ANNUAL REPORT 2010

CSTEP
CENTER FOR STUDY OF SCIENCE, TECHNOLOGY & POLICY

VISION

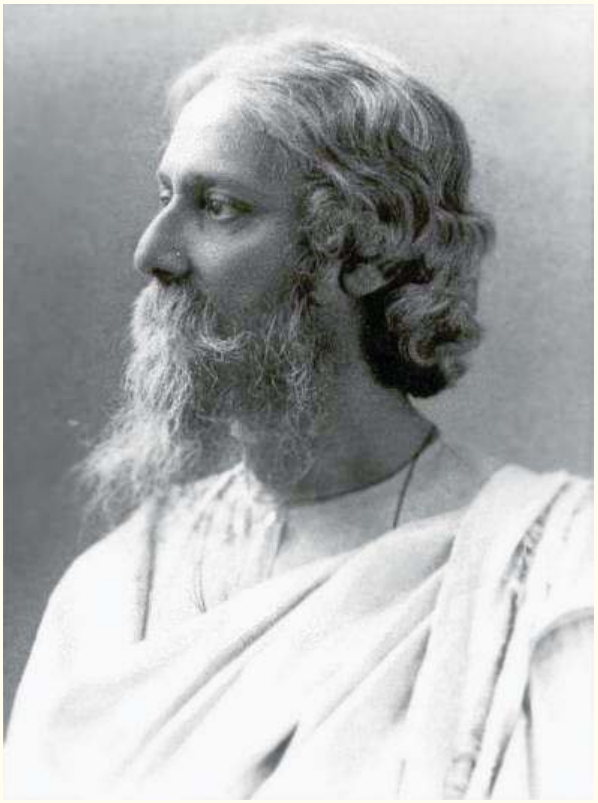
To enrich the nation with technology enabled policy options for equitable growth

Mind without Fear

Where the mind is without fear and the head
is held high;
Where knowledge is free;
Where the world has not been broken up
into fragments by narrow domestic walls;
Where words come out from the depth of truth;
Where tireless striving stretches its arms
towards perfection;

Where the clear stream of reason
has not lost its way into the dreary desert sand
of dead habit;
Where the mind is led forward by thee into
ever-widening thought
and action into that heaven of freedom,
my Father, let my country awake.

Gitanjali, Verse 35



Rabindranath Tagore
1861-1941

PREFACE

Greetings,

Technology is the enabler for growth, both for economic and human welfare. How we choose the options that technology provides and implement the chosen ones in society will determine their relevance and usefulness. CSTEP's mandate is to help the society make the right choice by providing options arrived at after careful analysis. Such analyses involve quantitative studies, computer based simulations and pilot plant and experimental work that are available in the open literature. Developing and publishing options are not by themselves adequate. We must be able to disseminate these studies widely for potential users to consider. CSTEP is fortunate: its studies are now being considered and used by various government ministries and departments.

The Center is continuing to grow. The annual budget is around Rs. 10crore and the number of professionals has grown to 50. The scope of projects is enticingly diverse: from managing emergencies and disasters to discovering new materials for substituting lithium battery electrodes. In all these our scientists and analysts have brought their insight and experience, unique in many ways and the growth is widespread. As is common with learned institutions, CSTEP has held a number of seminars, workshops and conferences.

CSTEP is grateful to several organisations such as SSN Trust, Jamsetji Tata Trust, DRDO, ClimateWorks Foundation, Government of Karnataka and Next Generation Infrastructure Foundation for the support. Recently, International Development Research Centre (IDRC) as part of Think Tank Initiative selected CSTEP for providing core support. This followed a stiff competitive process. This funding enabled CSTEP to strengthen research quality, organisational development and outreach. The OAK Foundation also provided core support for research in sustainable energy options. CSTEP recently was allotted land by Government of Karnataka in North Bangalore to build its campus. We are grateful to Narotam Sekhsaria Foundation for the support in procuring the land. We are now seeking financial support from government and philanthropic donors to build our campus.

We have been fortunate with our Board. With their timely suggestions and advice, they have been guiding our activities. Our collaboration with institutions of higher learning is going well and along with them, we are planning to submit a few proposals for support. Summing up, 2010 has been challenging with excellent opportunities for growth and all of us at CSTEP have taken up the challenges to make our presence felt in the world of Think Tanks.

Dr. V. S. Arunachalam

Chairman

Dr. AnshuBharadwaj

Executive Director

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ABOUT

CSTEP
CENTER FOR STUDY OF
SCIENCE, TECHNOLOGY & POLICY

CSTEP is a 'not for profit' research organisation 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.

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 minimises energy and material flow.

CSTEP is 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.

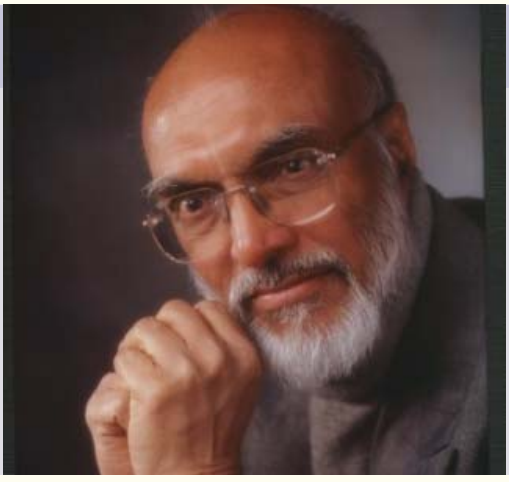
BOARD MEMBERS

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 the 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, Banaras Hindu University, and Director of the Defence Metallurgical Research Laboratory. Prof. Rao was appointed as Secretary to the Government of India, Department of Science and Technology. Later he was 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 and Padma Vibhushan.



SHRI. PRAFULL ANUBHAI

Shri. Prafull Anubhai is a management consultant who 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 organisation). He has over 30 years of experience as a Chief Executive of textile manufacturing operations and presently he is a Director in companies like Birla Sun Life, GRUH Finance Ltd., Mahavir Spinning Mills Ltd., etc.

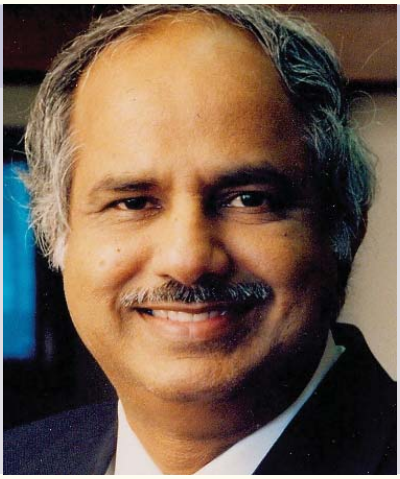
BOARD MEMBERS

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 Raksha Mantri. He was a Member of Parliament - RajyaSabha and Minister of State for Science and Technology.
Prof. Menon is a recipient of several National and International honours including the 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. Prof. Ranganathan is a recipient of the Platinum Gold 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 and 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.

BOARD MEMBERS

DR. ANSHU BHARADWAJ

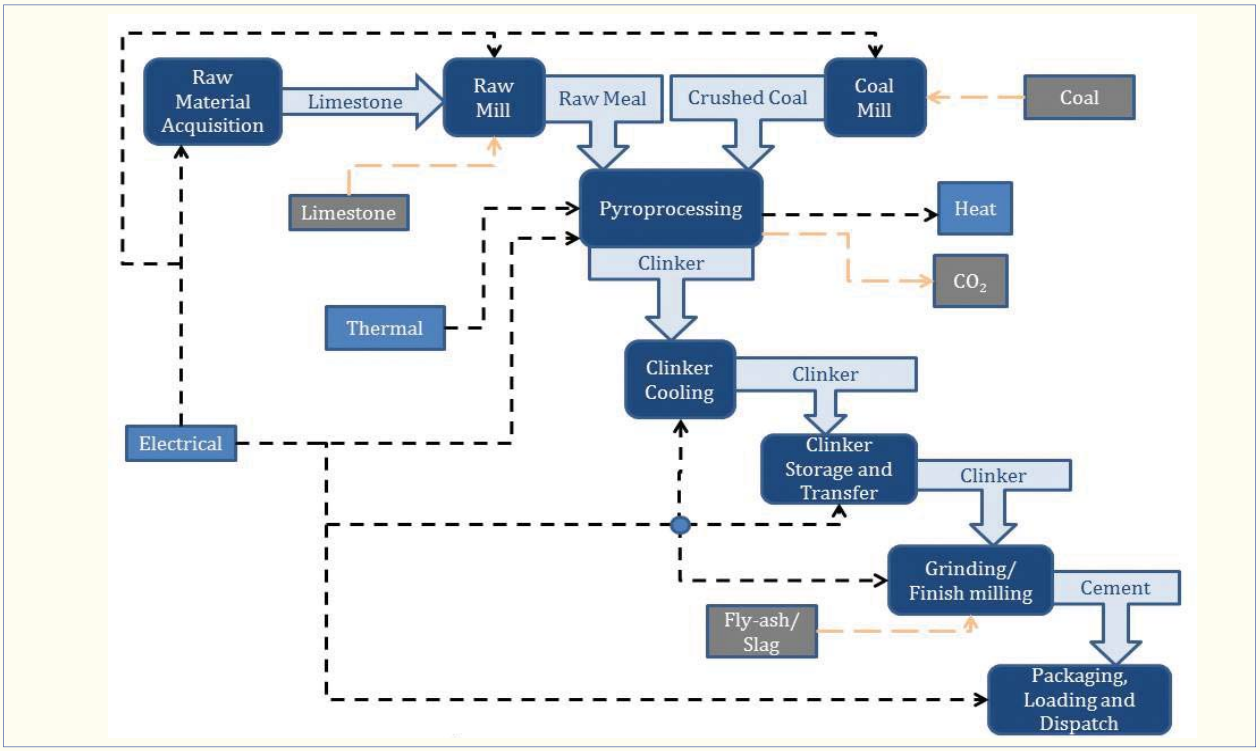
Dr. Bharadwaj is a former member of the Indian Administrative Service (IAS) and worked with Government of Karnataka in various capacities.
He is a B.Tech in Mechanical Engineering from the Indian Institute of Technology, Kanpur and PGDM from the Indian Institute of Management, Calcutta. He got his PhD from Department 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 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 lower carbon intensity of the economy. CSTEP is undertaking several studies covering industrial processes, appliances, buildings and information and communication technologies. Currently, the focus is on the industrial energy efficiency in manufacturing industries 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 customised 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.



Cement Process Flow Diagram

ENERGY EFFICIENCY

Energy efficiency in large industries

CSTEP initiated a project to study the energy consumption of cement industry in India. We visited several cement plants and conducted studies on energy efficiency of various sub-processes such as raw mill, coal mill, kiln, cooler and cement grinding mills. We are developing detailed sub-process level models of energy consumption and efficiency, which can be used to compute energy efficiency potential for the plants. This work is useful in suggesting options to improve energy efficiency of a cement plant based on the relevant parameters.

Energy efficiency in SME sector

The objective of the project is to study energy consumption in discrete manufacturing processes and in Small and Medium Enterprises (SME). This involved regular visits to small-scale manufacturing industries and measuring energy consumption in the processes. The data helped provide options to reduce the energy consumption in specific processes such as injection moulding, compression moulding, sheet metal stamping, electro-discharge machining, foundry etc.

EMERGENCY MANAGEMENT SYSTEMS

Emergency Management Systems

Post 26/11 Mumbai terror attack, CSTEP initiated a project with the support of iDefence Research Defence Research and Development Organisation (DRDO) to develop tools for better preparedness for handling such incidents.

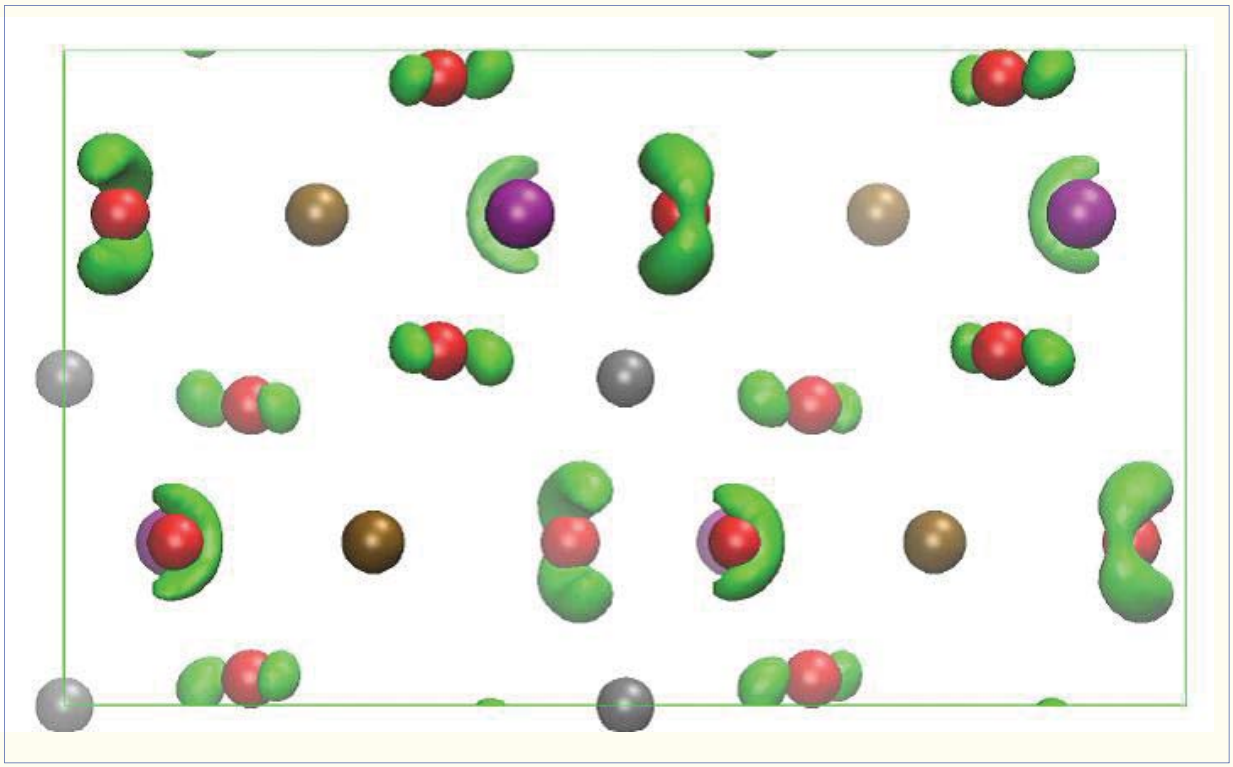
CSTEP is working with Centre for Artificial Intelligence and Robotics (CAIR) to develop models which simulate a disaster situation in an urban location and indicate how to build the emergency response system to handle the situation. The project relies on computations to develop a platform wherein a simulated environment is created and the agencies can examine their safety procedures.

An agent based prototype using CRYengine 3 has been built in the Phase-I of the project. This multi-agent model demonstrates movement of people and emergency vehicles and we are now working on including geographic references. In addition, we created several training videos as examples. The working prototype developed served as the base for specification of a robust system. It is being tested and validated in consultation with CAIR and other agencies and will be transferred to DRDO on completion.

A Disaster Management Situation

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 newer 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.



Charged Transfer Distribution in $LiNiPO_4$

MATERIALS

New approach to design and development of advanced battery materials

Lithium ion batteries have emerged as the work-horse in several systems. Efficient performance of the battery depends on the best choice of cathode, anode and electrolyte. Designing of new materials utilising multi-scale material modelling (atomistic-nano-meso-micro-macro) techniques along with data mining and applying them to identify potential cathode materials with improved characteristics for the lithium ion batteries is the primary objective of this study.

Density Functional Theory (DFT) is the first principle based approach for this study. Ab-initio simulations were carried out for two transition metal oxides ($LiCoO_2$ & $LiVO_2$), $LiAlO_2$, a few olivine phosphates $LiMPO_4$, where M = Fe, Mn, Co, Ni and an olivine silicate $LiFeSiO_4$. Vienna Ab-initio Simulation Package(VASP) was used. Simulations were carried out to determine the ground states of the lithiated and delithiated structures of all the above materials. Charge transfer analysis from Bader charges was also carried out.

Compilation of structural information data of 35 battery materials from Inorganic Crystal Structure Database (ICSD) was carried out. Centre for Artificial Intelligence and Robotics (CAIR), our collaborator in this study has carried out the pattern recognition and data mining work. Chemical bonding aspects are currently under investigation.

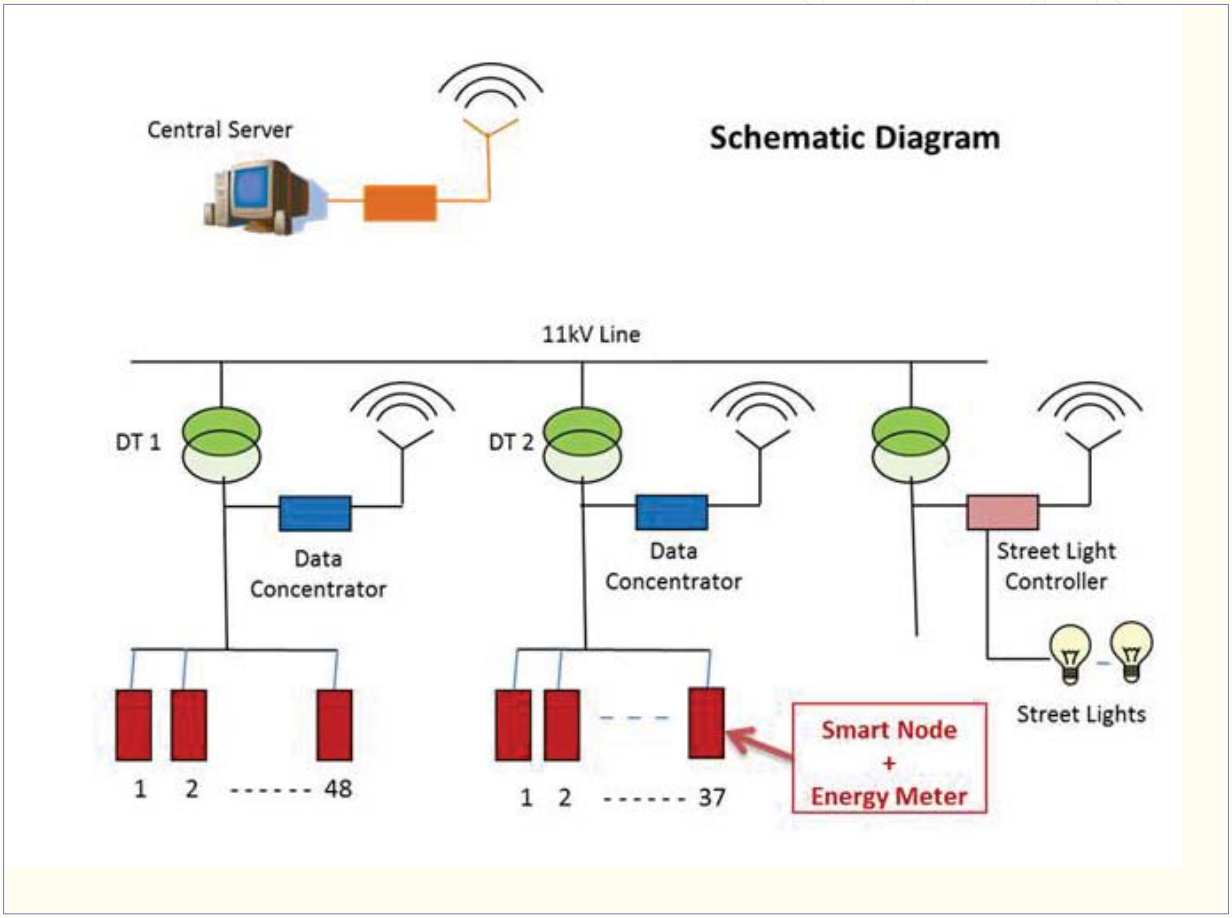
Development of energy storage technology and electric/hybrid transport programme in Karnataka

The Government of Karnataka constituted the Task Force in July 2010 with CSTEP as its Chair. CSTEP is actively involved as nodal agency to build a consortium of various govt departments, bus manufacturers, engine manufacturers and battery companies to help Govt. of Karnataka make transition from diesel-based buses to hybrid/electric based public transportation. We are in the final stages of discussion with a few private companies to make electric motor for retrofitting in the current BMTC diesel mini buses. A battery manufacturer has been contacted to arrange for battery for hybridisation of prototype buses of Bangalore Metropolitan Transport Corporation (BMTC). We are currently waiting for these two companies to accept the proposal and present retrofitting plans. In addition, a few bus manufacturers are also being roped into this consortium as they have already made the first CNG+Li battery bus in India this year.

SMART GRIDS

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.

Not only do smart grids promise a low-carbon future, as they harness renewable sources, but they also ensure accessible power supply for the economically poorer sections of the society.



Schematic Diagram of 'Smart' Electricity Network

SMART GRIDS

CSTEP implemented one of India's first smart grid pilots in Mangalore that extended down to small homes and we demonstrated how the technology could end feeder level load shedding. Even during periods of shortfall of supply, every consumer was provided a minimum quantity of power, which we set at 300-500 watts. This is enough for all basic needs and even to run a television. For the few with inverters/diesel sets, this saves money, and for the rest, it avoids complete power cut.

We are now working with the Mangalore Electricity Supply Company Limited (MESCOM) to develop a larger pilot project in a selected township to assess the impact of the technology on a larger group of consumers. This proposed study will provide options for developing policies to incentivise faster deployment of smart grids.

CSTEP is working with Ministry of Power as technical advisor to the India Smart Grid Task Force and the Smart Grid Forum.

Cost benefit analysis of smart grids

We developed a desktop toolkit model using Analytica platform to evaluate the cost benefit of smart grids in India. This model has been provided to BEE and could potentially be used by utilities to assess the feasibility of Smart Grids in their jurisdiction. Our model captures all the benefits accruing to the utility, consumer and to the society. In addition, we also suggested that utility driven Demand Side Management (DSM) activities should be taken up in India and also adopt various international best practices.

SOLAR THERMAL RESEARCH

The Jawaharlal Nehru National Solar Mission (JNNSM) is one of the eight national missions under the Prime Minister's National Action Plan for Climate Change. It set 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 Ministry of New and Renewable Energy. We are developing models for parabolic trough, linear fresnel and tower systems. We are also examining the possibility of indigenous manufacturing of solar thermal equipment in India.

We visited solar thermal power plants and solar research laboratories in Spain such as CEIMAT (Energy Research Center), Plataforma Solar de Almeria (Field Research Station) and Andasol (50 MW Solar Power Plant).

Fixed Focus Dish

Fixed Focus Dish

CSTEP developed a novel parabolic dish system to demonstrate its distinct advantages over the existing dish systems. The unique feature of this system includes a receiver at the fixed focal point and the rotation of the mirror about polar axis for diurnal tracking. The rotation required for seasonal variation is simplified with the rotation being provided once in three days. This makes the dish tracking simpler compared to other systems and also permits the installation of a heavy receiver at the stationary focus. The fabrication of the dish is complete and further progress is being made on the automation for tracking and the receiver modelling.

INFRASTRUCTURE

CSTEP initiated a project with the support of Jamsetji Tata Trust and the Next Generation Infrastructure Foundation , Netherlands to develop rigorous methodologies and innovative tools for testing the efficacy of infrastructure development in the country. The long-term objective of this initiative is to analyse infrastructure planning, design and testing and to develop and disseminate skills and tools.

CSTEP in collaboration with TU-DELFT developed an innovative game that sensitises the participants to the trade-offs in policy with respect to the funding and building of power plants based on goals set by the Planning Commission. We also jointly developed a simulation game to understand the workings of the European electricity market. This game provides the base for adaptation to a multi-market simulation model and has been used for classroom instruction in several European countries.

CSTEP worked closely with Karnataka Department of Urban Land Transport (DULT) to revise the pedestrian guidelines for the State.

The urban poverty work and slum survey, one of the sub-projects, focussed on links between shelter, mobility and livelihood. CSTEP, with assistance from slum residents, conducted a household survey of 36 slums of more than 1,000 households. This survey builds on the existing work on the homeless in Bangalore city.

The Infrastructure and Energy Groups at CSTEP worked with the Society for the Elimination of Rural Poverty (SERP), a World Bank funded NGO working with the government of Andhra Pradesh to analyse their non-pesticide management of agriculture program to explore possibilities to extend their work into expanding energy options for these farmers.

We hosted a visit with Prof. Don Carter of the Remaking Cities Initiative at Carnegie Mellon University and jointly developed a concept paper and proposal for a project entitled “Saving Cities, Building Towns”.

PUBLICATIONS

Journals

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2. Reich, Y. Hatchuel, A. Shai O. and Subrahmanian E., "A theoretical analysis of creativity methods in engineering design: casting and improving ASIT within C–K theory", Journal of Engineering Design iFirst, 2010.

Magazines and Newspaper articles

1. Arlekar, S., "Open source tools in GIS," Linux For You, January 2010, 84-85.
2. Bharadwaj, Anshu, "Why, how and how much?" Business Standard, April 22, 2010.
3. Bharadwaj, A., "In support of Indian think tank", Business Standard, December 26, 2010.
4. Arunachalam, V. S. Fleischer, E.L., "Introducing energy quarterly," MRS BULLETIN, 2010, Vol. 35, 649.

Reports

1. N. S. Suresh, G. Ramakrishna, Badri S. Rao and M. A. Ramaswamy, "Solar energy impinging on unit aperture area of a parabolic dish whose axis is oriented towards the Sun', CSTEP E/1, 2010.
2. N. S. Suresh, G. Ramakrishna, Badri S. Rao and M. A. Ramaswamy, "Solar energy impinging on unit area of a parabolic trough, aligned N-S axis and East-West tracking", CSTEP/E/2, 2010.
3. Sebastiann Meijer, Jayanth, R. Bharath Palavalli, Robin King, and Alexander Verbraceck, "Supply chain gaming simulation for Indian food supply chains: a review of the need for an introduction of a new design", CSTEP/I/1, 2010.
4. N. S. Suresh, G. Ramakrishna, Badri S Rao, Thirumalai N. C. and M. A. Ramaswamy, "Solar energy impinging on unit aperture area of a Fresnel mirror located at different positions relative to the absorber", CSTEP/E/3, 2010.
5. Shuba Raghavan, "Concept note on monitoring and verification of decentralised solar applications", CSTEP/E/4, 2010.
6. Tongia, R. Saquib, M. and Ramakrishna, H.S., "Indian power supply position working paper series No. 1", CSTEP/E/5, 2010.
7. Badri S. Rao and M. A. Ramaswamy, "Optimisation of focal lengths of the Fresnel mirror collector for efficient operation", CSTEP/E/6, 2010.
8. Kaveri K. Iychettira, "Optimisation of focal lengths of the Fresnel mirror collector with mirrors of 0.5m chord", CSTEP/E/7, 2010.
9. Raghavan Shuba et al., "Harnessing solar energy: options for India", CSTEP/E/8, 2010.

Symposia and Conference Presentations

1. Tongia, R., "Integrated technology, policy, and business model design: International and India perspectives", BESCOM Smart Grid Workshop, January, 2010.
2. Robin King, "Indian-Latin American economic ties", Presentation at Georgetown University Center for Latin American Studies Seminar Series, Washington DC. USA, April 2010.
3. Smulders, F. E. and Subrahmanian, E., "Design beyond design: design thinking and design acting", presented at the 8th Design Thinking Research Symposium (DTRS8) Sydney, October 2010.
4. Shubha Raghavan, "Low carbon growth options for India: a case for solar", in Swissnex Workshop, Bangalore, December, 2010.
5. Robin King, "Changing international economic relations: a focus on India, China, and Brazil," Crowne Plaza presents – Niagara Falls, NY. USA, December, 2010.

FUNDING PARTNERS

- Bureau of Energy Efficiency, Government of India
- Central Power Research Institute, Government of India
- Climateworks Foundation
- Defence Research and Development Organisation
- Government of Andhra Pradesh
- Government of Karnataka
- International Development Research Centre, Canada
- Jamsetji Tata Trust
- Ministry of New and Renewable Energy, Government of India
- Narotam Sekhsaria Foundation
- Next Generation Infrastructures Foundation, Netherlands
- OAK Foundation, Switzerland
- Power Finance Corporation of India, Government of India
- SSN Trust
- The World Bank
- WIPRO

COLLABORATIONS

- Carnegie Mellon University, Pittsburgh, USA
- Centre for Artificial Intelligence and Robotics, DRDO, Bangalore
- Defence Laboratory, Jodhpur
- Indian Institute of Science, Bangalore
- International Institute for Information Technology, Bangalore
- Lawrence Berkeley National Laboratory
- Manipal University, Mangalore
- National Renewable Energy Laboratories
- Naval Materials Research Laboratory, DRDO, Ambernath
- RAND Corporation, USA
- Shristi School of Art, Design and Technology, Bangalore
- SSN Research Centre, Chennai
- Technical University, Delft, Netherlands
- Wipro

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