Report on November 2002 Trip
"Seminars, Workshops, and Strategic Planning Meetings in India for Energy Efficient Windows and Building Design"

By:

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EXECUTIVE SUMMARY:

This report summarizes achievements of the two seminars and workshops titled: “Energy Efficient Windows and Building Design” that were held in New Delhi from November 22 to 23, 2002 and in Bangalore from November 25 to 26, 2002 and strategic planning meetings held in conjunction with these seminars and workshops. The report also offers directions and suggestions for potential future areas of collaboration in the area of building energy efficiency and sustainability. The intent is to develop a basis for proposals in some of these promising areas and to eventually follow-up with real projects.

The seminar and workshop was intended to introduce fenestration simulation programs like WINDOW, OPTICS and THERM, as well as the use of whole building energy simulation software, like DOE2, EnergyPlus, etc. in the design of new buildings and improvement of energy performance of existing buildings. In addition, the seminars also served as open forums for the discussions on the status of energy efficiency in the building sector in India, including the field of energy codes and regulations. In conjunction with the seminars and workshops, separate strategic planning meetings took place to discuss potential future projects and status of energy codes with Indian officials, researchers, and building practitioners.

BACKGROUND:

The August 23, 2002 issue of the *Hindustan Times* newspaper carried an article titled “India offers energy conservation masterplan” from Agence France-Presse, New Delhi, that summarized key points in an important energy efficiency policy statement:

“Indian Prime Minister Atal Bihari Vajpayee said his Government would take the first steps in implementing the national action-plan on energy conservation.

"I call on all Government organizations to reduce their energy consumption by 30 percent in the next five years," Vajpayee said, adding that public buildings and state facilities must ensure guaranteed energy-efficient power supply systems.

He called on all ministries and Government industries to log their power consumption in their annual reports and said energy-guzzling airports, ports, the military, railways and state housing must cut consumption as part of the action-plan.

"We look forward to the implementation of the action-plan over the coming weeks and months," the prime minister said and added that India's 29 state administrations too must participate in the national programme.

"If the central and state Governments provide the lead, the private sector and even households will surely follow, not least because energy conservation makes economic sense," he said.

Vajpayee said President, Abdul Kalam, too has agreed to a comprehensive audit of power consumption in his 330-roomed presidential palace, which is serviced by 1,200 employees besides the secret service.

"For too long, throughout the world, energy 'conservation' has in practice meant energy 'conversation'. This time I ask of all of us, to 'walk the talk'," the premier added."
(A complete copy of the newspaper article is included in Appendix E.)

In answering this open invitation and considering the strategic relationship between India and United States, the U.S. Department of Energy (DOE) in conjunction with National Fenestration Rating Council (NFRC) and University of Massachusetts' Center for Energy Efficiency and Renewable Energy (CEERE), with the help of Confederation of Indian Industries – Godrej Green Business Centre (CII – Godrej GBC), organized a seminar on "Energy Efficient Windows and Building Design" at New Delhi (November 22 – 23, 2002) and Bangalore (November 25 & 26, 2002).

In the current global market environment, the U.S. manufacturers would benefit from a uniform rating system and would be able to sell their products in this developing market. Manufacturers often find difficulties selling their products due to lack of knowledge and misinformation that exists in the market place. Uniform labeling and certification would provide a level playing field and make it easier to market their products.

For the U.S. government, one benefit would be that reducing the use of energy (most energy in India comes from fossil fuels) in developing countries like India would help control greenhouse gas emissions and the U.S. would be able to claim some credit. Another would be that the U.S. would also be able to help its manufacturers benefit from marketing their products in developing market place. Overall it is in the U.S.' strategic interest to help India in their effort of achieving the goal of Energy Efficiency.

WORKSHOP PARTNERS: NFRC, CEERE, DOE, and CII

National Fenestration Rating Council (NFRC)

The National Fenestration Rating Council (NFRC) is a non profit organization that provides energy ratings for windows, doors and other fenestration products. Major U.S. fenestration manufacturers are currently members of the NFRC. Currently NFRC has 548 manufacturers as program participants that place NFRC labels on their fenestration products, for a total of over 120,000 unique products being rated and labeled. NFRC was formed in 1989 to develop a program to establish fair, accurate, and credible energy ratings for fenestration products. NFRC's role was enhanced by directives contained in the Energy Policy Act of 1992 (EPACT) in which Congress directed the U.S. Department of Energy (DOE) Secretary to charge NFRC with establishing a labeling and certification program. Under the same directive, NFRC was asked to work with other international organizations on harmonization of standards and promotion of energy efficient products. NFRC has been very successful in the U.S. and its model is being looked at by the United Kingdom as well as other European Union countries, Russia, Ukraine, Lithuania, Latvia, Estonia, Poland, South Korea, and China. Currently NFRC, along with the U.S. Department of Energy, University of Massachusetts and Lawrence Berkeley National Laboratory, works

on establishing certification and technical standards and also assisting partner countries in developing codes, establishing testing facilities and simulation training. NFRC has been providing training in computer programs that help analyze energy performance of fenestration products (windows, doors and skylight) in buildings. These computer programs were developed by researchers from the Lawrence Berkeley National Laboratory and the University of Massachusetts, and have been incorporated by NFRC into their certification procedures in the U.S.

Center for Energy Efficiency and Renewable Energy (CEERE)

The mission for the Center for Energy Efficiency and Renewable Energy (CEERE) is *"to explore, research, develop, and promote energy efficient technologies and practices and the use of renewable energy resources*." For over 25 years, CEERE has worked to further the educational goals of the University of Massachusetts by providing courses and research opportunities to both graduate and undergraduate students. Additionally, CEERE partners with government organizations, other universities, and private industry to deliver services to public and private sector clients on energy and environmental issues. This unique combination of academics and industry experience enriches all of the activities within the center and has led to the Center's reputation in Massachusetts as a leader in renewable energy and energy efficiency research.

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE)

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), supports a broad range of international activities consistent with its mission, and the laws and regulations governing the conduct of the EERE:

"The EERE mission is to strengthen America's energy security, environmental quality, and economic vitality in public-private partnerships that:

- Enhance energy efficiency and productivity;
- Bring clean, reliable and affordable energy technologies to the marketplace; and
- Make a difference in the everyday lives of Americans by enhancing their energy choices and their quality of life. "

Regarding EERE's position on international activities related to subjects addressed in the Indian workshops, particularly the rating of window energy performance, this position was published in the Federal Register on September 23, 1994 in its Notice of Determination on the Energy Policy Act of 1992, Section 121. That document cited the Conferees report: "It is the intent. …that the Secretary shall seek to harmonize these standards internationally, ….Such harmonization will simplify enforcement, reduce impediments to trade, and will reduce burdens on manufacturers." The document further noted "Work underway by NFRC technical committees is being closely coordinated with related work in other countries through such organizations as the International Standards Organization (ISO), the International Energy Agency, and through bilateral agreements between the U.S. and other countries. This effort by NFRC has sought to establish a common scientific and technical basis for window performance rating which, in the opinion of the Department, is an effective approach in complying with EPAct requirements for international harmonization of standards. This approach presumes the technical excellence of the common basis for rating, and a willingness by all parties to move towards adoption of cost-effective rating procedures which have been demonstrated to be technically superior." More recently, DOE has provided significant technical support to NFRC and its

work with ISO which has lead to the adoption, by NFRC and other countries, of ISO 15099, the technical basis for accurately rating the thermal performance of windows.

EERE through its Building Technologies Program supports international standards harmonization and outreach. It conducts research and development on technologies and practices for energy efficiency, working closely with the building industry and manufacturers; promotes energy and money-saving opportunities to builders and consumers; and works with state and local regulatory groups to improve building codes and appliance standards.

This workshop was cosponsored by EERE, Building Technologies Program. For more information visit the website http://www.eere.energy.gov/.

Confederation of Indian industries (CII) – Godrej Green Business Centre

Launched during the year 2000, CII - Godrej Green Business Centre (CII-Godrej GBC), offers Green Services to the Indian Industries. CII-Godrej GBC offers services on Green Buildings, Environment & Recycling, Energy efficiency and Renewable Energy. CII – Godrej GBC will be the **"***Centre of Excellence" on clean energy, environment and climate change activities in India with the objective to promote Green concepts leading to sustainable development, efficiency and equitable growth.*

For more details, please visit www.greenbusinesscentre.com

OVERVIEW OF SEMINAR AND WORKSHOP GOALS:

This seminar and workshop was intended to introduce fenestration (windows, skylights, doors, curtain walls and other transparent façade systems) simulation programs like WINDOW, OPTICS and THERM, as well as the use of whole building energy simulation software, like DOE2, EnergyPlus, etc. in the design of new buildings and improvement of the energy performance of existing buildings.

Fenestration simulation programs are widely used in the United States by NFRC for window rating purposes and also by the fenestration industry to design and produce energy efficient products.

The annual energy analysis software helps in estimating the energy performance of a whole building so that Building Envelope and HVAC systems are optimally designed and overall energy use in buildings can be minimized, while preserving comfort and productivity.

The main objective of the seminar and workshop was to demonstrate the capability and role of these programs in improving energy efficiency in the building sector in India, to share insights on the importance of energy code language and uniform implementation, and to assist the Indian industry in establishing key testing facilities to carry out fair and accurate measurements of building product performance.

POTENTIAL AREAS OF FUTURE WORK IDENTIFIED IN STRATEGIC MEETINGS:

During the strategic meetings between Indian colleagues and U.S. experts (Bipin Shah, Charlie Curcija, Mahabir Bhandari, and John Hogan), several areas were identified as having potential for future collaboration and proposals (items 1-5 are related to building energy savings, and items 6 and 7 relate to renewable energy development that could be used in conjunction for greater overall energy savings):

1. **Technical Assistance in the Development of Standards for Building Energy Codes, and of Rating, Labeling and Certification (Rating) Programs for Fenestration Products:** Share expertise and provide critical review of building Energy Codes as well as work on the development of an organization that would develop and provide fenestration rating standards and labeling and certification procedures and that be referenced in India's Energy Code.
2. **Testing Laboratory:** Indian and the U.S. experts identified that, in order to implement a successful energy saving certification program and have industry trust, a non-biased testing facility is necessary. Any disputed claims could be verified by such an independent laboratory. As India is a hot climate, cooling-load-dominated, reducing solar gains would be the main objective. Therefore, a spectrophotometer with an integrating sphere to determine the spectral optical properties of glazing material, and a solar calorimeter, would be of importance as they would be able to determine indices or properties that are needed for calculation of Solar Heat Gain Coefficient. U.S. experts recommended that Indian glass manufacturers participate in the International Optical Properties Database where most of the U.S. and European countries are participants. They also agreed to provide their Indian counterparts with the technical information and cost estimate for various equipment required for testing thermal and optical performance (see Appendix D for details). It would also be important for Indian scientists to visit the leading national laboratories participating in the International Optical Properties Database (Lawrence Berkeley National Laboratory, National Physical Laboratory (near London), TNO, Delft, Netherlands, etc. and perhaps arrange a sabbatical at one of those laboratories.
3. **Demonstration Projects, Mock-ups, and/or Test Facilities:** Architects and builders need a greater understanding of the potential for energy efficiency improvements. The best way to increase awareness of energy efficient fenestration technologies is to demonstrate their effectiveness to architects and builders with real examples and small demonstration projects. The U.S. and the Indian governments could collaborate on a project to demonstrate the latest U.S. advanced building technology. An alternative to demonstration projects may be mock-ups, a test facility, or some combination of the two housed in a mobile facility.
4. **Market and Feasibility Studies:** There would be value for U.S. manufacturers to know the potential of the Indian window and glass market. A detailed survey of market conditions would help identify investment opportunities for the U.S. window and glass manufacturers. Some U.S. glass manufacturers are already present in the Indian market, and others have expressed interest.
5. **Continuous Commissioning:** This strategy could be used as a way to achieve the ambitious goal of increasing energy savings in the public sector by 30% in the next 5 years, as requested by the Indian Prime Minister. Energy efficient fenestration is one of measures that would be implemented (examples of other areas are: efficient lighting, daylight utilization, envelope insulation, thermal mass of the envelope, recyclable materials, efficient cooling equipment, efficient motors, pumps and blowers, natural cooling and heating strategies, utilization of solar power, etc.). Continuous commissioning would provide assurance that implemented energy

efficiency measures would work as intended and that further operation would be scrutinized for additional improvements and energy savings.

6. **Remote Application of Hybrid Generated Power:** Remote villages that are not connected to the electric grid would benefit from installation of distributed generation utility systems, consisting of renewable generation as a main source (i.e., wind power, solar power, fuel cell from renewable source, etc.) and backup source in a hybrid power setup, which could be non-renewable (e.g., diesel, fuel cell from non-renewable source, like methane), or one of renewable sources. The program can also help reduce peak loads and reduce transmission line loss, both would help save substantial energy.
7. **Offshore Wind Power.:** In the areas with favorable conditions (i.e., shallow coastal waters, higher wind availability), like the western state of Gujarat (highest wind availability in India and wide spread shallow coastal waters), there is the potential to develop offshore wind farms that would supply green power to urban areas that are experiencing severe power shortages and reduced power quality due to the demand exceeding the generating capacity. Implementing state-of-the-art technologies available in United States and Europe (i.e., Denmark, Germany, etc.) would provide significant additional generating capacity.

IN-DEPTH SUMMARY OF SEMINAR, WORKSHOP & MEETINGS IN NEW DELHI, INDIA

On-site Preparation for Energy Efficient Windows and Building Design:

21 November 2002, New Delhi

Final details were reviewed for the Seminar and Workshop to take place at Le Meridien Hotel, Windsor Place, New Delhi – 110 001. Workshop was organized to start the next day at 10:00 am with registration starting at 9:00 am. Bipin Shah, John Hogan, and Charlie Curcija met with Madhuri Kapur, Senior Manager of Banquet Sales to discuss logistics for the seminar including room availability, room setup for main meeting and breakout meetings, audio-visual needs.

Later in the evening, the local conference organizers, M. Anand, Energy Counsellor, and G. Venkatarama Reddy, Energy Engineer (CII Southern Regional Headquarters, 35/1, Abhiramapuram, 3rd Street, Alwarpet, Chennai – 600 018, India; voice: (91-44) 466-0291, 466-0570, 466-1311, 466-0773; fax: (91-44) 468-0312) from the Confederation of Indian Industry (CII) arrived and had a dinner meeting with the U.S. group. In initial discussions with John Hogan and Mahabir Bhandari, M. Anand and G. Venkatarama Reddy indicate that CII is working on the design for a project that seeks to attain a Platinum rating in the LEED Green Building Program. Bipin Shah, John Hogan, Charlie Curcija, Mahabir Bhandari, M. Anand and G. Venkatarama Reddy discuss logistics and goals for the seminar, where the need for Strategic meeting after the seminar was emphasized by Mr. Bipin Shah to decide on the future course of action.

Seminar on Energy Efficient Windows and Building Design:

22 November 2002, New Delhi

"Seminar on Energy Efficient Windows and Building Design" takes place at Le Meridien Hotel in New Delhi, attended by 82 people (Registration list attached in Appendix A.3). The seminar consists of the Inauguration Session, followed by the Technical Session (Program attached in Appendix A.2).

For the Inauguration Session:

- Sudhir Kapur, Chairman of the Energy and Power Subcommittee of the Confederation of Indian Industry (CII), gave a welcome address. He offered congratulations to NFRC for their successes in the United States and to CII for their Green Building Centre and aspiring to achieve a LEED Platinum rating. He indicated that the seminar was very timely and useful, specially thanked the U.S. group for organizing a workshop to train Indian attendees in the use of computer tools.
- John Hogan delivered a Theme Address for the seminar: "Promoting Fenestration

Energy Efficiency: Role of Rating and Certification" (copy of Powerpoint slides attached in Appendix B.2). The presentation focused on the need of uniform labeling system and need for code language for implementation. He talked about his experiences in the NFRC and as a code personal working with the City of Seattle.

- Dr. Prem C. Jain, Chairman and President of Spectral Services Consultants (E-6, Greater Kailash-III, Masjid Moth, New Delhi – 110 048, India; voice: (91-11) 641-0791, 645-1074, 648-0594, 863-6982; fax: (91-11) 647-0947; e-mail: sscdel@ndf.vsnl.net.in), provided concluding remarks. In response to John Hogan's point that the NFRC standards are referenced in the IECC and ASHRAE/IESNA Standard 90.1 and that these documents require double-glazing and an SHGC of 0.40 or lower, Dr. Jain notes that Indian designers were aware of ASHRAE Standard 90.1 and use it in their designs, and that double-glazing is used in public/commercial buildings, but not in residential buildings. (However, during the break that followed, one attendee discusses with John Hogan a proposed residential project that will have double-glazing as well as significant overhangs for shading.)

* **Meeting with S. Padmanaban, USAID staff representative:**
Mr. Shah met with Mr. Padmanaban during the lunch break and discussed the future work that can be done collectively between USAID, US-DOE, NFRC and CEERE. Mr. Shah indicated that big items, identified by Indian scientists, Government officials and building officials, like constructing a test laboratory, and demonstration program can be funded by USAID. NFRC can help acquire fenestration products for demonstration of U.S. advanced technologies. NFRC and CEERE will help establish the laboratory by providing technical and equipment design details. Mr. Shah also suggested that, under the DOE grant, he would like to invite some professionals from India for the train-the-trainer workshop where the participants would be trained to use computer modeling software like THERM, WINDOW5 and OPTICS. These trained professional would then set up a certification program in India to train and certify people for modeling products using computer modeling.

Mr. Padmanaban liked the ideas and asked Mr. Shah to work in co-operation. He specifically suggested the idea of having demonstration space in the Green Building Centre in Hyderabad city. He apologized for not being available for the strategic meeting in the afternoon as he had made prior commitments. He said that if possible he would try and attend the Bangalore meeting. Mr. Shah mentioned that he would contact him later and also provide him with a detailed project proposal.

(**Mr. J M Bhavani Prasad** Director General (Works) CPWD, New Delhi was unable to attend the seminar due to a last minute engagement with the ministry; he sent Mr. Dave to address the seminar on his behalf. Mr. Dave reached the hotel late and was able to talk to the attendees later in the technical session)

For the Technical Session:

- Mr. Dave, CPWD, New Delhi provided the key note address on behalf of the Director General (Works) CPWD Mr. J.M. Bhavani Prasad. He gave some facts and figures of energy consumption in India and how Central Public Works Department could play a key role in the implementation of energy efficiency in government buildings.
- Bipin Shah summarized the role of NFRC in the U.S. in his presentation "Energy Efficiency in India" (copy of Powerpoint slides attached in Appendix B.1). He explained why a similar body

needs to be created in India to monitor the uniform implementation of code requirement. Simulation would help the market place as it would provide a means to control the product quality assurance and would also be a unbiased tool in case of a challenge.

- Charlie Curcija presented the U.S. perspective on the role of simulation models in energy efficiency in buildings in "Role of Computer Simulations in Window Ratings and Design" (copy of Powerpoint slides attached in Appendix B.3). He explained to the audience that the computer program met the latest ISO 15099 standard (standard used for the analysis of thermal performance of fenestration products) requirement. He also explained how simulation can be helpful to the manufacturers as it provided a means to analyze a design without building physical prototypes which could be very costly.
- Professor N. K. Bansal of IIT Delhi presents the Indian perspective on the role of simulation models in energy efficiency in buildings. He told the audience how the interaction started between NFRC and IIT Delhi, and his visit to the U.S. to attend an NFRC meeting. He mentioned that due to all this effort a current student is to graduate and his thesis was in the field of fenestration and that he used THERM and WINDOW program. He also mentioned that Dr. Mahabir Bhandari was able to go to the U.S. as a research fellow because of the interaction. He emphasized the need of energy efficiency and told the manufacturers to face the challenge. He talked about the details of Indian climate and other technical information relevant for the building efficiency (copy of Powerpoint slides attached in Appendix C.1).
- Anurag Roy, a visiting faculty and research scholar at the School of Planning and Architecture, New Delhi presents the Indian architect's point of view. He told the audience that India is blindly imitating the West without understanding the basic principles. He emphasized that while analyzing the energy savings one needs to account for the embodied energy of the material and processes. If overall analysis, considering entire production steps, showed that there was saving in energy achieved then the effort would be useful. He reminded everyone not to forget the age-old methods used by people to design houses and that would help save energy.
- Jai Singh Dhumal, Chief Manager of ICICI Bank, summarizes Indian energy conservation and commercialization program (copy of Powerpoint slides attached in Appendix C.4). He informed the audience that the bank was encouraging energy efficiency and that fund or loans were available at lower cost if energy efficient methods were employed in the project.

Workshop on Energy Efficient Windows and Building Design:

22 November 2002, New Delhi

Later in the day, the "Workshop on Energy Efficient Windows and Building Design" took place at Le Meridien Hotel in New Delhi, attended by 34 people (Registration list attached in Appendix A.4). Charlie Curcija and Mahabir Bhandari provide training on the THERM program.

CDs were distributed to all participants, while hard copies of simulation manual were distributed to selected group individuals (10 copies at each location). Some participants were slower in following learning how to use programs, while some were faster. The training was kept at the sustained pace to accommodate both groups. PowerPoint presentations for the workshop are attached. General introduction to the fenestration programs was given, followed by the outline of steps to perform simulation by WINDOW and THERM. The training on WINDOW was then given, including the

sample problem. THERM training followed and then participants were given the whole problem to simulate, starting with WINDOW for glazing system analysis, then THERM for simulation of three cross sections (sill, jamb, head) and back to WINDOW for total product analysis. The total time for the workshop did not allow for complete training, but participants were given enough information and hands on practice to be able to fully understand the simulation process and to be able to start using the programs. Each CD contains software and simulation manual, so that they can continue with practicing the use of program after the workshop.

For OPTICS and RESFEN, only demonstration of program capabilities was given along with an example.

The first day, after the seminar and lunch, the main conference room was re-arranged into a classroom-like setting with two computers at each desk and one or two participants at each computer. There were 20 computers and about 35 participants in Delhi. The first day's workshop finished at 5:30 pm and CDs were collected from the participants so that we would have a better attendance on the second day. Several participants left early and took CDs with them. By the end of the first day, there were roughly 20 participants left each having their own computer for working on a sample problem. Generally, the workshop was better attended. It was not possible to complete the in-class exercise in Delhi as it had to be interrupted art and a demonstration given of the remaining steps by instructors.

Instructors were Charlie Curcija, Mahabir Bhandari and Bipin Shah. Bipin Shah also had a task to participate and organize side meetings with representatives from Indian government, academia and other. So he was helping with the workshop whenever he had opportunity and was not in other meetings.

During the workshop it became apparent that most of attendees did not understand the difference between the different low-e coatings and their benefits. Charlie Curcija spent some time during the workshop explaining the basis of the technology and benefits of spectrally selective low-e coatings in warm and cooling dominated climates. There was also interest in acoustical performance and thermally-induced stresses in glazing among the attendees and if it is possible to simulate those. It was pointed that these capabilities are not available at present, but that they might be added at a later date.

The second half of the second–day's workshop was devoted to energy analysis of whole buildings and how to use the results of THERM and WINDOW programs in this analysis. First, a presentation was made outlining the approach and various programs used for this purpose. Programs based on DOE2 and Energy Plus simulation programs were explained in some more detail. The workshop ended with a demonstration and interactive session on the use of one of the DOE2 based programs and an explanation on how to use results from fenestration programs in whole building energy analysis. (Copies of Powerpoint slides attached in Appendices B.5 and B.6.)

Strategic Planning Meeting in New Delhi:

22 November 2002, New Delhi

Concurrent with the New Delhi workshop, Bipin Shah and John Hogan had a strategic planning meeting with key players in the energy-efficiency field in India to develop a work plan for future activities. Meeting attendees include:

- Dr. Narendra K. Bansal, Professor at the Centre for Energy Studies (Indian Institute of Technology at Delhi, Hauz Khas, New Delhi – 110 016, India; voice: (91-11) 659-1247; fax: (91-11) 686-2037; e-mail: narendra@ces.iitd.ernet.in)
- Dr. Bibek Bandyopadhyay, Director, MNES (voice: (91-11) 436-0331; e-mail: bbibek@yahoo.com)
- Dr. Ashvini Kumar, Director, Solar Energy Centre/MNES (with the Solar Certification Program: email:ashvini_sec@yahoo.com)
- Kunal Mathur, Architect and Partner at Architect Yetinder Mathur (U-21, Green Park Extension, New Delhi – 110 016, India; voice (91-11) 619-4313; fax: (91-11) 619-8337; e-mail: matkunal@yahoo.com)
- P. L. Bhatia, Architect
- M. Anand, Energy Counsellor with CII Southern Regional Headquarters
- Pradeep Dutta, Center for Science and Environment, an NGO

- P. K Verma, Architect with CPWD Training Institute (Kamla Nehru Nagar, Hapur Road, Ghaziabad – 201 002, India; voice: (91-575) 471-0936, 475-8998; fax: (91-575) 471-0920; email: praphakarverma@hotmail.com)
- S. Chakraverti, Marketing Manager for ESCO and Consumer Products at Sintex International Limited (Seven Garnala, Kalol – 382 721, India; voice: (91-2764) 24301 to 24305; mobile: 98253 18120; fax: (91-2764) 20385; e-mail: satyajit@sintex.co.in)
- R. Govinda Rao, Director of Energy Economy & Environmental Consultants (506, 15th Cross, Indiranagar, 2nd Stage, Bangalore – 560 038, India; voice: (91-80) 521-3986 to 89; fax: (91-80) 525-9172; e-mail: eeec@vsnl.com)
- Anshu Gupta, Head of Architectural Division of Gujurat Guardian Limited (4-7C, DDA Shopping Centre, New Friends Colony, New Delhi – 110 065, India; voice: (91-11) 631-4007, 682-0846, 693-4707; fax: (91-11) 683-7855, 631-4008; cell: 9810061298; e-mail: agupta@modiguard.com)

(Earlier in the day, John Hogan was introduced to Interjeet Singh, the Senior Economist at the Associated Chambers of Commerce and Industry of India in New Delhi; Dr. Jyotirmay Mathur of the Mechanical Engineering Department at the Malaviya National Institute of Technology in Jaipur; and P. Srinivas Kumar of the School of Engineering & Technology at the Indira Gandhi National Open University in New Delhi; but they did not participate in the afternoon strategic planning discussions.)

Bipin Shah opened the meeting by suggesting that the main goal was to strategize on how to move forward, and to have frank and open discussion of ideas.

Govinda Rao responded that lots of software companies in the south of India are U.S. based and we should have them agree to use U.S. standards in their fenestration products and for overall building construction. The challenge was how to obtain standard products.

Kunal Mathur indicated that architects were controlled by two agencies: council of architecture and council of architectural education (regulates teachers of architecture).

Professor Bansal stated that the development of testing laboratories was essential (need solar calorimetry as well as U-factor).

Kunal Mathur felt that the ultimate aim was to get energy efficiency in the Building Code. There already is regulatory testing of solar devices. Most architects are using AutoCad. The TAD (tools for architecture design) software was a front end for TRNSYS and DOE-2.

Anshu Gupta responded that trying to get requirements in the Building Code would take too long. He was part of a group that looked at the ASTM, DIN, and BIS (Bureau of Indian Standards) standards and it took seven years to get standards adopted in India. The all-India Glass Manufacturers Association is looking at standards and CBRI (Central Building Research Institute, www.cbri.gov.in) is developing standards.

Professor Bansal indicated that there needs to be the development of a neutral body to make recommendations.

Kunal Mathur raised the problem that there is glass and there are windows, and that there is no information on how to combine window components to obtain energy performance. He recommended taking 4th year students from the best of the 115 schools of architecture in India and training them about fenestration energy efficiency. He predicted that the information would spread quickly in several years after that.

Professor Bansal stated that the education program was already written up and proposed to the appropriate authorities to include it in the education curriculum.

In response to a concern about where all the funding would come from for any activities, Dr. Bibek Bandyopadhyay stated that MNES would try and provide some funding for the setting up of the testing laboratory and for development of codes. However he mentioned that appropriate proposal needs to be prepared and submitted for funding request.

Kunal Mathur recommended that sample energy efficient buildings be constructed throughout the country. Kindergartens could be rated as an example.

Dr. Bandyopadhyay replied that there is partial government funding for demonstration projects in government and semi-government buildings.

Kunal Mathur brought up the problem of PVC windows, indicating that architects cannot take risks. There is the problem of plaster being splashed on the vinyl. Also, there is the problem of window tolerances, that standard construction practices leave air gaps around the windows. Vinyl is not mosquito-proof. There should be some financial support for non-conventional windows as they cost four times as much.

Mr. Shah responded that technology in the U.S. addressed all his concerns. He also mentioned that there is an ASTM standard on fenestration installation, which Indian experts can study and develop something similar for the industry to follow. He also offered help in development of such standard.

Professor Bansal responded by suggesting that an institution should be set up for energy ratings. This institution would be responsible for Labeling and quality assurance. He also suggested that it should be unbiased just like NFRC.

Anshu Gupta indicated that there were now sixteen manufacturers of sealed insulating glass units in India that the first only started in 1997. Work should be done within existing organizations such as CCPS (Committee for Construction Products and Services) and CIDC (Construction Industry Development Council). Mr. Shah asked Mr. Gupta to provide some detailed information about the glazing suppliers and market study on the glazing used. He agreed to provide such data by email on a later date.

Govinda Rao noted that ESCOs want a guarantee from the manufacturer of performance.

Kunal Mathur added that architects are considered negligent if they don't comply with the national Building Code. Architects are now involved in revisions to the national Building Code,

recommendations are due in six months. He wanted to make all government buildings show energy efficiency ratings.

Professor Bansal noted that there was a new law that all buildings with 500 kV or greater connected loads must be energy efficient, but that the term "energy efficient" was not defined.

Kunal Mathur stated that, because the WTO law had been signed, all design work was now being done by outside architects. There needed to be a plan for national standards and codes: start with simple steps now, bigger steps in five years, need to lay out a plan. John Hogan could help with code language.

Professor Bansal indicated that he wanted to frame a proposal within two weeks with BEE (Bureau of Energy Efficiency).

Kunal Mathur suggested that NFRC could help formulate the document; one portion would be to introduce requirements into the Building Code.

Pradeep Dutta stated that his organization, the Center for Science and Environment (CSE), could be an effective voice. They are constructing a new building now and they want a green building.

Kunal Mathur returned to the proposal idea and indicated that they needed a briefing document for the code.

Bipin Shah summarized the proposal ideas and asked who would be the champion. Professor Bansal would take this on for Proposal #1, establishing a testing laboratory and education. Professor Bansal and Kunal Mathur would work on Proposal #2, establishing energy efficiency requirements in the Building Codes, and that John Hogan would participate in such effort.

Professor Bansal stated that he would strive to complete the first proposal in two weeks, and asked if John Hogan could come back within a month or by the end of the year to help with the Building Code proposal. The government is going to fund a workshop on Building Codes in February 2003.

Kunal Mathur raised several other concerns: how feasible it would be to base any requirements on the use of computer software, and how to make sure that products are installed correctly so as to achieve the expected performance level.

Regarding the use of software by architects, only 10,000 of the 45,000 registered architects have computers. The architects rely on the air-conditioning engineers.

Regarding getting products installed correctly, there are two success stories of certified installers that could be used as a model. Gypsum board has certified installers and Armstrong suspended ceilings has certified installers. There are 3,000 components that go into a building. Architects must be able to trust that these components will be installed correctly.

Anshu Gupta suggested that replacement windows in railway coaches be addressed.

John Hogan noted that U.S. codes require that replacement windows comply with the standards for new construction. For manufactured homes, HUD establishes standards. Perhaps, this could be a model for rail cars.

Bipin Shah returned to a recap of the proposals.
Proposal #1: Setting up a testing facility that would also include spectral data. Bipin will send information on the cost of equipment.
Proposal #2: Establishing energy efficiency requirements in the Building Codes, Mr. John Hogan and Mr. Shah would participate in such effort.
Proposal #3: Market research study for the fenestration market in India.
Proposal #4: Development of a fenestration certification program. Bipin Shah stated that NFRC would be holding a workshop in mid-March 2003 in the Washington DC area. One portion of this would address the NFRC program. A second portion would be an international train-the-trainers program. Bipin suggested that Anand come to the DC workshop. Bipin also noted that there would be a second workshop during the last week in October 2003.

Regarding Proposal #3, Kunal Mathur indicated that IMBR (Indian Marketing & Business Research) does market research and should have some of this information. Anshu Gupta indicated that the glass manufacturers had some information on this subject and that he would pass on that information to Mr. Shah.

At this point, the meeting formally ended.

Following the meeting, John Hogan had some additional discussions with Professor Bansal and Kunal Mathur about the Building Codes process. In response to a series of questions from John, Kunal Mathur suggested that Building Code proposals be submitted within two months, and that there would be a response in 10-15 days. There was not a formal hearing for proposals, that there was a rolling evaluation and approval on a topic-by-topic basis. Proposals must be understandable and implement-able. The current version of the Building Code is from 1976, so we should not miss this opportunity. However, energy efficiency is not in the current Building Code, so it will be necessary to convince the review committee why to add energy efficiency. There also is the problem of code implementation. The ministers must agree on the importance of energy efficiency so as to get good implementation. Professor Bansal and Kunal Mathur agreed to develop a draft proposal and then meet with John to discuss this on 23 November 2002.

Workshop on Energy Efficient Windows and Building Design:

23 November 2002, New Delhi

"Workshop on Energy Efficient Windows and Building Design" continues at Le Meridien Hotel in New Delhi. Charlie Curcija and Mahabir Bhandari provide training on WINDOW5, OPTICS5, and RESFEN.

Strategic Planning Meeting with Mr. Shashi Shekhar, Director General of the Bureau of Energy Efficiency:
23 November 2002, New Delhi

Bipin Shah and John Hogan (joined later by Charlie Curcija and Mahabir Bhandari) had a strategic planning meeting with Shashi Shekhar to discuss a work plan for future activities. Meeting attendees include:

- Shashi Shekhar, Director General of the Bureau of Energy Efficiency – BEE (118, Ashirwad Complex, D-1, Green Park, New Delhi – 16, India; voice: (91-11) 651-0815, 686-4867, 686-4868, 656-6038; fax: (91-11) 686-8914; e-mail: shekhars_2000@yahoo.co.uk)
  (Business card also lists Shashi Shekhar as Director of the Ministry of Power, Shram Shakti Bhawan, Rafi Marg, New Delhi – 110 001, India; voice: (91-11) 371-6020)
- Professor Bansal, IIT Delhi
- M. Anand, CII
- G. Venkatarama Reddy, CII
- S. Chakraverti, Sintex Pvt. Ltd

Bipin Shah reviews the outcome of the strategic planning meeting on 22 November 2002.

Shashi Shekhar listens, at first only asking clarifying questions. Having the context, he then provides an overview of related work in India.

Mr. Shekhar talked about the Act (law) cleared by the Indian Parliament effective in March 2002, which mandated development of energy conservation code (part of the Act) and will address the six climate regions in India. When Professor Bansal mentions about the previous day's discussion of working on a proposal to amend the national Building Code, Shashi Shekhar replied that he did not think that this would be so useful. Now energy is "under the act", whereas the Building Code is not and thus is voluntary. Consequently, his suggestion was that the efforts should be devoted to the Energy Conservation Building Code. Shashi Shekhar indicates that he expects Professor Bansal to be working on India's Energy Conservation Building Code. Bureau for energy conservation should be able to push this concept through. It is estimated that it would take between 9 months and a year to develop energy conservation code. It is expected that 80% of the requirements will be the same for all six climate regions, with only 20% of the content varying by climate. Code will include fenestration provisions. When the new code is ready there would be 2-3 options for implementation. A) Incorporate into codes/permit process that are followed by local bodies (currently this method is deemed ineffective due to corruption present at local levels) and B) Rating and Labeling or some other marketing means, it would be necessary to identify the party to do it? Maybe CII, or Architectural association. C) Initially have requirements apply to new buildings with a peak load of over 0.5 MW. It is estimated that there are 100-200 new buildings per year in India that would fall into this criterion.

In response to John Hogan's question about whether the Energy Conservation Building Code would be a national minimum, Shashi Shekhar indicated that it would be. John suggested that the U.S. experience was that it was a good idea to allow individual cities and states to adopt more stringent requirements. This way other energy efficiency measures could be applied on a smaller scale and later these improvements could be incorporated into the national Energy Conservation Building Code. Shashi

Shekhar's response was a caution and concern about corruption, that different standards opened options for abuse at the local level.

John Hogan responded that it was important to have some mechanism for approval so that the Energy Conservation Building Code would really be implemented. If the local government officials were not knowledgeable, then there could be a third party evaluation by others such as Certified Energy Analysts.

Shashi Shekhar then summarized the plan for existing buildings. The Prime Minister has said that energy used in existing buildings must be reduced 30%. It's important to consider windows and air-conditioning together. Window replacement should be tied to replacement of window air-conditioning units. (Window units are more typical in India than central air-conditioning.)
Mr. Shashi Shekhar mentioned that Energy efficiency was always taking 2nd place (dominated by supply side). Now things are slowly changing. Stakeholders would be simulators, installers, manufacturers, researchers, etc. Need to work at 3 levels: 1) developers of code; 2) how to apply/ implement code; and 3) builders, architects, building officials.

He mentioned that some other issues of concern were: enforcement, education, relationship to developers?

Comments and thoughts: A) Commissioning is important new field that is under development in U.S. and it would be good to mandate it in Indian codes. Commissioning is advanced energy auditing which makes sure that things are implemented correctly (quality assurance). B) Encourage U.S. manufacturers to sell their product in the Indian market place. C) NFRC helps develop education program that can explain energy efficiency concept considering Indian climatic conditions.

The discussion then turned more specifically to fenestration products. Shashi Shekhar asked what it would take to get manufacturers to start labeling fenestration products. Bipin Shah replied with an example from California where the California Energy Commission provided funding for initial testing for a 3-month time period to jumpstart the process. John Hogan noted that most Energy Codes in the U.S. contain default tables that are punitive and that this provides an ongoing incentive for manufacturers to get their products rated.

Shashi Shekhar then offered a three-step training plan: first, involve the stakeholders in the development of the Energy Conservation Building Code; second, determine how to "operationalize" the Energy Conservation Building Code and implement it in the market; and, third, provide the training to stakeholders with the message tailored to each audience: architects (design and use of materials), manufacturers (materials available), etc..

IN-DEPTH SUMMARY OF SEMINAR, WORKSHOP & MEETINGS IN BANGALORE, INDIA

Seminar on Energy Efficient Windows and Building Design:

25 November 2002, Bangalore, Karnataka

The "Seminar on Energy Efficient Windows and Building Design" took place at Leela Palace Hotel in Bangalore, attended by 45 people (Registration list attached in Appendix A.6). The seminar consisted of the Inauguration Session, followed by the Technical Session (Program attached in Appendix A.5).

For the Inauguration Session:

- Umesh Rao, Convener of the Energy Panel of the Karnataka State Council of the Confederation of Indian Industry – CII (Managing Director, Lotus Energy Systems, 27, Nandidurg Road, Jayamahal, Bangalore – 560 046, India; voice: (91-80) 333-1912; fax: (91-80) 333-2866, 333-4804; e-mail: urao@lotusenergy.net), giving the welcome address. He said that knowledge must be followed by action. The purpose of this seminar is knowledge dissemination. Sustainable development must be the direction for India. Energy efficiency is a key component. CII is doing energy audits. CII will hold a seminar on 20-22 February 2003 in Bangalore on distributed generation. He welcomed the U.S. team and thanked both NFRC and CII for organizing the seminar and the workshop.
- ParasuRaman R, Chairman of the CII Green Building Council at Godrej Green Business Centre and Managing Director for MK Electric India Limited (Crescendo, 995 B, Second Avenue, Anna Nagar, Chennai – 600 040, India; voice: (91-44) 616-1234; fax: (91-44) 616-2020; e-mail: parasu@mkindia.net ; website: www.mkelectricindia.com), gave a follow-on address. He offers congratulations to NFRC and then went on to provide an overview of the Green Building Council. He said, Green building means energy efficiency, recycling, better indoor environment, rainwater harvesting. The cost may be more, but there is payback within two years. They are striving for the first LEED platinum rating in India and only the third in the world. They are working to develop green building codes in India, to address energy efficiency in the production of the building and operation.
- John Hogan delivers Theme Address for the seminar: "Promoting Fenestration Energy Efficiency: Role of Rating and Certification" (copy of Powerpoint slides attached in Appendix B.2).
- Umesh Rao provides concluding remarks and asks for questions/comments. There is interest in a document that specifically addresses India's climates: i.e. the importance of shading devices, dust (which can be addressed through windows with lower air leakage). There is the challenge of ratings vs. performance. Ratings refer to the product as it leaves the factory. Performance in the actual building is affected by overhangs, orientation, position in the wall (flush with the façade vs. recessed into the wall). Another factor is the effects of plantings on solar gain through the windows, on moderating the effect of temperatures around the building, and on dust control.

During the question answer period, some specific questions were raised A) regarding the cost of simulation and testing in the U.S.. B) How does energy standard address the issue of acoustics and dust

prevention through fenestration products. C) Does one take the natural methods of shading into consideration while talking about solar heat gain.

Mr. Shah provided answer to most of the questions; A) Simulation cost roughly $1000-$1500 for an entire Product Line. Testing would cost about $800-$1200 per product. B) Energy efficient widows are also good for acoustics and are more air tight and therefore prevent dust. C) Yes, one needs to account for all mean of energy efficiency in the building (reference to slide in the presentation). But one needs to start with the envelope and then optimize the equipment used for environmental control in the building.

For the Technical Session:

- Bipin Shah summarizes the role of NFRC in the U.S. in his presentation "Energy Efficiency in India" (copy of Powerpoint slides attached in Appendix B.1).
- Charlie Curcija presents the U.S. perspective on the role of simulation models in energy efficiency in buildings in "Role of Computer Simulations in Window Ratings and Design" (copy of Powerpoint slides attached in Appendix B.3).
- Dr. Jyotirmay Mathur, Associate Professor in the Mechanical Engineering Department of the Malaviya National Institute of Technology (J.L.N. Marg, Jaipur – 302 017, India; voice: (91-141) 270-2708; e-mail: jyotirmay@recjai.ac.in), presents the Indian perspective on the role of simulation models in energy efficiency in buildings (copy of Powerpoint slides attached in Appendix C.3).
- K. V. Pradeep, of ARCO Air-conditioning and Refrigeration Consultants, presents the Indian architect's point of view (copy of Powerpoint slides attached in Appendix C.2).

Workshop on Energy Efficient Windows and Building Design:

25 November 2002, Bangalore, Karnataka

Later in the day, the "Workshop on Energy Efficient Windows and Building Design" takes place at Leela Palace Hotel in Bangalore, attended by 22 people (Registration list attached in Appendix A.7). Charlie Curcija and Mahabir Bhandari provide training on the THERM program (see description of workshop in New Delhi for general information). (Copies of Powerpoint slides attached in Appendices B.5 and B.6.)

Strategic Planning Meetings in Bangalore:

25 November 2002, Bangalore, Karnataka

Concurrent with the Bangalore workshop, Bipin Shah and John Hogan had two strategic planning meetings with key players in the energy-efficiency field in India to develop a work plan for future activities.

Attendees at the first strategic planning meeting in Bangalore include:

- Umesh Rao, Convener of the Energy Panel of the Karnataka State Council of the Confederation of Indian Industry (CII) and Managing Director of Lotus Energy Systems
- ParasuRaman R, Chairman of the CII Green Building Council at Godrej Green Business Centre and Managing Director for MK Electric India Limited
- S. Raghupathy, Senior Advisor at CII Southern Regional Headquarters (35/1, Abhiramapuram, 3rd Street, Alwarpet, Chennai – 600 018, India; voice: (91-44) 466-0291, 466-0570, 466-1311, 466-0773; fax: (91-44) 468-0312; e-mail: s.raghupathy@ciionline.org and gbc@ciionline.org; website: www.greenbusinesscentre.com)
- M. Anand, Energy Counselor with CII Southern Regional Headquarters

(Earlier in the day, John Hogan was introduced to G. Srinivas Murthy, Chief Executive and Architect of SMG Design in Visakhapatnam; and V. Gopal, General Manager for Projects for the Prestige Estates Projects Limited in Bangalore; but they did not participate in the afternoon strategic planning discussions.)

Bipin Shah opened the meeting by reviewing the four tasks suggested in New Delhi. John Hogan mentioned the opportunity of the March 2002 Energy Act that called for an Energy Code to be developed within 6-9 months.

ParasuRaman R indicated that the national Building Code was fragmented. Each locality has their own laws. Locally, this is the BDA (Bangalore Development Authority). It's an impossible task to agree on a national code, it's too easy for it to be blocked by any person or interest. There are 700 members of CII, many are in real estate. It's better to work on green building concepts with them.

John Hogan replied that CII needs to allocate its resources to the best use, but they shouldn't miss out on an opportunity with the national Energy Code.

ParasuRaman R said that there was no "branding" in glass until St. Gobain started in the market several years ago. Not sure if there is an architect interest in fenestration except for aesthetics. CII planed to "Indianize" the LEED rating system and they could come up with some specific requirements for fenestration. He agreed to (1) put information on fenestration and NFRC on the CII website, (2) do a direct mailing to assess the level of interest and importance of fenestration, (3) will contact the Green Building Committee that is "Indianizing" LEED for them to look at fenestration.

Umesh Rao said that they need scenarios for India, how to best use fenestration products and how to use the best products.

Bipin Shah replied that there was no good analysis yet. Returning to ParasuRaman R's comments on the green building program, Bipin recommended that requirements be established for air leakage, SHGC, and VT.

Umesh Rao recommended contacting the Central Power Research Institute (CPRI) in Bangalore. The director is Saachi Danand.

John Hogan and Mr. Shah recommended that CII consider an Energy Star type of program to encourage better fenestration products in projects that don't go all the way to green buildings.

ParasuRaman R agreed that this was a good idea. Double-glazing is used now in hotels near the airport for sound control.

John Hogan replied that fenestration product manufacturers should take credit for acoustical improvements. Mr. Shah explained the energy efficient products would provide better acoustical and air-tight windows for dust prevention.

Umesh Rao said that Bangalore has a good acoustics laboratory and that, at Lotus, his company's product was sound control. He's worked on sound control guidelines for diesel generator sets and published documents with this information. Same should be done for fenestration products. Need examples of sound benefits, otherwise people would just rely on simple economics.

S. Raghupathy indicated that this seminar was part of an effort to push green buildings. The question is how the ratings will drive the market. Need to think ahead.

Bipin thanks everyone for participating and the first strategic planning meeting comes to a close. The second strategic planning meeting starts a little later.

Attendees at the second strategic planning meeting in Bangalore include:

- M. K. Chandrasekhar, Executive Advisor to BPL Engineering Limited (59, 100 ft Road, Kedia Villa, Indiranagar, Bangalore – 560 038, India; voice: (91-80) 521-9166; fax: (91-80) 521-9377; e-mail: grd@bplnet.com)
- C. Shekar Reddy, Chairman of CSR Estates Ltd. and President of the Builders Forum (3-6-432, 11 Floor, Velama House, Himayatnagar, Hyderabad – 500 029, India; voice: (91-40) 763-1515, 763-7709; fax: (91-40) 764-4474; e-mail: csheharreddy@yahoo.com)
- Rajan Venkateshayar, Chief Architect of Larsen & Toubro Ltd. – ECC Division (P.O. 979, Mount Poonamallee Road, Manapakkam, Chennai – 600 089, India; voice: (91-44) 249-3318 ext 4119, 249-2747; fax: (91-44) 249-3888; e-mail: yvn@lntecc.com and poonsri@usnl.net.in
- K. L. Shashikant, Assistant General Manager, Building Controls Systems Division, MK Electric India Limited (Crescendo, 995 B, Second Avenue, Anna Nagar, Chennai – 600 040, India; voice: (91-44) 616-1234; fax: (91-44) 616-2020; e-mail: shashi@mkindia.net ; website: www.mkelectricindia.com),
- N. Parasuraman, Deputy General Manager of the Tamul Nadu Energy Development Agency, College Road, Chennai – 600 006, India; voice: (91-44) 822-2973, 822-4830)
- S. Raghupathy, Senior Advisor at CII Southern Regional Headquarters
- M. Anand, Energy Counsellor with CII Southern Regional Headquarters

Bipin Shah opened the meeting by reviewing the four tasks suggested in New Delhi.

Rajan Venkateshayar felt that people had lost track of environmental impacts. Architects are putting too much glass in buildings. They have designed work spaces with all the lighting through skylights, but need a way to analyze this.

Bipin Shah replied that the software program Radiance developed by LBNL can evaluate lighting before the design is done.

M. K. Chandrasekhar stated that he did not think that train-the-trainers would work in India.

S. Raghupathy, however, replied responded that the Green Building Council was an example of a joint effort of architects, builders, and others. They want more efforts to stimulate demand, money is not a problem.

Bipin Shah indicated that it is necessary for people to commit, for someone to champion an issue, such as training on Radiance.

N. Parasuraman wants to see support of solar and renewable technologies.

C. Shekar Reddy said that demand is needed to train builders, architects, and government agencies.

M. K. Chandrasekhar replied that energy was a central government objective. There's an energy shortage in all the states. Get government to set up codes for energy.

C. Shekar Reddy talked about how the Builders Forum had established a rainwater harvesting program. Then it became a government law, and people stopped doing it because it was one more office to pay a bribe. Builders must go to two dozen government agencies to get approval for construction (95% of their job is getting the permit, 5% is for construction and selling). There was a need to identify products to introduce in India, and then a way to indicate their availability. Standardization is needed to bring down costs. Regarding CREDI (the Confederation of Real Estate Developers in India), 80% of the developers in India are members.

John Hogan asked C. Shekar Reddy what would make builders use energy efficient fenestration.

C. Shekar Reddy responded market advantage. Builders need information on energy efficient products because it's a buyer's market in India now.

Rajan Venkateshayar described the decision making process for fenestration product selection as follows: the fenestration product representative makes a proposal, the designer considers it, and the builder estimates the cost.

C. Shekar Reddy said that you don't get quality fenestration products in India because you have to buy the wood, then the glass, then get someone to fabricate a window and put it together. There are few manufactured products available because window sizes are not standardized. He added that the government has a 160 acre campus to set up the National Academy of Construction.

M. K. Chandrasekhar indicated that he had just put in new windows, two layers (two separate windows a short distance apart, however, not a single window with sealed double-glazed unit) to prevent noise.

Bipin Shah asked if demonstration projects could be done, and then have the results continuously monitored.

C. Shekar Reddy replied that we should contact the National Academy of Construction, Mr. R. C. Sinha, Director General.

Bipin thanks everyone for participating and the second strategic planning meeting comes to a close.

Strategic Planning Meeting in Bangalore:

26 November 2002, Bangalore, Karnataka

Bipin Shah, John Hogan, Charlie Curcija, and Mahabir Bhandari had a morning meeting with Umesh Rao to continue discussions on strategic planning for future activities.

Umesh Rao described how CII is organized. The main headquarters is in Delhi, and there are separate branches in each state. Ashuk Soota is now president. (CII also has an office in Washington D.C.) CII works with the Indian government formulating policies. CII has 15 different working groups including ones for energy, IT, and quality production. Umesh Rao heads up the ICC energy panel for Karnataka State. Bhopal Krishna is the head of the CII national energy panel.

John Hogan asked how the CII energy panels, both national and locally, decide on what issues they will work on.

Umesh Rao replied that the CII energy committee has a national agenda for bringing in power sector reform, which includes the Bureau of Energy Efficiency. State panels also work on local issues. The State electric boards have challenging problems. Electricity distribution losses are 40%, then 35% of the power is distributed free to farmers. One of the policy questions now is should farmers pay for electricity. Rural areas indicate that they are willing to pay, but they need better power quality. They receive 6-8 hours of power per day at most, and even that has atrocious power quality that burns up pump motors. CII wants to demonstrate hybrid systems (distributed power generation combined with renewable).

Mahabir Bhandari asks if there are any working examples of hybrid systems in India.

Umesh replies that there are not. He continues, however, that there are good opportunities now. There is a movement of healthcare and IT into rural areas (there are 80,000 villages in India). They need distributed generation, waste heat can be used to drive absorption cooling.

John Hogan asked how fenestration fit in.

Umesh Rao responded that they should put energy efficiency in the new healthcare buildings, including better windows.

John Hogan noted the benefits here of optimizing building design to minimize the peak load.

Mahabir Bhandari suggested that plantings could be used to reduce cooling costs as rural areas have lots of space.

Umesh Rao then talked about the necessity of identifying and training rural entrepreneurs to run these hybrid systems.

The meeting comes to a close.

Workshop on Energy Efficient Windows and Building Design:

26 November 2002, Bangalore, Karnataka

The "Workshop on Energy Efficient Windows and Building Design" continues at Leela Palace Hotel in Bangalore. Charlie Curcija and Mahabir Bhandari provide training on WINDOW5, OPTICS5, and RESFEN.

DETAILS ON POTENTIAL AREAS FOR FUTURE WORK

The following seven topics have been identified as potential areas for future work:

1. **Technical Assistance in the Development of Building Energy Codes and of Rating, Labeling, and Certification Programs for Fenestration Products**.
2. **Design and Construction of Fenestration Testing Laboratory**.
3. **Demonstration Projects, Mock-ups, and/or Test Facilities**.
4. **Market and Feasibility Studies**.
5. **Continuous Commissioning**.
6. **Remote Application of Hybrid Generated Power**.
7. **Offshore Wind Power.**

1. Technical Assistance in the Development of Building Energy Codes and of Rating, Labeling, and Certification Programs for Fenestration Products:

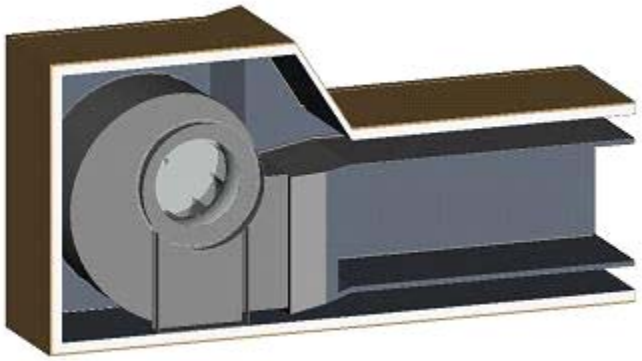
India currently does not have a national Energy Code for Building Construction, or a national system for rating, labeling, and certifying the energy performance of fenestration products. With the passage of the Energy Act in March 2002, work will soon begin on the development of a national Energy Code for Building Construction.

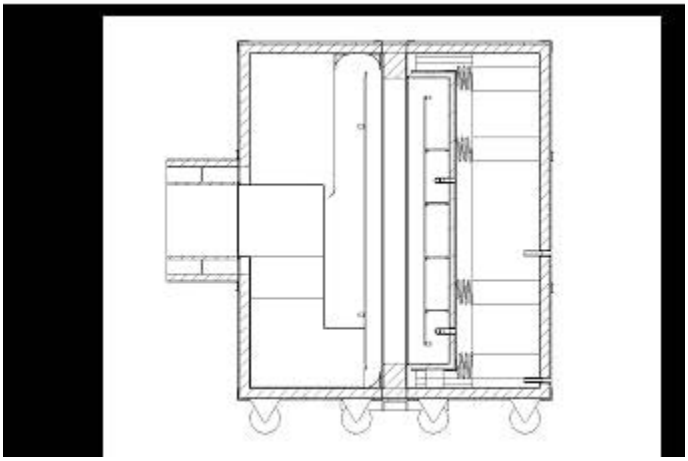
Technical assistance would be very beneficial in the development of a national Energy Code. It would be useful to have experts participate in overall development and review of the work. This would include review of draft building Energy Codes, participating in meetings to offer comments and share expertise, and to provide recommendations on implementation. Expertise could be shared on prescriptive and performance compliance options, level of stringency, etc.

Fenestration would play a key role in the national Energy Code. Here again technical assistance would be very valuable. It would be desirable to develop a national energy rating system for fenestration products. It would be useful to have experts participate in overall development and review of the work. This would include review of draft technical rating standards and certification and labeling procedures, participating in meetings to offer comments and share expertise, and to provide recommendations on implementation.

2. Testing Laboratory:

U.S. and Indian experts identified that, in order to implement the energy saving certification program and have industry trust, a non-biased testing facility is necessary. Any disputed claims could be verified by such a laboratory. U.S. experts mentioned that they would be able to provide technical information and cost for various equipment required for testing thermal performance (see Appendix D for details). Spectrophotometer (Spectral and optical data for glazing material), Solar Calorimeter (Solar heat gain coefficient), Guarded hot-box (U-factor), material conductivity meter (measurement of thermal property





material) were some of the equipment identified for setting up the thermal testing facilities. As India is a hot climate, cooling load dominated, reducing solar gains would be the main objective. Therefore, solar calorimeter and spectrophotometer with integrating sphere would be of importance as they would be able to determine indices or properties that would calculate Solar Heat Gain Coefficient. The U.S. experts mentioned that they will work on the project cost. Ministry of Non-Conventional Energy Sources (MNES), India, Syntex, Industry, and GSC Toughened Glass Pvt. Ltd mentioned that they are a potential source for funding. Outside of India, work with USAID, DOE to provide funding for this activity.

A specific proposal for this activity is included in Appendix D.

It would also be important for Indian scientists to visit the leading national laboratories participating in the International Optical Properties Database (Lawrence Berkeley National Laboratory, National Physical Laboratory (near London), TNO, Delft, Netherlands, etc. and perhaps arrange a sabbatical at one of those laboratories.

3. Demonstration Projects, Mock-ups, and/or Test Facilities:

Architects and builders need a greater understanding of the potential for energy efficiency improvements. The best way of increasing awareness of energy efficient fenestration technologies is to demonstrate that to architects and builders with real display examples in India. (This suggestion was made by Mr. Padmanaban, S., of USAID staff during his discussions with Mr. Bipin Shah.) Indian manufacturers mentioned that marketability of energy efficiency will be more improved if explained along with the benefits of achieving acoustical improvement and dust prevention. Work with USAID to prepare a proposal to develop a location for the demonstration of the benefits of double glazed windows (including acoustics), spectrally selective glazing, and air-tight fenestration products.

Work with USAID, DOE and some U.S. manufacturers to provide funding for this activity as a potential source.

An alternative to demonstration projects may be mock-ups, a test facility, or some combination of the two housed in a mobile facility.

4. Market and Feasibility Studies:

It would be of interest for U.S. window and glass manufacturers to know the potential of the Indian market. The window and glass manufacturers tend to operate independently; window manufacturers looking to in-country suppliers for glass, and glass manufacturers looking to in-country window

manufacturers to supply glass to. A survey of the market should provide both more general information on past trends and future forecasts for new construction and replacement windows, as well as specific information on annual sales by window operator types (useful to window manufacturers) and market shares of glass types such as spectrally-selective coated (useful to glass manufacturers). This assessment would give manufacturers more confidence in participating in the Indian market by providing guidance for decisions on which products they might offer. Some of the U.S. glass manufacturers are already players in the Indian market; Guardian has agreed to provide some information on the Indian market. The Confederation of Indian Industry (CII) can be a potential party to conduct a survey and provide information to NFRC that in turn can provide the information to the industry. Work with U.S. Department of Commerce, and U.S. DOE to provide funding for this activity.

5. Continuous Commissioning:

According to the World Watch Institute, "as much as a tenth of the global economy is dedicated to buildings: to construction, operating, and equipping our built environment. This economic activity uses even larger shares, one-sixth to one-half, of the world's wood, minerals, water, and energy. Blame for much of the environmental damage occurring today, from destruction of forests and rivers to air and water pollution and climate destabilization, must be placed squarely at the doorsteps of modern buildings. Many buildings do harm on the inside as well: they subject us to unhealthy air or alienating physical environments, making us both less healthy and less productive than we are capable of being."

Buildings generally do not perform as well in practice as anticipated during the design stage. There are many reasons for this, including improper equipment selection and installation errors, the lack of rigorous commissioning, improper maintenance, and poor feedback on ongoing performance, including energy performance. These problems arise at various stages of the building's life cycle, from design to operation, and exist in virtually all building systems, including envelope, HVAC system, and lighting. Consequences of such sub-optimal performance are increased energy costs, occupant discomfort, poor productivity, health problems and higher maintenance costs.

Building Commissioning is a systematic process of ensuring that building systems (i.e., HVAC, mechanical, envelope, controls, lighting, etc.) perform according to the design intent and the owner's operational needs. This is achieved in the design phase by documenting the design intent and continuing through construction, acceptance, and the warranty period with testing and verification of performance, operations and maintenance (O&M) verification, and the training of operating personnel. Commissioning traditionally referred to only the process of HVAC testing and balancing (TAB), however, as is typically the case when speaking of commissioning in current practice, it now emphasizes the interaction between different systems with the goal that their integrated performance is optimized. For example, as building insulation, other envelope and window systems are improved, and more efficient lighting is specified, a building's heating and cooling requirements may, in turn, avail the opportunity for modification or down-sizing of the (previously specified) mechanical system.

Continuous commissioning is a process developed by the Energy Systems Laboratory (ESL) at Texas A&M University and according to their definition it consists of the following: 1) optimization of the operation of existing systems to improve building comfort and reduce building energy cost; 2) solution of existing comfort and IAQ problems; 3) guaranteeing continuous optimal operation by operational staff in future years; and 4) provide optimal energy retrofit suggestions to owners to minimize project costs. The continuous commissioning process has been very successful in reducing building energy consumption by

anywhere from 15% to 50%, with higher saving achievements in buildings that were not previously commissioned.

Continuous Commissioning can be successfully used as a way to achieve the ambitious goal of energy savings in for the public sector by average of 30% in the next 5 years, as requested by Indian Prime Minster Mr. Vajpai. Energy efficient fenestration would be just one of measures that could be implemented (examples of other areas are: efficient lighting, daylight utilization, envelope insulation, thermal mass of the envelope, recyclable materials, efficient cooling equipment, efficient motors, pumps and blowers, natural cooling and heating strategies, utilization of solar power, etc.). Continuous commissioning would provide assurance that implemented energy efficiency measures would work as intended and that further operation would be scrutinized for additional improvements and energy savings. In the United States, continuous commissioning has been proven to provide savings of up to 50% for buildings that were never commissioned and 15-30% of savings for buildings that were commissioned in a traditional way (i.e., commissioning process ends 1 year after the start of construction).

Potential sponsors and funds include USAID, World Bank, DOE FEMP program, sources from India.

6. Remote Application of Hybrid Generated Power:

There are more than 80,000 villages in India that are not electrified. Although the grid has been extended to as many as 87% of the villages, only 34 million or 31% of rural households have availed electrical connections as per 1991 census. The Indian power sector has more than tripled its installed capacity from 30,000 MW in 1981 to over 100,000 MW in 2001. With demand exceeding supply shortages continue to plague the sector. Despite rapid progress in rural electrification, 18,000 villages in India are said to be without electricity. Besides power quality supply to rural areas is poor. Remote villages that are not connected to the electric grid would benefit from installation of distributed generation utility consisting of renewable generation as a main source (i.e., wind power, solar power, fuel cell from renewable source, etc.) and backup source in a hybrid power setup, which could be non-renewable (e.g., diesel, fuel cell from non-renewable source, like methane), or one of renewable sources. To maximize utilization of such a setup, in conjunction with the installation of hybrid power generation capacity, energy efficiency measures would be implemented (i.e., efficient building construction, efficient lighting and daylighting, efficient cold storage facility, communal bathing utilizing solar heating, etc.). An alternative to grid extension could be stand-alone systems feeding a local grid connecting a few villages. Hybrids (Wind-Solar-Hydro) lend themselves to this application

Most part of India receives 4 to 7 kWh of solar radiation per square meter per day, with 250 to 300 sunny days in a year. This makes India potential area in solar energy. As a result solar energy development is seen all over the country. The main problem with solar power is its intermittent nature. Wind, Solar, Hydro and along with the conventional power source of a diesel generator, if it is used sparingly, in hybrid mode can provide 100% power reliability.

In India a few of hybrid systems have been implemented and are running successfully. In 1995 the Australian government helped to fund the development of a solar-wind-hybrid power system at Mount Abu, Rajasthan. This 'stand alone' system consisting of a 5 kilowatt solar array and a 2.5 kilowatt wind generator, is capable of a maximum output of 10 kilowatts (kW) of energy. Another good example is Sagar Island Wind Project implemented by Auroville Energy Products. With a wind power capacity of 500 kW and diesel generating capacity of 290 kW this plant will supply electricity to the surrounding Villages. Auroville Energy Products has also successfully implemented the Madhuka Project, Auroville.

This project was designed to provide the electricity requirements of a community called Madhuca in Auroville, by means of a Wind Solar Hybrid System. 4 kWp of Solar Photo-voltaic panels were installed along with a AEP 1500 Wind Battery Charger. These load a 24 Volt Battery Bank of deep discharge lead acid cells of capacity 12,500 Ah each.

All of these hybrid projects are maintained by well trained professionals. The problem, however, is of adapting an existing technology for application in rural areas with a vastly different technological and economic capacity. The challenge is also to create a sustainable financial model for long-term viability as well utilization of rural skilled/semi skilled work force. The end purpose should be to create a viable model that can be replicated beyond the demonstration at the selected site. This problem is at once technical and socio-economic. Aim of the project would include the determination of the estimated load, offering an optimization of the system, giving annual energy output estimation, offering an evaluation of suitable installation sites.

The potential for expanding the project beyond the limited demonstration would also a prime consideration. The cooperative nature of the project would also be expected to lead to improved relationships between our two countries and further trade expansion. Most importantly, the benefits of electricity would be made available to those who had little or no access in the past. Improvements in educational opportunities, health care, productivity, and entrepreneurship would be standards for success of the project. Finally, the project would be self-sustaining. An infrastructure would remain to support additional applications including financing, education, training, repair, and maintenance. Successful deployment of the project would pave the way for acceptance of hybrid systems as a means for providing the reliable power supply to the rural areas of developing world.

Hybrids have been a strong research focus for the Renewable Energy Research Laboratory at the University of Massachusetts, Amherst and could thus be a potential area for collaboration. University of Massachusetts will help the Indian counterparts in designing and implementing the demonstration projects. The activities would include identifying load profiles, assessing the wind and solar resources, collecting price and performance specifications for U.S. and Indian components, running sophisticated computer models, such as *Hybrid2*, and evaluating system designs for cost of energy and percentage of load to be met by Diesel or any other conventional power source for power reliability. The *Hybrid2* code can model many combinations of wind turbines, photovoltaic arrays, diesel generators, power converters, and battery storage, both in AC, DC, or two-bus systems. *Hybrid2* also allows for more than 100 different dispatch configurations with multiple diesel generators, renewable sources, and battery storage. The code also includes a comprehensive economics package.

Potential sponsors and funds include USAID, World Bank, sources from India, private donors.

7. Offshore Wind Power:

In the areas with favorable conditions (i.e., shallow coastal waters, higher wind availability), like in the western state of Gujarat (highest wind availability in India and wide spread shallow coastal waters), developing offshore wind farms would supply green power to urban areas that are experiencing severe power shortages and reduced power quality due to the demand exceeding the generating capacity. Implementing state of the art technologies available in United States and Europe (i.e., Denmark, Germany, etc.) could provide significant additional generating capacity. In conjunction, introduce comprehensive energy efficiency measures in buildings and industrial facilities. These comprehensive measures would ideally be implemented through the continuous commissioning process, described earlier.

In addition to reducing energy use and therefore achieving decreased dependence on imported oil and other fossil fuels, the pollution would be significantly reduced. One of most problematic environmental issues in India today is excessive pollution, especially in urban areas. There has been successful attempts to substitute high polluting fuels (i.e., diesel, gasoline) with less polluting technologies, like compressed natural gas (CNG) or Liquid Propane Gas (LPG). The level of pollution in some of the big urban centers, like New Delhi, has been noticeably cut. With the more substantial introduction of renewable, green power, there is tremendous potential to reduce pollution to acceptable levels.

There have been attempts in the past to introduce more wind power, but problems arose during the exploitation period. The wind energy projects in India have not all been success stories. Some of the problems faced have been:

- Poor adaptation of turbines to Indian conditions has led to failure.
- Grid problems: Weak grids lead to lower capacity utilization. In 1996 grid abnormalities induced a loss of 20% in potential revenue due to 'direct generation losses'. Half of these were due to weak grid in the region.
- Though solar energy has been used in rural electrification programs, wind energy is as yet an under exploited potential for such applications. 'Off-grid' application has been neglected despite a range of applications for remote communities.

Several wind farms had been constructed in the past, but there was no real incentive to operate those farms due to unfavorable pricing schemes (i.e., heavily subsidized or outright free electricity to rural areas, etc.). The incentive was there to build farms, but not to operate them. This is one of paradoxes that would need to be addressed as a part of this project.

Potential sponsors and funds are USAID, World Bank, DOC (support for U.S. based technologies that would be exported to India), private donors, and Indian government.

Appendix A:

Announcement, Programs, and Attendance Lists:

A.1 Announcement and Registration Form

A.2 New Delhi Program

A.3 New Delhi Attendance List for Seminar

A.4 New Delhi Attendance List for Workshop

A.5 Bangalore Program

A.6 Bangalore Attendance List for Seminar

A.7 Bangalore Attendance List for Workshop

(Electronic versions are included with the disk in Appendix F.)

Appendix B:

U.S. Presentations:

B.1 "Energy Efficiency in India"
by Bipin Shah

B.2 "Promoting Fenestration Energy Efficiency: Role of Rating & Certification"
by John Hogan

B.3 "Role of Computer Simulation in Window Ratings and Design"
by Charlie Curcija

B.4 "Building Energy Simulation Tools: An Overview"
by Charlie Curcija and Mahabir Bhandari

B.5 "Energy Efficient Windows and Building Design * Software Workshop *"
by Bipin Shah, Charlie Curcija, and Mahabir Bhandari

B.6 "Energy Efficient Windows and Building Design * Software Workshop * Building Simulation Tools"
by Bipin Shah, Charlie Curcija, and Mahabir Bhandari

(Electronic versions are included with the disk in Appendix F.)

Appendix C:

Indian Presentations:

C.1 "Role of Simulation Models in Energy Efficiency in Buildings"
by N. K. Bansal

C.2 "Energy Efficient Windows and Building Design"
by K. V. Pradeep

C.3 "Role of Simulation Models in Energy Efficiency in Buildings"
by Jyoti Mathur

C.4 "Energy Conservation and Commercialisation"
by ICICI Bank

(Electronic versions are included with the disk in Appendix F.)

Appendix D:

Proposal for Test Laboratory Set-Up:

Thermal Chamber: Guarded hot box test method is used for establishing the thermal performance of building assemblies when exposed to controlled environmental conditions (surface heat transfer coefficients at temperature conditions representative of their use). This method may also be used to measure a building material's thermal performance at standardized environmental conditions. This method may also be used to measure a building material's thermal performance at controlled conditions such as those required in material specifications or specified for special conditions.

This test method is used for large homogeneous or non-homogeneous specimens. Smaller flat specimen can be tested using Heat Flow Meter. This test method may be applied to building structures or composite assemblies of building elements for which it is possible to build a representative specimen appropriate for the test apparatus.

Components in Guarded Hot Box:

1) Room Side Metering Chamber
2) Environment Side Room Chamber
3) Guard Chamber
4) Surround Panel for installing test specimen

Equipment:

Room Side Metering Chamber:

1) Heater
2) Fans to circulate air in the metering room within natural convection flow requirements.
3) Baffle
4) Heaters for Baffle
5) Temperature controlled ON/OFF switch
6) Thermocouple wire, Type T 30 gauge.

Environment Side Room Chamber:

1) Refrigeration System
2) Heater
3) Fan System to generate required film coefficient
4) Thermocouple wire, Type T 30 gauge.
5) Baffle

Guard Chamber:

1) Fans to circulate air
2) Split system to maintain the required temperature in the guarded area

Surround Panel:
1) Foam of at least 4" thickness for installation of products.

Controls:
1) PID controller system for control of environmental conditions in the chambers.
2) Data acquisition System to read thermocouple readings, heat energy and etc.
3) Inverter, to control environmental chamber fan speed.

Calibrations:
1) Calibration transfer standard
2) Thermocouple calibrator

Computer:
1) Computer that would be able to hold required controller cards.

Reference Documents:
ISO 8990, ISO 12567
ASTM C 1363, C1199, and E1423
Design of Thermal Chamber technical paper University of Massachusetts.
NFRC 100 and 102

Estimated Cost of the Project:
$250,000 includes all material labor and consultations.

Solar Calorimeter: Solar gain properties measurements are made using solar calorimeters exposed to solar radiation under clear sky conditions (outdoors) or using artificial solar radiation (indoors). The test sample is illuminated with either direct beam radiation only, or with direct beam plus diffuse sky and ground reflected radiation.
This test method applies to all fenestration systems, glazed apertures in buildings intended for the controlled admission of solar radiation. This includes windows, glazed doors, translucent panels, skylights, and glazing systems incorporating integral or attached shading devices such as insect screens, drapes, shades, and blinds.

Components for Indoor Solar Calorimeter:

1) Room Side Metering Chamber
2) Guard Chamber
3) Surround Panel for installing test specimen
4) Artificial Solar Energy source

Equipment:
1) Heater
2) Fans to circulate air in the metering room within natural convection flow requirements.
3) Absorptance Plate

4) Water flow system to absorb incident and gain solar energy.
5) Tracking system
6) Thermocouple wire, Type T 30 gauge.
7) Sample Plane Pyranometer: WMO Class 1 instruments, a pyranometer to measure the incident irradiance on a plane parallel to the test aperture.
8) Horizontal Pyranometer - WMO Class 1 instruments, a horizontal pyranometer shall be used to measure the global horizontal (beam plus diffuse) irradiance.
9) Wind Velocity meter
10) Chiller system

Controls:
1) PID controller system for control of environmental conditions in the chambers.
2) Data acquisition System to read thermocouple readings, heat energy and etc.

Calibrations:
1) Calibration transfer standard
2) Thermocouple calibrator

Computer:
1) Computer that would be able to hold required controller cards.

Reference Documents:
ISO 8990, ISO 12567
ASTM C 1363, C1199, and E1423
Design of Thermal Chamber technical paper University of Massachusetts.
NFRC 200, 201 and 300

Estimates Cost of the Project:
$100,000 includes all material labor and consultations. Artificial source system cost not included.
Note: Thermal chamber, Room Side Metering Chamber and guard room can be so designed to be used for solar calorimeter.

Spectrophotometer and Integrating Sphere: These Instruments are used for determining the solar optical properties of glazing materials and systems of relevant to energy transfer in flat specular glazing materials. The Solar Absorptance, Reflectance, and Transmittance of Materials are determined using Spectrophotometer and Integrating Spheres.

Equipment:

These instruments are available commercially in the U.S.. Perkin Elmer (203-925-4600 Toll Free (U.S. Only): 800-762-4000), CVI (phone # 860-928-5834) and Labsphere are the manufacturers of (603-927-4266)

Reference Document:
NFRC 300
ASTM E903

Estimated Cost:
This instruments cost approximately $125,000

Heat Flow Meter: The heat flow meter apparatus establishes steady state one-dimensional heat flux through a test specimen between two parallel plates at constant but different temperatures. By appropriate calibration of the heat flux transducer(s) with calibration standards and by measurement of the plate temperatures and plate separation. Fourier's law of heat conduction is used to calculate thermal conductivity, and thermal resistivity or thermal resistance and thermal conductance.

Equipment:

These instruments are available commercially in the U.S..

Reference Document:
ASTM C 518, 1045

Estimated Cost:
This instruments cost approximately $30,000

Air Leakage Chamber: The equipment is used to determine the air-leakage rates, water leakage and structural test of windows, doors and curtain walls.

Components in Guarded Hot Box:

1) Room Side Metering Chamber
2) Surround Panel for installing test specimen

Equipment:

Room Side Metering Chamber:
1) Blower
2) Pressure measurement instruments
3) Laminar flow device
4) Water spray rack
5) Temperature measurement device
6) Clamping accessories

Reference Document:
ASTM E 283, E330, E331, E547
AAMA 101,

Estimated Cost for the project:
This instruments cost approximately $50,000

Appendix E:

Hindustan Times article:

India offers energy conservation masterplan

Agence France-Presse
New Delhi, August 23

India on Friday unveiled a blueprint to conserve energy and said the Government action-plan would goad the private sector to slash consumption and boost productivity to revitalise the gasping economy.

The announcement at a global conference in New Delhi coincided with deepening worries in India that a thick brown haze shrouding South Asia could choke the agriculture-dependent economy of the country.

Ministers, experts and captains of industry said efforts to meet India's power needs of 100,000 megawatts could irreversibly cripple the ecology and the only mantra in hand was to drastically cut energy consumption and modernise electricity generation.

Prime Minister Atal Bihari Vajpayee, flagging off the conference entitled "Energy Conservation in the New Millennium", said his Government would take the first steps in implementing the national action-plan on energy conservation.

"I call on all Government organisations to reduce their energy consumption by 30 percent in the next five years," Vajpayee said, adding that public buildings and state facilities must ensure guaranteed energy-efficient power supply systems.

He called on all ministries and Government industries to log their power consumption in their annual reports and said energy-guzzling airports, ports, the military, railways and state housing must cut consumption as part of the action-plan.

"We look forward to the implementation of the action-plan over the coming weeks and months," the prime minister said and added that India's 29 state administrations too must participate in the national programme.

"If the central and state Governments provide the lead, the private sector and even households will surely follow, not least because energy conservation makes economic sense," he said.

Vajpayee said President, Abdul Kalam, too has agreed to a comprehensive audit of power consumption in his 330-roomed presidential palace, which is serviced by 1,200 employees besides the secret service.

"For too long, throughout the world, energy 'conservation' has in practice meant energy 'conversation'. This time I ask of all of us, to 'walk the talk'," the premier added.

The two-day global conference is being jointly hosted by the Federation of Indian Chambers of Commerce and Industries (FICCI) and the Government, which only recently passed legislation on energy consumption.

The legislation, which India claims is the world's "most comprehensive law," provides for provisions such as energy audits, energy labelling and managing demand.

Demand for power in India is steadily rising by eight per cent per annum, and it is estimated that the country needs a staggering $200 billion to generate new power capacity of 100,000 MW to fill the gap between demand and supply.

Environmental experts say energy consumption is the only escape route from further degradation of the environment.

The haze, known as the "Asian brown cloud," which currently spans an area seven times the size of India across all of South Asia, could modify rainfall patterns and the intensity of sunlight.

Appendix F:

CD with Electronic Versions of Appendices A, B, and C: