurgist by training started his career at the Bhabha Atomic Research Centre and later on worked at the National Aerospace Laboratories and the Defence Metallurgical Research Laboratory, before taking up the position of Scientific Advisor to Raksha Mantri and Secretary to the Government of India. He initiated India's major defence projects such as the Light Combat Aircraft and the Integrated Guided Missiles programmes. He is a recipient of numerous honours and awards including the SS Bhatnagar Prize for Engineering Sciences and Padma Vibhushan.

DR. P. RAMA RAO

Prof. Rama Rao, began his career at the Indian Institute of Science and had been the Professor of Metallurgy at Banaras Hindu University and Director of the Defence Metallurgical Research Laboratory. He was appointed as Secretary to the Government of India, Department of Science and Technology. Later he became the Chairman of the Atomic Energy Regulatory Board and presently is a member of the Atomic Energy Commission. He is a recipient of numerous awards including the Shanti Swarup Bhatnagar Prize and Padma Vibhushan.



SHRI. PRAFULL ANUBHAI

Shri. Prafull Anubhai is a management consultant and is associated with educational institutions like the Indian Institute of Management Ahmedabad, Ahmedabad Education Society (AES) etc. He is actively involved with Saptak (Indian Classical Music organization). He has over 30 years of experience as Chief Executive of textile manufacturing operations and presently is a Director in companies like the Birla Sun Life, GRUH Finance Ltd., Mahavir Spinning Mills Ltd., etc.



CSTEP BOARD



PROF. M. G. K. MENON

Prof. Menon has held important positions such as Director, Tata Institute of Fundamental Research, Secretary, Department of Science and Technology, Director General, CSIR, and Scientific Advisor to RM. He was a Member of Parliament - Rajya Sabha, and Minister of State for Science & Technology.

Prof. Menon is a recipient of several National and International honours including Padma Vibushan.

PROF. S. RANGANATHAN

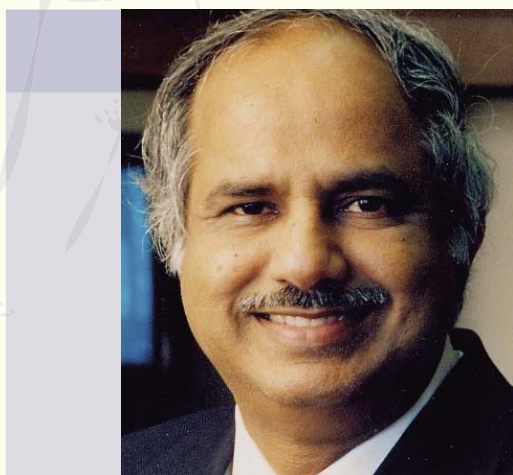
Prof. Ranganathan is an Emeritus Professor, IISc. and Homi Bhabha Visiting Professor, National Institute of Advanced Studies, Bangalore.

A specialist in Physical Metallurgy and Materials Engineering, Prof. Ranganathan has made outstanding contributions in field-ion and electron microscopy, structure of interfaces and quasicrystals. He is a recipient of the Platinum Medal of the Indian Institute of Metals, MRSI medal and the Materials Science Prize of the Indian National Science Academy.



PROF. RAJ REDDY

Prof. Raj Reddy is the Mozah Bint Nasser University Professor of Computer Science and Robotics in the School of Computer Science at Carnegie Mellon University. His research interests include the study of human-computer interaction and artificial intelligence, universal digital libraries, role of ICT in developing economies. He is a member of the US National Academy of Engineering and the American Academy of Arts and Sciences. Dr. Reddy's awards and honours include Legion of Honor from France, Padma Bhushan, the ACM Turing Award, the Honda Prize and the Vannevar Bush Award.





CSTEP BOARD

DR. ANSHU BHARADWAJ

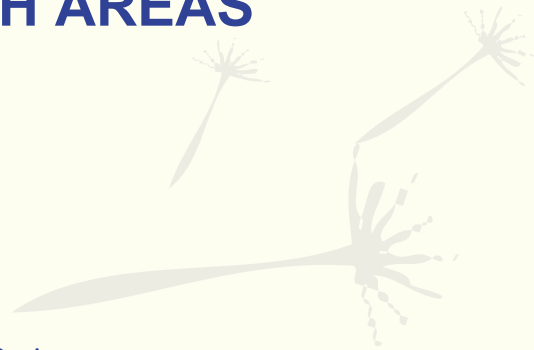
Dr. Bharadwaj is a former member of the Indian Administrative Service (IAS) and worked with Government of Karnataka in various capacities.

He is a B.Tech in Mechanical Engineering from the Indian Institute of Technology, Kanpur and PGDM from the Indian Institute of Management, Calcutta. He got his PhD from Departments of Engineering and Public Policy and Mechanical Engineering, Carnegie Mellon University. His interests are in emerging technology and policy options for India's low carbon inclusive growth. He specialises in computational modelling of energy systems.





RESEARCH AREAS

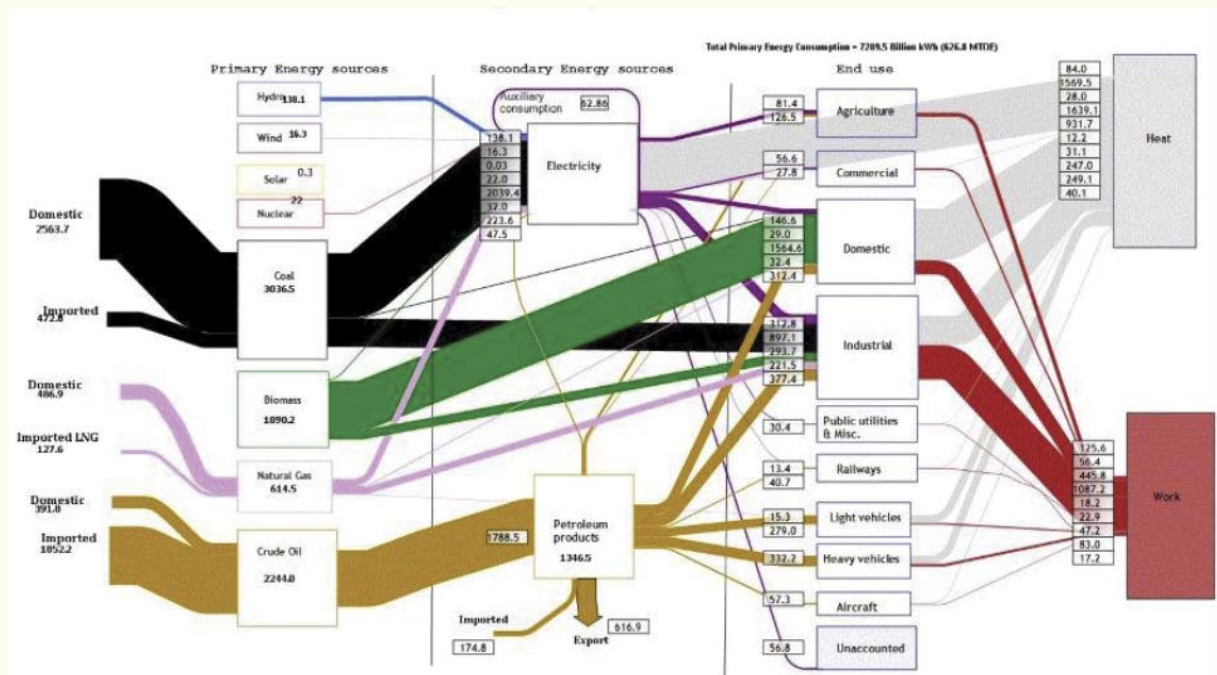


Energy Efficiency and Low Carbon Energy Policy Options

National Mission for Enhanced Energy Efficiency (NMEEE) is one of the eight missions under Prime Minister's National Action Plan for Climate Change to improve the energy efficiency and to lower carbon emission. CSTEP is undertaking several studies covering industrial processes, appliances, buildings and information and communication technologies. Currently, the focus is on industrial energy efficiency in manufacturing sectors such as cement, iron and steel, textiles, fertilizers and paper and pulp.

Perform-Achieve-Trade (PAT) is a market based mechanism under the NMEEE mandated by the Energy Conservation Act, 2001 of Parliament. It required the development of a robust methodology for the computation of Specific Energy Consumption (SEC) norms customized for the needs of Indian industry. CSTEP participated with Bureau of Energy Efficiency (BEE) in the development of the methodology based on detailed technical, economic and policy focused analysis of several energy intensive industrial sectors such as cement, iron and steel etc.

CSTEP participated with BEE in several workshops to discuss the PAT methodology with relevant industry stakeholders.



Energy Flow Diagram for India 2009-10

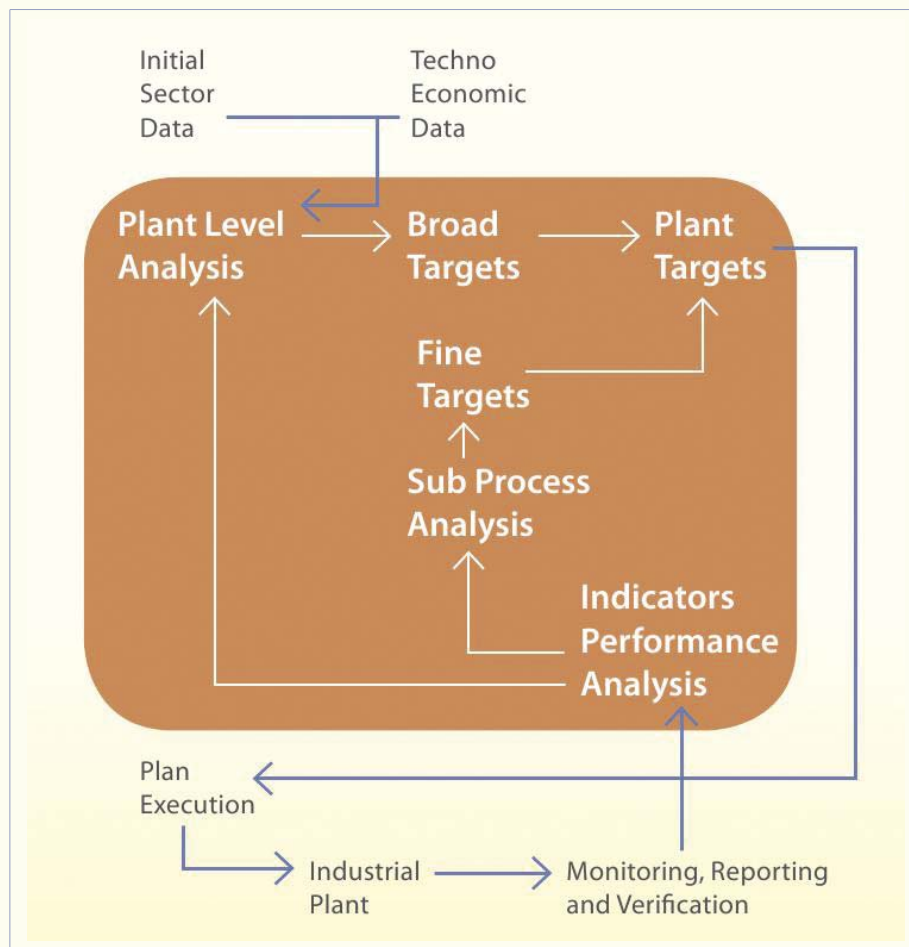


ENERGY EFFICIENCY

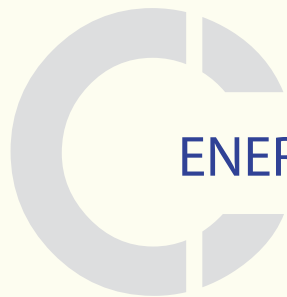
Cement

CSTEP initiated a project to study the energy consumption of cement industry in India. We studied the variations in plant operating conditions and their impact on the overall baseline performance of typical plants.

We organised a workshop at which representatives of BEE and cement industry were present. The methods of normalisation were discussed at this workshop and the outcome was that the industry and BEE continued in refining the methodology of normalisation for a more robust baseline computation for the cement sector under the PAT mechanism.



A Methodology of Industrial Energy Efficiency



ENERGY EFFICIENCY

Iron and Steel Sector

CSTEP has initiated a project to study the energy consumption in iron and steel industry in India. We would develop detailed sub-process level models of energy consumption and efficiency, which can be used for computing energy efficiency potential of the plants. The critical issues that this study will focus on include factors that impact energy efficiency of major sub-processes in a steel plant, the levers available to improve efficiency, techno-economic analysis of available measures, realistic normalisation factors for variations in plant operating conditions and the impact of various measures on the base line performance with respect to the PAT mechanism.

Low Carbon Strategies for Inclusive Growth

India has committed to reduce the emissions intensity of its GDP by 20-25% from the 2005 levels by the year 2020. An expert group has been set up to devise strategies to achieve this, so that the recommendations of this group will help in the XII plan formulation of the Planning Commission. An interim report was published in May 2011. CSTEP worked on the power and industry sectors of the report and outlined various options to achieve emission reduction in these two sectors. It analysed the demand side savings that can be achieved from the power and industry sectors as well as supply side savings from a fuel mix change that is achievable under two scenarios of determined and aggressive effort. In this interim report, CSTEP has proposed a menu of options that can reduce India's emission intensity. Some policy measures implied by various options have also been indicated.

We are working on a detailed analysis of policy options that can be addressed in the iron and steel and cement industries. These two sectors contribute to about 17% of India's annual emissions. A study of these sectors therefore will be able to identify the most effective policy interventions for decarbonisation in the short to medium term.

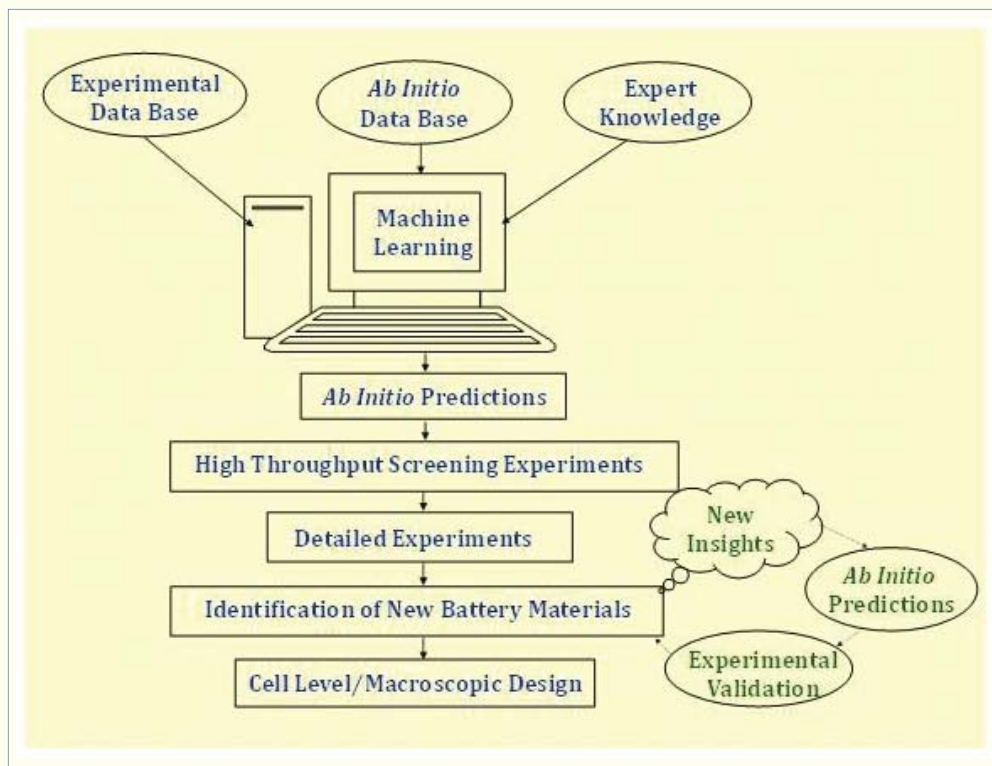


MATERIALS



The Materials Group is engaged in the design of new materials for cost effective storage devices that are vital for large-scale deployment of renewable energy sources. The novel approach that is adopted for this study is based on Integrated Computational Materials Science (ICMS). Traditional methods of materials development involve costly and time consuming empirical approach of processing materials and evaluating structure-property correlations through experiments. Researchers make use of the recent advances in computing power to carry out data mining and to train the computer to identify possible new materials by Artificial Neural Network(ANN) methods. Analogous to the human genome project, this study is named "Materials Genome". This methodology speeds up discovery and insertion of new engineering materials in the targeted applications.

In addition, this group is involved with the Government of Karnataka on Hybrid Electric Vehicles programme. Recently, the Materials Group has been entrusted with the task of bringing out a road map for Rare Earths (RE) and Energy Critical Elements(ECE) by the Ministry of Mines, Government of India.



Schematic Diagram of our Approach in Lithium Ion Battery Design



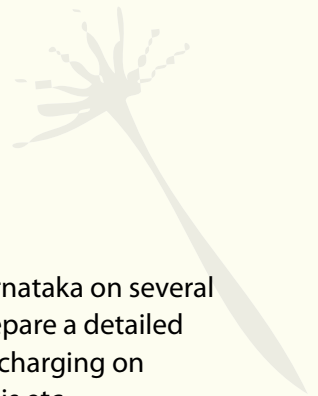
New Approach to Design and Develop Advanced Battery Materials

The main aim of this program is to find a cathode material that can work at a higher voltage giving higher energy. Both ANN methodology and Density Functional Theory simulation techniques were applied. Lithium diffusion within the cathode and in the electrolyte is of importance and classical Molecular Dynamics(MD) and Nudged Elastic Band(NEB) methods were developed for modelling the lithium diffusion process.

It was shown that aluminium (Al) substitution for cobalt (Co) enhances the electrochemical potential of LiCoO_2 . Bader charge analysis indicated a greater charge distribution on oxygen. But, in the case of olivines, the potential gets lowered. This was also corroborated by our study using the three body enhanced Buckingham potential, along with the General Utility Lattice Programme (GULP).

We have collaborated with a DRDO lab (Centre for Artificial Intelligence and Robotics) in this project. The work has shown that judicious choice of input parameters makes the ANN method more effective and universal. However, it requires a large number of experimentally observed data sets. This makes the choice of input parameters more important. ANN uses the input parameters effectively to establish structure –property correlations. Further a 10 fold cross verification has helped in narrowing down our choices. A set of 17 new compounds has been identified by this process. Experimental verification will be carried out shortly. A Graphical User Interface(GUI) has been built to integrate DFT calculations and data mining tools.

The Al substituted compounds were prepared by the Central Electro Chemical Research Institute and the electrode potentials measured were in agreement with our predictions. The samples were tested for their cyclability and a few were found to be good.



Development of Energy Storage Technology and Electric Vehicles in Karnataka

CSTEP is a member in this task force and actively advises the Government of Karnataka on several issues connected with the above mentioned programme. Its role in this is to prepare a detailed project report covering cost-benefit analysis, charging infrastructure, impact of charging on electricity grid, environmental impact and carbon finance, risk and safety analysis etc.

Roadmap for Rare Earths and Energy Critical Elements for India

A steering committee was constituted under the Chairmanship of Secretary, Ministry of Mines with Chairman, CSTEP as Co-Chair to prepare a roadmap for meeting the eventual constraints in supply chain in the rare earths. All concerned agencies are represented in the committee. CSTEP has to co-ordinate the activities along with Centre for Techno-Economic Mineral Policy Options to bring out a strategy report. This report will not only address the concerns about supply chain vulnerability but also suggest ways and means of reducing rare earths usage by alternate routes or by substitutional materials science.



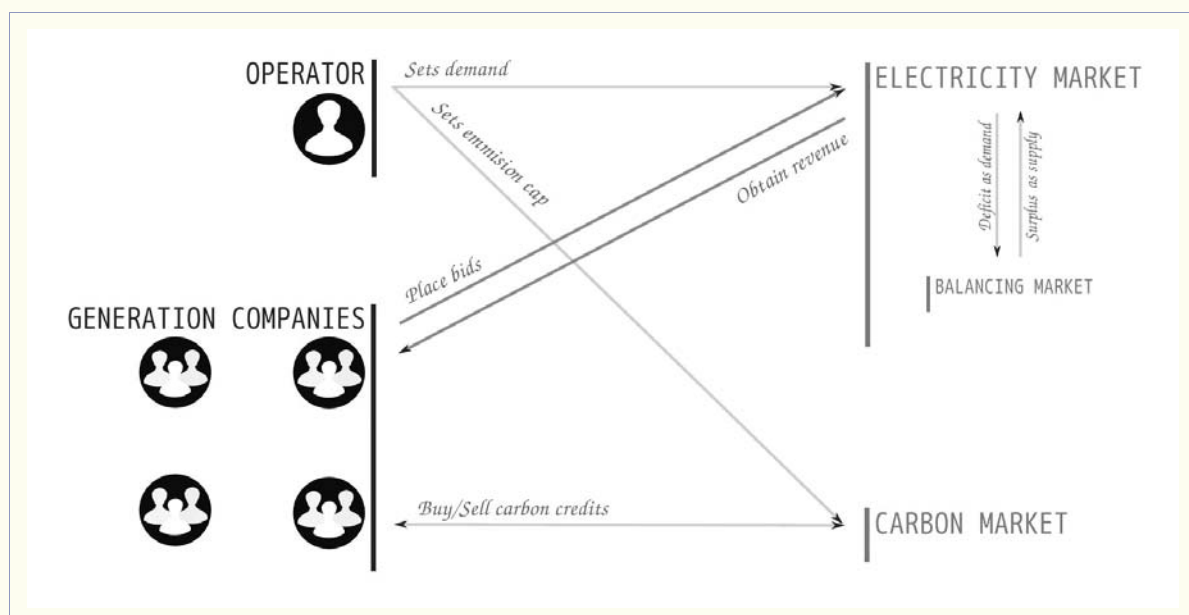
INFRASTRUCTURE



Modelling Electricity Markets

CSTEP worked closely with a Dutch intern to develop an innovative and well-received paper-based game where participants play the roles of government decision makers from different ministries and negotiate for funds to build additional power plants to attempt to reach the goals set by the Planning Commission. The private sector firms active in the energy space as well as students and other academics have played this game to understand the trade-offs in policy.

Collaboration with TU-Delft also continued in joint work on production of a simulation game on electricity markets. This game has been used in classes in several European countries, and will provide the base for adaptation to a multi-market simulation model.



Schematic Representation of Electricity Market



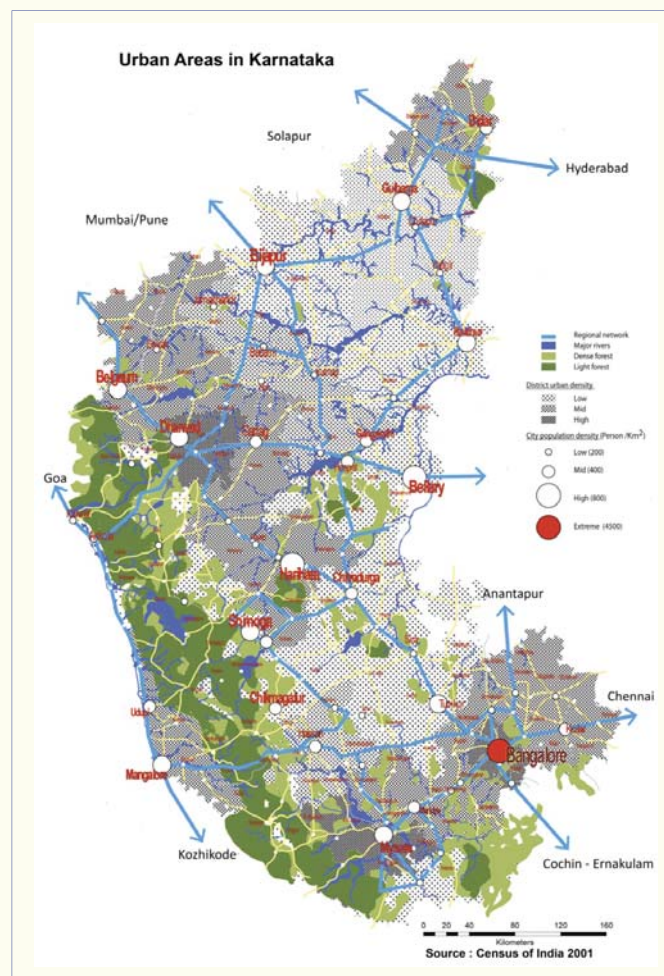
INFRASTRUCTURE

Saving Cities, Building Towns

The team at CSTEP developed a concept paper and proposal for a project entitled “Saving Cities, Building Towns” that highlights the high rate of urbanisation and the need to reorganise the regional space so that urbanisation is sustainable. It also suggested a need to develop smaller towns and cities and integrate them with each other and larger cities.

We continued our data collection efforts along with extensive GIS mapping efforts for interpretation of regional spatial data. We also conducted a primary survey of Ramanagaram town and carried out preliminary interviews and meetings with the local residents as well as the officials.

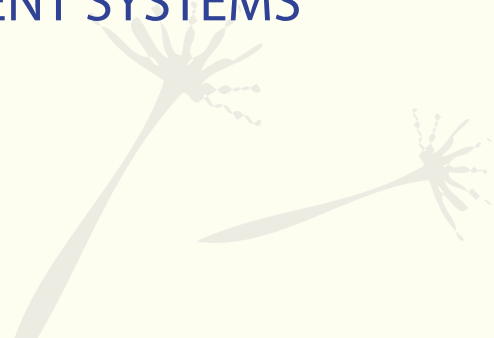
Our partners for this project include the Next Generation Infrastructure Foundation, Netherlands and Carnegie Mellon University, USA.



Urban Areas in Karnataka



EMERGENCY MANAGEMENT SYSTEMS



Post 26/11 Mumbai terror attack, CSTEP initiated a project with the support of Defence Research and Development Organisation (DRDO) to develop tools for better preparedness for handling such incidents. The goal of this project is to bring about joint decision-making amongst the various responding agencies in the event of an emergency through development of a platform for modelling the scale and scope of disasters along with the institutional and resource arrangements. The platform is essentially a virtual environment in which one can test and evaluate different institutional arrangements, procedures, and policies; examine the needs for and test the standardisation of various aspects in the operational processes; and develop games for training purposes.

The ongoing project builds on the first phase where a disaster in an urban location was simulated and the emergency response system was examined. The simulation platform is being extended to include the examination of multiple scenarios.

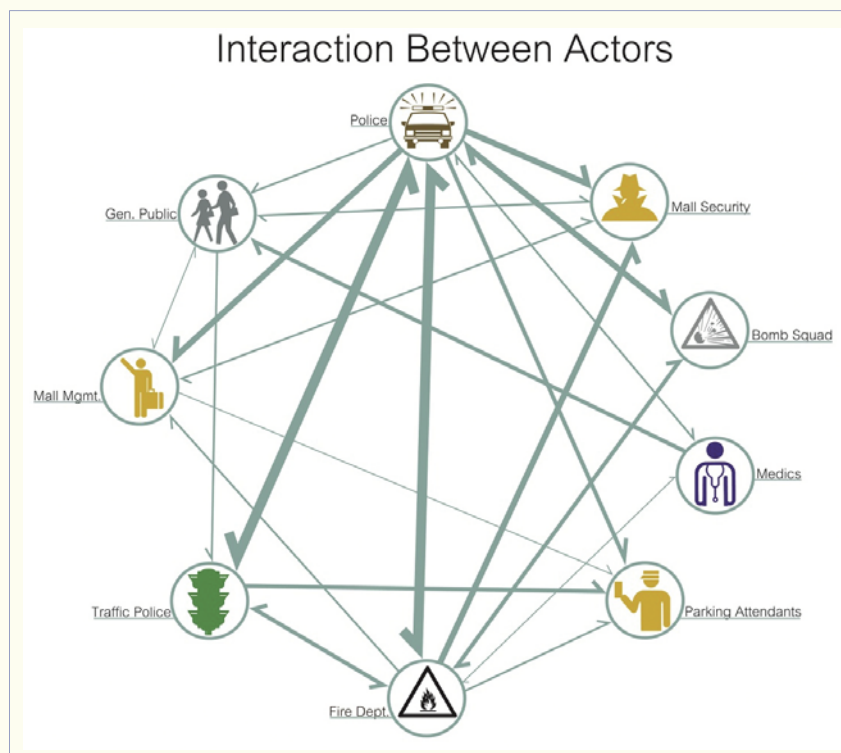
In the second phase of the project, a number of tools and games have been developed and are under development. Computer based games to train emergency responding personnel in the procedure of Cardio Pulmonary Resuscitation (CPR Game) and in the procedure of medical triage for injured citizens (Triage Game) have been developed. A paper based game to simulate an emergency and the various responding personnel, called the Communication Protocol Game (CPGame), has been developed. This game was played and tested by Armed Forces and IAS personnel at the Administrative Training Institute, Mysore. The Triage Game and CPGame have been developed in collaboration with Dr. Aruna Ramesh, M. S. Ramaiah Medical College. The feedback received for the CPGame has been very positive and further iterations of the game could make it part of a standard training exercise for civil administrative personnel. Similarly, a multiplayer game, using the CRYEngine-3 (of CryTekGmbH) includes the paramedics, policemen, firemen and building security guards coordinating with one another in the given situation, is also under development at CSTEP. Safety protocols can be developed by observing the simulated game for disaster management. The information obtained can be potentially stored and used to train the personnel concerned as well as help them practise handling such situations.



EMERGENCY MANAGEMENT SYSTEMS

Finally, a preliminary analysis of the policies and procedures as outlined by the National (and State) Disaster Management Authority (NDMA/SDMA) has been carried out. Further analysis and policy recommendations are part of the future work in this project.

The analysis of policies and procedures and development of tools and platforms for simulation and training will go a long way in achieving our goal of bringing about joint and reasoned decision-making amongst the various responding agencies in the event of an emergency.



Schematic Representation of a Disaster Handling Model



SMART GRIDS

Smarter Electricity Networks for India

The Smart Grid leverages information, communication, and control technologies to be smarter, efficient, and nimble – an overhaul of the entire transmission and distribution system. It starts with knowing where power is going down to the last unit, and in (near) real time. Smart grids then allow dynamic pricing that captures in far greater granularity and precision than today's grid operations.

Recently, Ministry of Power (MoP) allotted Rs. 600crore for carrying out smart grid pilot projects in different parts of the country. MoP is planning to develop smart grid in India in stages by taking up pilot smart grid projects as suggested by India Smart Grid Task Force. Pilots will be evaluated for techno-commercial benefits, technology evaluation and then scaled up into full projects.



Street Light Control System

Not only do smart grids promise a low-carbon future, as they harness renewable sources, but also ensure accessible power supply for the economically weaker sections of the society. We, at CSTEP, are assisting Mangalore Electricity Supply Company (MESCOM) for the 2nd stage of the pilot project. This project would cover nearly 4,000 consumers across two 11kV feeders. The earlier mini pilot, where we demonstrated certain functionalities of Smart Grid, was just 90 consumers. We are assisting MESCOM to come up with detailed project proposal for submission to MoP.

We propose to continue our work in design, deployment, and testing of smart grid systems for Bangalore and other cities. The focus of our work is to ensure reliable lifeline power supply for the poor in an environmentally sustainable manner.



The wind energy potential in the country was initially placed decades ago at approximately 20,000 MW, and was later revised to 48,500 MW (by C-WET, the Center for Wind Energy Technology). However, this figure was based on a number of assumptions including the use of wind maps based on 50 meter hub height, which is measurably lower than state-of-the-art wind turbine heights, and a 2% land area usage based on topography and land-usage restrictions. From the previous studies, the official potential for Tamil Nadu was estimated at approximately 5,000 MW, but as of February 2011 the installed capacity is nearly 6,000 MW. This suggested that the true potential in the country is higher than the estimate of 48,500 MW. In fact, there are reports that indicate that wind potential in India is multiple times greater than earlier estimations.

CSTEP has taken up a study to estimate the actual wind potential in Karnataka and Andhra Pradesh that attempts to correlate the hub heights and land usage. Site visits will also be performed as part of this project to validate our results.

In addition to analysing the wind power potential, we will study the suitability of integrating large quanta of wind power into the grid. Rather than addressing only issues of transmission line, the study will focus on the ability of the grid to handle variable and unpredictable supply. We make use of actual grid data of existing wind farms and the grid overall as available with the state SCADA (Supervisory Control and Data Acquisition) system. To manage the variability, we will study policy options such as pricing uncertainty or capacity separately from generation, and attempt to make recommendations for the state. In addition, we shall examine grid-scale storage technologies from a technical and economic perspective for wind-integration.

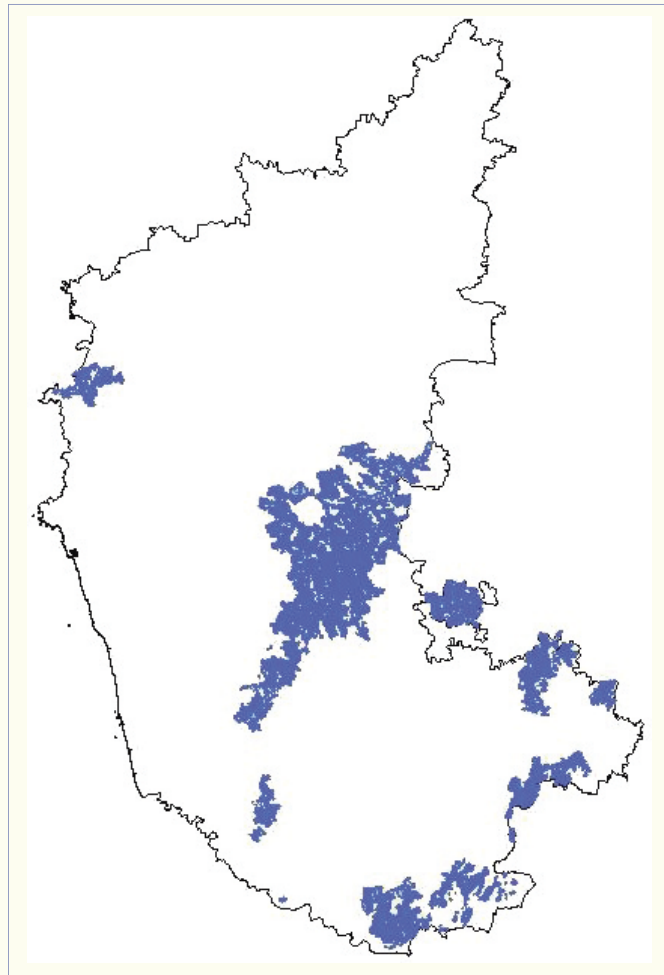




WIND POWER

As a possible option for the intermittency we propose to examine is Demand Response (DR), which dynamically adjusts the load in response to supply conditions.

The proposed study aims to rigorously and transparently address the issue of wind power potential in Karnataka and Andhra Pradesh.



Potential Regions of High Wind Power ($300\text{W}/\text{m}^2$) at the Height of 100 m



SOLAR THERMAL RESEARCH

Engineering–Economic Policy Assessment of Concentrating Solar Thermal Power Technologies in India

The Jawaharlal Nehru National Solar Mission (JNNSM) is one of the eight national missions under Prime Minister's National Action Plan for Climate Change. It sets an ambitious target of 22,000 MW of solar power by 2022 from a combination of solar thermal and solar PV.

CSTEP has undertaken a study to evaluate the engineering economic feasibility of Concentrating Solar Power (CSP) technologies in India. This is supported by the Ministry of New and Renewable Energy. We are developing models for parabolic trough, linear fresnel, solar tower and dish sterling engine. We are also examining the possibility of indigenous manufacturing of solar thermal equipment in India.



Variation of Daily Solar Energy Over a Year
for Various Locations

Several solar thermal power plants are under construction in India using four different technologies: parabolic trough, linear fresnel and solar tower. The plant capacities vary from 1MW to 100 MW. This project attempts to develop engineering - economic models for the four main CSP options and to evaluate their performance and economic viability in the Indian context. The project will also provide insights into various innovations required for achieving grid parity and also the role of indigenous technology development. It is also proposed to incorporate these models into a Graphic User Interface (GUI) tool.

An interim report submitted to MNRE outlines a detailed cost model closely integrated with the engineering model. This includes the capital cost of the plant, O&M cost and the financing options such as debt/equity, feed in tariff and discounting options. The economic model evaluates the Levelised Cost of Electricity (LCOE) and also estimates the sensitivity of LCOE to various engineering and cost variables.

We plan to develop a heat transfer model for linear fresnel reflector system, a detailed engineering model for the tower technology, hybridisation model using biomass, thermal storage model, an economic model to cover fresnel and solar tower technologies, indigenisation road map and develop interactive desktop tool for parabolic trough technology.



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Journal Publications

1. R. Tongia and E. J. Wilson, "The flip side of Metcalfe's law: multiple and growing costs of network exclusion", International Journal of Communication, 2011, Vol. 5, 665.
2. Das, A. K., "An explicit J-V model of a solar cell for simple fill factor calculation", Solar Energy, 2011, Vol. 85, 1906.
3. Das, A. K., "Analytical derivation of explicit J-V model of a solar cell from physics based implicit model", Solar Energy, 2011, (in press).

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1. Sebastiaan Meijer, Jayanth R. and Bharath Palavalli, "Indian food supply chains: a game and model to study economic behavior", in Economics and Mathematical Systems (Editors) Osinga Sjoukje, Hofstede Gert Jan, and Verwaart Tim (Eds.), Springer Berlin / Heidelberg, 2011, Vol. 652, Part 6, 201-212.

Magazine, Newspaper Publications

1. Arunachalam, V. S., "Birth of LCA", Deccan Chronicle, January 9, 2011.
2. Arlekar, S., "Rails plug-ins making site development easy", Linux For You, March, 2011.
3. Arunachalam, V. S. and Subrahmanian, E., "Learning from failure", Deccan Chronicle, April 15, 2011.
4. Harish Santosh M. and Raghavan Shuba, "Redesigning the national solar mission for rural India", Economic & Political Weekly, June 4, 2011, Vol. XLVI No. 23, 51.
5. R. Tongia, "What the smart grid means and doesn't mean for India", IEEE Smart Grids Newsletter, July 2011.
6. R. Tongia, "Bridging the energy gap", Connect: Newsletter of the Indo-US Science and Technology Forum, 2011, 2(3), 20.
7. R. Tongia, "A smart solution to power shortage", Business Standard, July 5, 2011.
8. Subrahmanian, E., "Where in the world is India in global design contests?", Business Standard, August 13, 2011.
9. Bharadwaj, A., "Getting a buy-in from the public on Kudankulam", Business Standard, November 20, 2011.

Symposium, Conference Presentations/Publications in Proceedings

1. V. S. Arunachalam, "Energy and material scarcity: Achilles' heel of future global manufacturing", Keynote address at the World Manufacturing Forum 2011 in Cernobbio, Italy, May 16-17, 2011.
2. V. S. Arunachalam, "Nuclear power: challenges and opportunities for India", Conference on China and India's Nuclear Doctrine and Dynamics by Carnegie-Tsinghua Center for Global Policy at Beijing, June 2-3, 2011.
3. Meera Sudhakar, Rajgopal, S. and V. S. Arunachalam, "Nuclear power – opportunities and challenges", presentation at Carnegie Endowment for International Peace (CIEP) Conference, China, July 28, 2011.
4. Bharath Palavalli, Harsha K. and Onkar Hoysala, "Discovering communication protocols for inter-agency collaboration for emergency response", presented at International Simulation and Gaming Association, Poland, July 11-15, 2011.
5. Abhik Kumar Das and Jai Asundi, "A simple explicit model approximating the relationship between speed and density of vehicular traffic on urban Roads", presented at the 4th Annual Conference on Next Generation Infrastructures(NGInfra 2011), Norfolk, Virginia, USA, November 16-18, 2011.
6. Abhik Kumar Das and Jai Asundi, "Using the Gini index to measure the inequality in infrastructure services provided within an urban region", presented at the 4th Annual Conference on Next Generation Infrastructures(NGInfra 2011), Norfolk, Virginia, USA, November 16-18, 2011.
7. Moumita Mukherjee and Jai Asundi, "Considering emergency and disaster management systems from a software architecture perspective", presented at the 4th Annual Conference on Next Generation Infrastructures(NGInfra 2011), Norfolk, Virginia, USA, November 16-18, 2011.
8. Vivek Vaidyanathan and Robin King, "Institutional analysis of urban transportation in Bangalore", presented at the 4th Annual Conference on Next Generation Infrastructures(NGInfra 2011), Norfolk, Virginia, USA, November 16-18, 2011.
9. S. S. Krishnan, A. Murali Ramakrishnan and N. Balasubramanian, "Energy efficiency of the Indian mobile telecom industry", Proceedings of the 4th Annual International Conference on Next Generation Infrastructures(NGInfra), Virginia Beach, VA, USA, November 16-18, 2011.
10. Niket Narang, Onkar Hoysala, Jai Asundi, Sagar Arlekar and Amar Chadgar, "Developing GIS tools for planning, mitigation and preparedness for large scale emergencies and disasters", accepted in proceedings of the 4th Annual International Conference on Next Generation Infrastructures(NGInfra), Virginia Beach, Virginia, November 16-18, 2011.



PUBLICATIONS

Reports

1. Regulatory value proposition of smart grids in India - submitted to USAID/Tetrattech, February 2011.
2. Consumer outreach and education for smart grids in India- submitted to USAID/Tetrattech, February 2011.
3. Low carbon strategies for inclusive growth - submitted to Planning Commission, Govt. Of India, May 2011.
4. Report by BCCI-K for Karnataka climate change action plan to Govt. of Karnataka, CSTEP et al., June 2011.
5. GHG inventory and mitigation options for Karnataka – an interim report submitted to Govt. Of Karnataka, July 2011.
6. Engineering –Economic policy assessment of solar thermal technologies in India – an interim submitted to MNRE, September 2011.

Participation in Roundtables, Workshops, Meetings etc.

1. R. Tongia, Panelist, “Smart grids: opportunities and challenges”, Third International IEEE/ACM Conference on Communication Systems and Networks 2011, Bangalore, January 6, 2011.
2. Shubha Raghavan, “ Role of renewable energy in India”, Presented and participated in a panel discussion in the Stakeholder Workshop on Renewable Energy organised by ‘eParliament’ in Delhi, January 12, 2011.
3. R. Tongia, Panelist, “Developing India’s smart grid strategy”, Smart Energy India 2011, New Delhi, February 1, 2011.
4. R. Tongia, Chair, “Panel on the information and communications technology (ICT) layer, smart grid integration”, Smart Energy India 2011, New Delhi, February 2, 2011.
5. R. Tongia, Moderator, “Indian electricity markets: leaping towards competitive transition”, Panel on Retail Competition and Smart Grids, New Delhi, February 3, 2011.
6. Sagar A. conducted a “Tuby on Rails” Workshop at INFOFEST 2011, Goa University, Taligao, Gao, February 12, 2011.
7. R. Tongia, “India Smart Grid Forum (ISGF) board presentation”, at the India ISGF Board of Governors meeting, New Delhi, February 17, 2011.
8. R. Tongia, on “Regulatory and policy issues for smart grids”, at Karnataka Electricity Board Engineers Associate (KEBEA) Workshop on smart grids, organised by KEBEA and Schneider Electric, Bangalore, February 22, 2011.
9. S. S. Krishnan, Presentation on “Baseline energy audit, estimating EE potential and technology options”, in a State level Workshop organised by BEE and Madhya Pradesh Urja Vikas Nigam (MPUVN) Bhopal, March 2011.
10. S. S. Krishnan, Presentations on behalf of Bureau of Energy Efficiency and coordinated interaction with participating designated consumers(DCs) in order to disseminate information on “NMEEE, PAT and the methodology of base-lining and target setting”, in Cluster Workshops organised by BEE and IGEN, in Hyderabad, March 8, 2011 and at Bhopal, March 15, 2011.
11. R. Tongia, Keynote address, “Smart grids in India: challenges and opportunities”, C-DAC – Intel Workshop on Smart Grids, Bangalore, March 11, 2011.
12. R. Tongia, Invited discussant, Roundtables at the 2nd Clean Energy Ministerial, Abu Dhabi, April 6, 2011.
13. R. Tongia, Keynote address, 8th International SAP Utilities Conference, Mannheim, Germany, April 14, 2011.
14. R. Tongia, Workshop organiser and chair, “Regulatory and policy options for smart grids in Karnataka”, Workshop by CSTEP, Bangalore, May 13, 2011.
15. R. Tongia, Keynote address “International perspective: exploring synergies between the West and the East at future grids Asia 2011”, organised by International Quality and Productivity Centre, Singapore (IQPC), May 25-27, 2011.
16. Onkar Hoysala, on “Emergency management system” at Carnegie Mellon University-Disaster Management Initiative, May 2011.
17. S. S. Krishnan, Presentation on the “PAT scheme and methodology of target setting”, at a State level Workshop organised by BEE and Rajasthan Renewable Energy Corporation (RREC), Udaipur, May 2011.
18. R. Tongia, Technical program chair, “Sustainable energy: economics, environment and equity”, IEEE/PES Workshop in Bangalore, India, June 2011.
19. R. Tongia, “Smart grids” tutorial presented at the Power System Training Institute, Govt. of India, Bangalore, July 2011.
20. Sathya Naidu and Onkar Hoysala, on “Emergency management systems and Cry engine” at Imaging Infrastructure Workshop, organised by CSTEP, July 2011.



PUBLICATIONS

21. Jayanth Raghothama, "City evolution game", at Imagining Infrastructure Workshop, organised by CSTEP, July 2011.
22. Sujaya Rathi, "The necessity of urban planning in growing cities", in Business networking meet, Urban Infra World Expo 2011, August 2011.
23. R. Tongia, Panelist, "Smart energy track" - SAP World Tour India 2011, Helping India Run Better, New Delhi, tracks co-organised by Dept. of IT, Govt. of India, August 2011.
24. Jayanth Raghothama in "Indian food supply chains: a game and model to study economic behaviour", at Artificial Economics, The Hague, September 2, 2011.
25. Meera Sudhakar in "Low-carbon strategies for power sector", The Indo-US Workshop by Planning Commission, September 28, 2011.
26. Sujaya Rathi, Panelist, "Sustainability and mobility – community concerns, in promoting low-carbon transport in India", Workshop, organised by Indian Institute of Technology, Delhi and Indian Institute of Management, Ahemdabad in New Delhi, October 19, 2011.
27. Shubha Raghavan, Panelist, "Bangalore climate change initiative for Karnataka", in Vidhana Soudha with Professor Nicholas Stern, Prof. B K Chandrasekhar and others in Bangalore, October 23, 2011.





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COLLABORATIONS

- Carnegie Mellon University, Pittsburg, USA
- Centre for Artificial Intelligence and Robotics, DRDO, Bangalore
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