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The U.S. Building Technologies Program: Moving to Marketable Zero Energy Buildings

Richard Karney, ECBCS Executive Committee Member for USA

Today, America's buildings consume more energy than any other sector of the U.S. economy, including transportation and industry. Almost three-quarters of America's 81 million buildings were built before 1979. Many will eventually require either significant retrofits or replacement, with projections for 15 million new buildings to be built by 2010. Together, ageing buildings and new construction represent a tremendous opportunity to transform how we design, build, and operate our buildings.

Emerging Technologies: an overview

Emerging technologies research is conducted within the context of systems-engineered whole building solutions, driving toward affordable net zero energy homes and buildings. It covers:

- Emerging Technologies, including Solid State Lighting, Thermal Envelope and Windows, Space Conditioning and Refrigeration, Solar Heating and Cooling, and Analysis Tools and Design Strategies.
- Residential Buildings Integration
- Commercial Buildings Integration

Let's take a brief look at what is happening with Emerging Technologies.

The **Solid State Lighting** R&D mission is to create a new market for high-efficiency, general illumination products. With high Congressional interest, the program just received a funding boost from the American

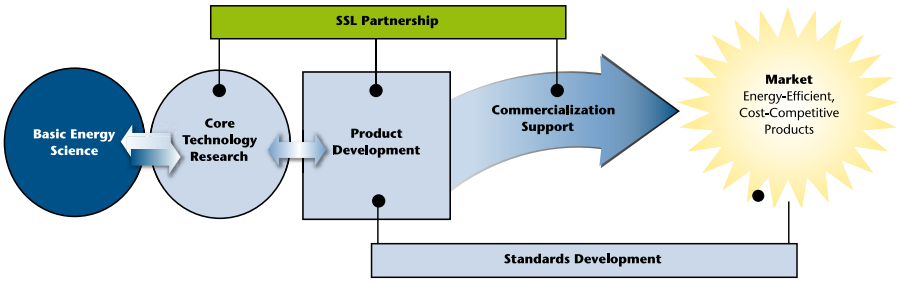

Figure 1: How the industrial partnership provides the country with development of products

ALSO IN THIS ISSUE:

Diagnosing Errors in Building Energy Simulation Codes

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Recovery and Reinvestment Act ("Stimulus Bill"). This program works directly with industry on a fully competitive basis (Figure 1).

The Solid State Lighting Program conducts demonstrations of products, the testing of products, and works with industry bodies to assist in developing consensus standards and test procedures. www.netl.doe.gov/ssl

The **Advanced Envelope** Program is currently helping develop the next generation of attic / roof systems by 2015 (cool roofs, radiant barriers, above deck ventilation, advanced insulation). The Program is also is looking into producing an advanced wall system that will double the efficiency of current wall systems by 2010. The Program is exploring materials that control building envelope thermal flows, such as using dynamic energy storage to reduce net energy transport through a wall or roof system and controlling moisture through passive dynamic systems (PCM, dynamic membranes, advanced foams, aerogels). Work on an international basis is taking place between the Oak Ridge National Lab. and Fraunhofer IBP on the WUFI moisture / heat transfer model.

The Windows Research Program is working internationally on the harmonisation of window rating and labelling, by developing ISO 15099 compliant software tools used for design by our National Fenestration Rating Council, promoting ISO 15099 compliance, promoting low-E window adoption worldwide, and promoting standards harmonisation for insulating glass quality and dur-ability. The program also works on assisting an NFRC-type rating process being developed in Australia, South Africa, UK, China, India, Middle East, and others.

The Windows Research Program seeks to reduce the building energy load due to windows by 40-60% by 2020. Current work includes research into dynamic fully-sputtered windows and manufacturing processes (electrochromics, cost reduction) and exploring daylighting and advanced façades.

BTP's **Heating, Ventilating and Air-Conditioning** work along with the **Water Heating** Research tasks hope to reduce these building energy uses by 50%. One fruit produced by the Program's Advanced Heat Pump Water Heater collaboration with industry is the soon-to-be-on-the-market hybrid water heater shown in Figure 2. Another research project in collaboration with industry is the Integrated Heat Pump for Zero Energy Houses (Figure 3).

Solar Heating and Cooling Systems research looks into expanding the range of low-cost solar water heating to freezing climates, photovoltaic / thermal systems, combined solar heating, cooling and hot water systems, technical assistance to states and cities in adopting policies to expand solar heating and cooling applications, and working with Solar Rating and Certification Corporation support to promote strong standards, certification processes and to increase capacity.

Analysis Tools and Design Strategies researches extending the capabilities of **EnergyPlus** through code compliance and inclusion of key technologies, validating **EnergyPlus** with widely accepted test methods for building simulation, and deploying through increasing interoperability with currently used tools, training firms, running work-

The US Department of Energy's Building Technologies Program

The United States Department of Energy's Building Technologies Program (BTP) works in partnership with the private sector, state and local governments, national laboratories, and universities to improve the efficiency of buildings and their equipment, components, and systems.

The Building Technologies Program's strategic goal is to create technologies and design approaches that lead to marketable zero energy homes by 2020 and zero energy commercial buildings by 2025. The program supports research and development (R&D) activities and provides tools, guidelines, training, and access to technical and financial resources. BTP's mission is to develop technologies, techniques, and tools for making residential and commercial buildings more energy efficient, productive, and affordable through three strategies:

- Research and Development (R&D) concentrating on whole building integration and components, materials and equipment
- Technology Validation and Market Introduction (TVMI) which includes ENERGY STAR, Building Energy Codes and Marketing Campaigns
- Appliance Standards.

The flow of technology maturation and the three strategies

Figure 2: Example hybrid water heater.

shops, and licensing with industry.

The Emerging Technologies program : www1.eere.energy.gov/buildings/technologies.html

Residential Buildings research: an overview

The **Residential Buildings Integration** Program is an all encompassing effort for both new construction and existing homes. The foundation is the Building America Program, which has been around since the mid-1990's. The public / private partnership focuses on systems-based R&D, technology implementation, and cost-shared technical support sponsored by the U.S. Department of Energy with the goal of developing marketable designs for homes that produce as much energy as they use.

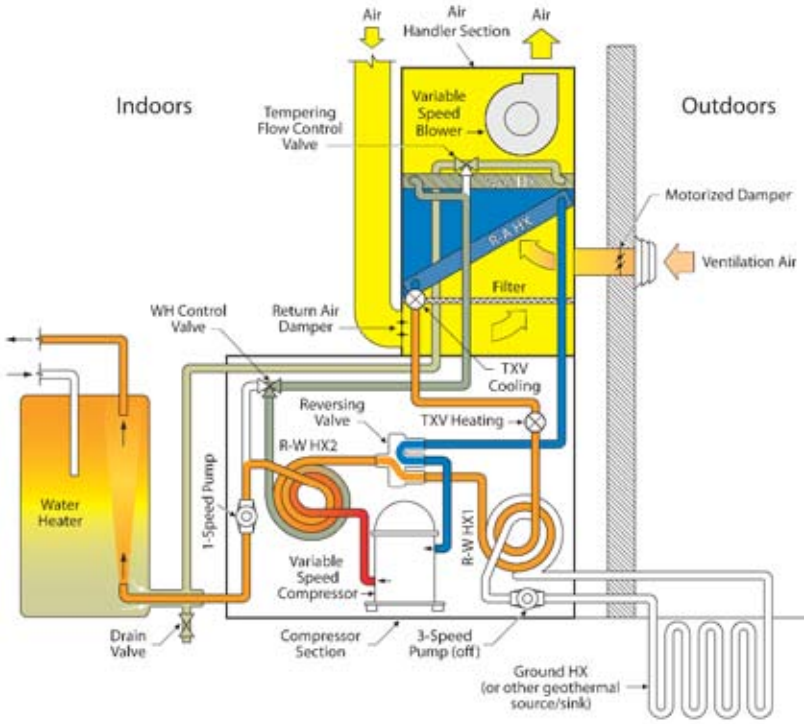


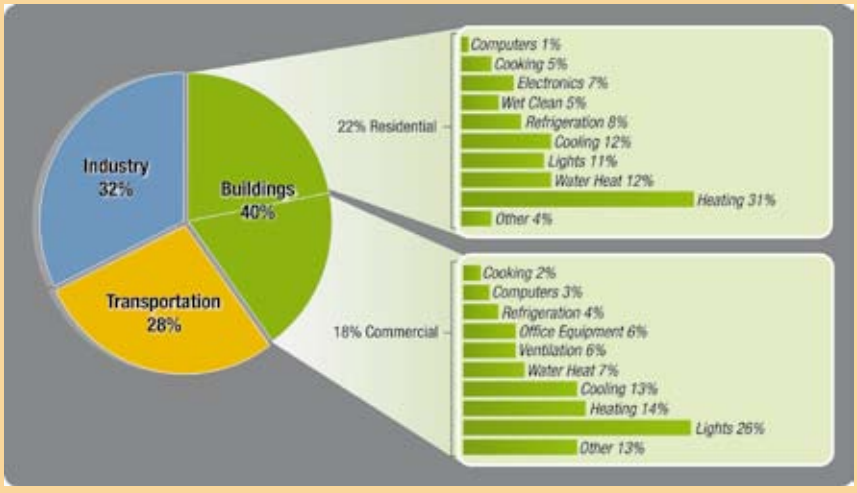
Figure 3: Integrated heat pump for zero energy houses, another product of research in collaboration with industry.

The Department works with home builders and building scientists to evaluate system options to ensure they meet minimum requirements to be used successfully in production homes. Work to optimise "building systems criteria," with "builder process criteria," constantly occurs. The result eventually provides the homeowner with a design created for the "Zero Energy Home." These system solutions, such as accelerated systems research on miscellaneous electric loads, reliable low cost solar hot water systems, high performance air distribution systems, advanced envelope assemblies, high R windows, low capacity (1.5-2.5 ton)/high SEER (Seasonal Energy Efficiency Ratio) cooling systems, and low capacity (10-30kBtu) greater than 90% efficiency furnaces, or equivalent can be integrated to provide the desired home. The consumer benefits from energy efficient homes are much broader than reductions in utility bills. In addition to providing the highest immediate cash flow back to a homeowner, a comprehensive approach increases delivery of other market drivers including increased durability, reduced maintenance, and increased comfort.
See Figure 4.

Residential Buildings Integration Program : www1.eere.energy.gov/buildings/building_america

United States buildings - energy use breakdown

The buildings sector consumes about 40% of America's energy, 72% of electricity, 55% of natural gas, 39% of carbon, 19% of NO_x, and 52% of SO_2 . The total U.S. energy consumption in 2005 was 100 quads (106 EJ).



Commercial buildings: an overview

The **High Performance Commercial Buildings** initiative works to achieve zero energy commercial buildings through research in the areas of energy-efficiency and renewable energy technologies, recycled and sustainable materials, and site sensitive design. "Net-zero energy commercial buildings" are grid-integrated buildings capable of generating as much energy as they consume through advanced efficiency technologies and on-site generation systems such as solar power and geothermal energy. The scale and scope of energy consumption and greenhouse gas emissions in the building sector demand a correspondingly large response.

Public-private partnerships, were created to achieve accelerated technology improvement and commercialization of advanced building technologies, and enable market-ready net-zero energy commercial buildings no later than 2025.

The Department works closely with all facets of the commercial building sector through Commercial Building Energy Alliances:

- **Retailer Energy Alliance** covering general merchandise, grocery store, restaurant, warehousing/distribution
- **Commercial Real Estate Energy Alliance** involving office, shopping centers, hospitality, medical offices, the government's General Services Administration
- **Institutional Energy Alliance** for federal / state / local government, hospitals (Hospital Energy Alliance), and colleges / universities / K-12 schools.

High Performance Commercial Buildings Program www.eere.energy.gov/buildings/commercial_initiative

Technology Validation and Market Introduction (TVMI) Program

The **Technology Validation and Market Introduction** (TVMI) Program moves technology into the market and common use through:

- ENERGY STAR
- Building Energy Codes
- Marketing Outreach.

ENERGY STAR is a voluntary labelling and recognition programme sponsored by the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) that seeks to accelerate the adoption of clean and efficient domestic energy technologies.

Building Energy Codes create mandatory levels of efficiency to which all manufacturers and builders must subscribe. The Codes are the vehicle to overcome regulatory barriers to new and emerging technologies, broaden use of feasible and cost effective technologies, and provide research development and deployment, an off-ramp to the buildings market. The Building Technologies Program works with

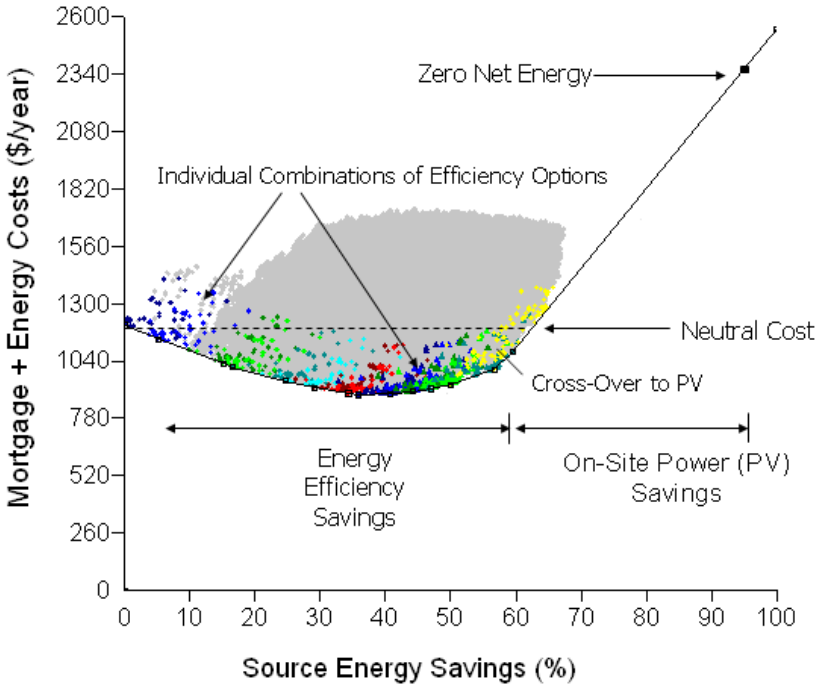


Figure 4: A comprehensive approach increases delivery of other market drivers including increased durability, reduced maintenance, and increased comfort.

Figure 5: Many actors support the work under the Commercial Buildings Initiative.

ENERGY STAR works with manufacturers, national and regional retailers, state and local governments, and utilities to establish energy efficiency criteria, label products, and promote the manufacture and use of ENERGY STAR products. ENERGY STAR removes technical, financial, and institutional barriers to the widespread awareness, availability, and purchase of highly-efficient appliances, compact fluorescent lighting products, windows, and other products. ENERGY STAR products include clothes washers, refrigerators / freezers, dishwashers, room air-conditioners, windows, doors and skylights, residential water heaters, compact fluorescent lamps, and solid state lighting luminaires. LED replacement lamps will be added soon.

In 2006, ENERGY STAR saved 170 billion kilowatt hours—or almost 5% of the total 2006 electricity demand. In addition, the program helped avoid greenhouse gas emissions equivalent to those from 25 million automobiles, while helping consumers save more than $14 billion on their energy bills.

www.energystar.gov

other government agencies, state and local jurisdictions, national code organizations, and industry to help develop improved national model energy codes. The BTP works with the International Code Council on its International Energy Conservation Code for residential code development and enhancement and the American Society of Heating, Ventilating and Air-conditioning Engineers (ASHRAE) for commercial buildings.

For information on this work please go to www1.eere.energy.gov/buildings/energycodes.html

TVMI outreach initiatives

The TVMI program also manages market outreach initiatives.

The **EnergySmart Schools** effort is to reduce schools' energy use and to provide better learning environments for children. Endorsed by the National School Boards Association (NSBA), the EnergySmart Schools initiative seeks to help school districts by disseminating financing opportunities, providing training to building industry professionals, and weaving together broad networks of public and private partners.

Schools spend more on energy than on any other expense except personnel. Yet high-performance schools don't have to cost more to construct than conventionally built schools and can lower a school district's operating costs by up to 30%. Schools can reduce energy costs without sacrificing educational quality. Central to the communities they serve, schools should reflect community values – like energy and resource conservation. Schools are a great place to teach the nation's children about energy and resource conservation.

Figure 6: The biennial Solar Decathlon competition

Further information can be located at www1.eere.energy.gov/buildings/energysmartschools.html

EnergySmart Hospitals works in conjunction with the Hospital Energy Alliance. Information on this market outreach effort is under development.

TVMI also manages the biennial **Solar Decathlon**, a popular housing design competition that draws thousands of people to the National Mall in Washington, D.C. Twenty teams of students from universities in the United States, Canada, and Europe compete to design a solar house, build it, test it, and then ship it across a state, a continent, or an ocean. Once they arrive on the National Mall, the student "Decathletes" must rebuild their houses within a week and put them through a series of ten contests to determine a winning combination of aesthetics and performance. This exciting, 21-day event culminates in the announcement of an overall winner—but for all the teams, the satisfaction of knowing that their houses could influence the way millions of people live in the future makes everyone a winner.

To learn more about the 2009 Solar Decathlon please go to www.solardecathlon.org

The Appliance Standards Program

The Appliance Standards Program, more formally known as the Appliances and Commercial Equipment Standards Program, develops test procedures and minimum efficiency standards for residential appliances and commercial equipment. The Program develops rules and regulations that manufacturers must adhere to in manufacturing products. These regulations apply to products manufactured for sale as well as those imported into the United States. While the minimum

energy efficiency standards require manufacturers to discontinue manufacturing products that do not meet the efficiency standards, products manufactured before the effective date of the new standards may still be sold.

DOE's Program carries out activities in three areas: labelling, test procedures, and mandatory energy conservation standards.

Labelling: The Federal Trade Commission (FTC) is required to prescribe labelling rules for residential appliances. DOE and FTC share responsibility for labelling commercial equipment.

Test Procedures: The Department outlines the test procedures that manufacturers must use to certify that their appliances meet the standards. The test procedures measure the energy efficiency and energy use and provide an estimate of the annual operating cost of each appliance. Test procedures are typically maintained by industry associations and incorporated by reference into the rules set by DOE.

Mandatory Energy Conservation Standards: DOE establishes federal standards to keep consistent, national energy efficiency requirements for selected appliances and equipment. By law, DOE must upgrade standards to the maximum level of energy efficiency that is technically feasible and economically justified. DOE strives to establish standards that maximize consumer benefits and minimize negative impacts on manufacturers and others.

The Department is on a tightly watched schedule to revise and develop test procedures and standards. In this highly visible work area, the Department is working diligently to meet its deadlines in order to provide the consumer the energy efficiency desired when one buys an appliance or orders a piece of equipment.

For detailed information and the schedule of products please go to: www1.eere.energy.gov/buildings/appliance_standards

Buildings Technology Program: www1.eere.energy.gov/buildings

Programmes within the office of the Department of Energy's Energy Efficiency and Renewable Energy: www.eere.energy.gov

SSB 2010 Conference

8th International Conference on System Simulation in Buildings

13th - 15th December 2010, University of Liège, Belgium

Scope of the Conference

Since 1982, the SSB conference has been an opportunity for researchers and specialists in building and HVAC&R systems simulation to present high quality papers and attend sessions and discussions on the latest developments and progress in this challenging and evolutionary sector.

Once again, the conference will be organized in very close cooperation with the International Energy Agency (IEA, Energy Conservation in Building and Community Systems) and with the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

This conference will be, among others, the occasion to present some final results arising from ECBCS Annex 47 *"Cost Effective Commissioning of Existing and Low-Energy Buildings"*, ECBCS Annex 48 *"Heat Pumping and Reversible Air Conditioning"*, HarmonAC *"Harmonizing Air Conditioning Inspection and Audit Procedures in the Tertiary Building Sector"* and the more recent ECBCS Annex 53 *"Total Energy Use in Buildings: Analysis and Evaluation Methods"*.

Conference Topics

- Advances in modelling of HVAC&R systems and components
- Latest developments in building energy simulation methods and tools
- Simulation assisted analysis and evaluation of building energy use
- Application to commissioning, energy management and maintenance
- Application to building energy audit and retrofit
- High quality case studies exhibiting in depth use of simulation tools

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Testing and Validation of Building Energy Simulation Tools

"How to Diagnose Errors in Half a Million Lines of Code"

Ron Judkoff and Joel Neymark, ECBCS Annex 43

Architects and engineers rely on building energy simulation tools. Accuracy improvements in simulation models have increased the confidence of building design professionals in the use of these complex models.

The *Testing and Validation of Building Energy Simulation Tools* project developed software quality assurance for complex building energy analysis tools and engineering models that are used to evaluate the performance of innovative low-energy buildings. These tools can often include hundreds of thousands of lines of complex code.

The project's activities included developing comparative, analytical verification, and empirical validation test methods for evaluating, diagnosing and correcting errors in building energy simulation software. The research results will be published on a single website.

Improvements to software and validation methodology

This work improved software tools for evaluating the impacts of energy efficiency and solar energy technologies commonly applied in buildings.

Field trials for the new test procedures identified 106 results disagreements, leading to 80 software fixes, including both model and documentation improvements.

Table 1 indicates the models tested and Table 2 indicates the number of model errors fixed.

Overall use of BESTEST, including codes and standards

National and international building energy standards organisations have standard methods of tests for building energy analysis tools such as ANSI / ASHRAE Standard 140, used for national building energy code compliance.

- Standard 140 is referenced by:
  - ASHRAE's commercial and non-low-rise residential building energy efficiency standard (ASHRAE Standard 90.1)
  - The U.S. tax code for certifying software that may be used to evaluate energy efficiency tax credits.
- Several EU countries use software tools that have been checked with IEA BESTEST.
- CEN used IEA BESTEST to check their reference cooling load calculation general criteria.

EMPA test cells in Duebendorf, Switzerland

Why are building energy simulation tools important?

Innovative low-energy buildings use energy-efficiency techniques and renewable energy technologies that frequently come with a higher construction cost, usually justified by estimated energy savings and reduction in CO_2 emissions. These estimates are often evaluated using complex building energy simulation tools.

Table 1. Models Tested

Model Tested	Participating Country
BASECALC	Canada
BSim	Denmark
CODYRUN	France
COMFIE	France
COMIS 3.2	Japan
DOE-2.1E	Switzerland
EES	Belgium
EnergyPlus	Switzerland
EnergyPlus	United States
ESP-r	United Kingdom
ESP-r/ BASESIMP	Canada
FLUENT*	Kuwait
HELIOS	Switzerland
HTB2	United Kingdom
IDA-ICE	Sweden
IDA-ICE	Switzerland
KoZiBu	France
MATLAB*	Ireland
MATLAB-Simulink	Germany
SUNREL-GC/ GHT	United States
TRNSYS-TUD	Germany
TRNSYS-16*	United States
TRNSYS-16	Belgium
VA114	Netherlands
VA114/ISO-13370	Netherlands
VentSim	Japan

- Australia and New Zealand referenced IEA BESTEST in their codes and standards.
- The 2005 ASHRAE Handbook of Fundamentals section on validation references IEA work.
- Researchers translated previous IEA BESTEST work into Dutch, German, and Japanese.
- A recent study comparing 20 whole-building energy simulation tools indicated that 19 of the 20 tools reviewed had been tested with at least one of the IEA BESTEST procedures and ten of the tools had been tested with more than one of the BESTEST procedures.
- Commercial equipment providers use BESTEST / Standard 140 for testing software.
- Many BESTEST suites have been integrated within the ESP-r software.
- EnergyPlus, the U.S. DOE's simulation program for building energy analysis, maintains their Standard 140 results on a website.

Aalborg University Double-Skin Facade Test Facility in Aalborg, Denmark

What the participants / software developers say…

Jeff Thornton, President of Thermal Energy System Specialists (TESS) in Madison, Wisconsin, U.S. – a private-sector company that develops and sells TRNSYS and does consulting work using TRNSYS:

"Without this IEA subtask for ground coupling, we would have had no means to check the results from our model, nor had a reason to make improvements to our model. There should be no question that the IEA subtask has improved the TRNSYS ground coupling model and, in doing so, has also provided energy modellers a greatly increased sense of confidence when modelling heat transfer to the ground."

Aad Wijsman, VABI Software BV, Delft, The Netherlands – a private-sector company that develops and sells VA114 and does consulting work using VA114:

"Bestest and IEA-34 / 43 tests brought a number of new errors to the surface. This shows the importance of these test [cycles]!! And still there will be errors in the software!! Development of new,

A brief guide to the testing options

Taken together these methods form a powerful validation and diagnostic methodology:

Comparative testing: Programs were compared to each other.

Comparative tests included:

- BESTEST ground-coupled heat transfer with respect to floor slab construction
- BESTEST multi-zone heat transfer, shading, and internal windows
- BESTEST airflow, including multi-zone airflow
- Chilled-water and hot-water mechanical systems and components
- Buildings with double-skin facades.

Analytical verification: Comparisons were made with closed-form analytical solutions or with generally accepted numerical solutions outside of whole-building energy simulation software. Analytical verification tests for evaluating basic heat transfer and mathematical processes in building energy analysis tools were included where possible.

Empirical validation: Software was compared with carefully obtained experimental data.

Tests developed included:

- Shading / daylighting / load interaction
- Chilled-water and hot-water mechanical systems and components
- Buildings with double-skin façades.

Work on double-skin façades also included a comprehensive literature survey on double-skin façade buildings.

International effort

The international project drew 53 participants from 32 organisations spread across 14 countries: Australia, Belgium, Canada, Denmark, France, Germany, Japan, Netherlands, Sweden, Switzerland, the United Kingdom and the United States, with Ireland and Kuwait as observers.

Testing 24 computer programs / models took an astonishing total of 33 person-years (400 person-months).

specific test cases is of big importance!!"

What the project leaders say…

Joel Neymark and Ron Judkoff on behalf of ECBCS / SHC:

"…the expertise available through IEA and the dedication of the participants were essential to the success of this project. Over the four-year field trial effort, there were several revisions to the BESTEST specifications and subsequent re-executions of the computer simulations. This iterative process led to the refining of the new BESTEST cases, and the results of the tests led to improving and debugging of the simulation models. The process underscores the leveraging of resources for the IEA countries participating in this project. Such extensive field trials, and resulting enhancements to the tests, were much more cost effective with the participation of the IEA SHC Task 34 / ECBCS Annex 43 experts."

Recommendations

Although this project has broadened the range of test cases available, building energy simulation software must keep pace with new technology development. Thus, there will always be a need for validation. Additional tests could include models of:

- More HVAC system configurations
- More realistic building / ground-coupled heat transfer
- Model calibration methods for existing buildings (for predicting retrofit energy savings)
- Active solar thermal systems
- Thermo-chemical systems
- More double-façade building configurations.

Reports

- IEA BESTEST In-depth diagnostic cases for ground coupled heat transfer related to slab-on-grade construction
- IEA BESTEST Multi-zone non-airflow in-depth diagnostic cases: MZ320-MZ360
- Airflow tests including multi-zone airflow
- Empirical validations of shading / daylighting / load interactions in building energy simulation tools
- Mechanical equipment and control strategies for a chilled water and a hot water system
- Double skin façades, a literature review
- Empirical validation of building simulation software: modelling of double façades.

Project Leader: Ron Judkoff,
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Email: ron_judkoff@nrel.gov

Joel Neymark, J.Neymark & Associates, U.S.

Publications:
www.iea-shc.org/task34/publications/index.html
or www.ecbcs.org/annexes/annex43.htm

Table 2. Model Fixes

		Disagreements		Models
Project	**Leader**	**Fixed**	**Identified**	**Tested**
Ground Coupled Slab-on-Grade,	**US**	**19**	**24**	**9**
Multi-Zone Non-Airflow	**US**	**32**	**48**	**9**
Airflow	**Japan**	**1**	**1**	**7**
Shading/Daylighting/Load Interaction	**Switzerland, US**	**14**	**14**	**7**
Mechanical Equipment and Controls	**Germany**	**8**	**10**	**5**
Double-Skin Facade	**Denmark**	**6**	**9**	**5**
TOTAL		**80**	**106**	**24***

Total Energy Use in Buildings: Analysis and Evaluation Methods

Hiroshi Yoshino, ECBCS Annex 53

Although building regulations dealing with energy saving have been strengthened in many countries, actual energy consumption worldwide has not reduced. Indeed, in some areas, energy consumption has increased. One of the most significant barriers to improving energy efficiency in buildings is a lack of knowledge about the six determinant factors for total energy use in buildings.

This project aims at understanding all factors affecting energy use in buildings, for the purpose of developing a method for total energy use in buildings.

The research will be carried out by looking at two types of buildings: residential dwellings and office buildings. The project covers methodology, case studies, statistical studies, measurement technology and analysis.

- **Methodology:** A coherent series of definitions of terms related to building energy use, energy efficiency, and related expressions will be made. New methodology for data collection and analysis of building energy use will be developed that will make it possible to investigate the effects of determinant factors for total energy use.
- **Case studies:** Existing case studies exploring energy use of residential and office buildings will be identified and quality data obtained for analysis.

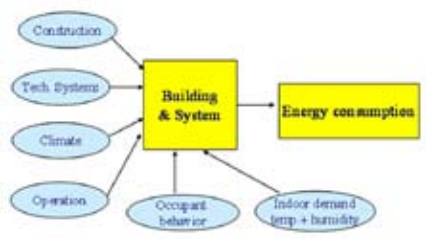


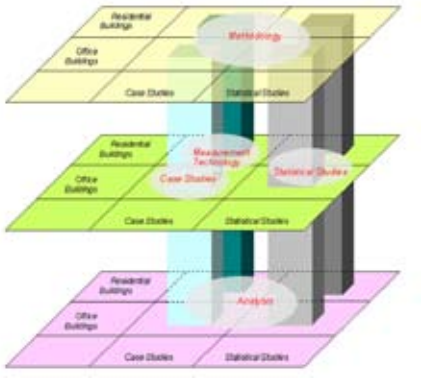
Figure 1: Indoor environmental quality provided

- **Statistical studies:** Statistical energy use studies will be carried out for both residential and office buildings.
- **Measurement technology:** Contemporary technologies in measurement and data acquisition in long-term applications will be assessed to appraise methods for online evaluation of monitored data.
- **Analysis:** The effects of building and occupant related factors on building energy use will be analysed. Reference values of indicators of building energy use for different building types will be provided. The effect of energy saving technologies on building energy use will be predicted by using this information.

The main goal of the project is the production of new knowledge of total building energy use, that will enable the development of new strategies and policies for energy savings. The deliverables will be:

- A methodology for analysis of the effect of six factors on building energy use by end use
- Description, methodologies, and results of case studies of energy consumption by end use in buildings
- Description, methodologies, and results of statistical studies of energy consumption by end use in buildings
- Indicators of energy consumption by end use (e.g. refrigeration, lighting, heating, etc.) in offices and residences
- Assessment of measurement and data acquisition technology for long term monitoring and of methods for online evaluation of monitored data
- A methodology to predict the effect of energy saving policies and technologies on building energy use.

The project leader is Prof. Hiroshi Yoshino of Tohoku University, Japan.



Six factors that influence energy consumption in buildings:

1. Climate and site
2. Building envelope and form
3. Building services and energy systems
4. Building operation and maintenance
5. Occupants' activities and behaviour
6. Indoor environmental quality provided (See Figure 1).

Current research focuses in the main on the first three factors in this list. However, factors four, five and six, reflect human behaviour – how people operate equipment, how many children they have, where they live etc. These factors can strongly influence building energy use. Another key problem is lack of scientific method to account for interactions between these six factors and energy use in a clear and thorough way, so that energy use in a building can be assessed accordingly.

International Participation at AIVC Kyoto Conference

Peter Wouters and Takao Sawachi, ECBCS Annex 5

The 29th AIVC Conference was held on 14th - 16th October, 2008, at the Kyoto International Conference Center. This was the same place where the Kyoto Protocol was negotiated in December 1997.

Dr. Morad Atif, Chair of the ECBCS Executive Committee, opened the conference by introducing the ECBCS Strategic Plan for 2007-2012: “Towards Near-Zero Primary Energy Use and Carbon Emission in Buildings and Communities”. He illustrated the building sector as uniquely fragmented, especially in the decision-making process, and both slow and relatively ‘resistant’ in adopting innovative technologies. Dr Atif stressed the importance of demonstrating building case studies with real energy consumption, and that the ECBCS target is to impact on the building sector through three aspects: decision making, products and systems, and deployment and dissemination.

Dr. Shuzo Murakami, Chief Executive of the Building Research Institute of Japan, and Chair of the AIVC2008 organising committee, looked at the result of actions taken by the Japanese government after the Kyoto Protocol. He stressed the difficulty in saving energy in the building sector and that the effect of drastic innovations in energy conservation in buildings might be a new restriction to current methods of controlling indoor environments. In conclusion, Dr. Murakami expressed his expectation that the ECBCS, the AIVC and researchers participating in the AIVC2008 will deal effectively with the problem of maintaining a comfortable indoor environment, without conflicting with the need for energy conservation.

Dr. Peter Wouters, Operating Agent for the AIVC, gave an overview of the status of building energy codes in relation to indoor air quality concerns in different countries. He reported the outcomes of a recent AIVC workshop on trends in national building ventilation markets and drivers for change.

Conference awards

An award for best paper and three awards for best posters were presented by Dr. Max Sherman, the Chair of the Steering Committee of the AIVC.

Best paper award

The best paper award was presented to H. Kotani and T. Yamanaka for the paper “Interference Coefficient for Discharge Coefficient in Prediction of Cross Ventilation Rate through Large Openings”

For predicting the cross ventilation rate through large openings, the use

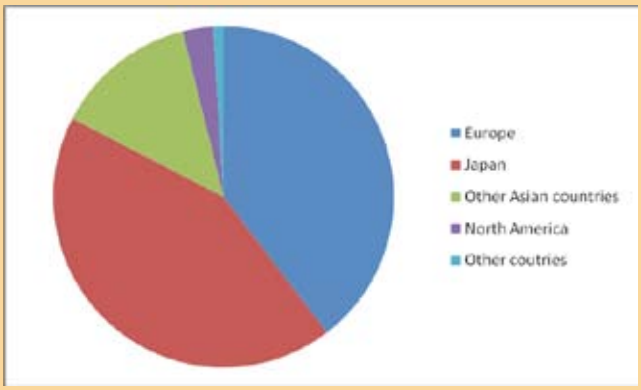
AIVC conference delegates on the main hall stage of the Kyoto International Conference Centre where the Kyoto Protocol was negotiated in December 1997.

Conference briefing

The 2008 AIVC event saw 207 researchers and engineers from around the world convene in Kyoto under the conference theme of “Advanced building ventilation and environmental technology for addressing climate change issues”. A review process by a scientific committee comprising twenty nine international and twenty seven domestic experts had selected 165 papers for the busy event.

Delegates from around the world attended the conference.

(Europe 82, Japan 89, Other Asian Countries 28, North America 6 and other countries 2.)



Conference topics

- Natural, Mechanical and Hybrid Ventilation
- HVAC Systems for Non-Residential & Residential Buildings
- Standards and Regulations for Ventilation and HVAC
- Control Technology
- Commissioning
- Integration of Building Envelopes and Services
- Envelope Air Tightness
- Condensation Prevention
- Case Study Buildings
- Air Distribution.

The conference was organised by Building Research Institute of Japan (BRI), National Institute for Land and Infrastructure Management (NILIM), ECBCS, AIVC and INIVE.

The next AIVC conference will be held in Berlin, Germany, on 1st - 2nd October, 2009, with theme of "Trends in High Performance Buildings and the Role of Ventilation". www.aivc.org

of the general discharged coefficient (CD) values for the conventional orifice equation is not suitable. The 'Interference coefficient' which is the ratio of the total pressure loss coefficient of the room to the connected value of the pressure loss coefficient of an opening in series (LS) was used. This is a kind of correction factor. Laboratory tests were conducted to measure this interference coefficient for the various opening sizes and room shapes using scaled models. Wind tunnel experiments to know the cross ventilation rate of the model were also conducted. Calculated ventilation rates using the interference coefficient were compared with measured ones.

Conference best poster awards

Three awards for best poster were presented to :

N. Choi, K. Sagara, T. Yamanaka, H. Kotani, T. Suzuki and T. Yamashita, for "Displacement Ventilation System with Radiation Panel for Sickroom - Influence of Radiation Panel on Contaminant Concentration Profile."

For the patient, the sickroom is both a place for medical treatment and also the living space where they spend almost all their time in any one day. Therefore, high indoor air quality and thermal comfort are needed in the sickroom. The authors propose to use displacement ventilation as a means of obtaining high indoor air quality, in combination with a radiation panel for individual control of the thermal environment. This paper examines the validity of this system. It describes the experimental and calculated results on the influence of the radiation panel on the contaminant concentration profile.

Stefano Schiavon and Arsen K. Melikov, for "Energy Analysis of a Personalized Ventilation System in a Cold Climate: Influence of the Supplied Air Temperature."

In this study the influence of the supply air temperature of a personalised ventilation system on energy need has been investigated by means of simulations. The simulated office room was located in a cold climate. The results reveal that the temperature of air supplied by personalized ventilation and its control strategy have a significant influence on the energy consumption. The energy consumption with personalized ventilation may increase substantially (from 61%-268%) compared to mixing ventilation alone if energy saving strategies are not applied. The results show that the best supply strategy is to provide air constantly at 20°C, the minimum allowed supply temperature. Energy savings (in the range: 32%-47%) may be achieved with personalized ventilation in comparison with mixing ventilation when the room temperature is controlled between 18°C and 29°C.

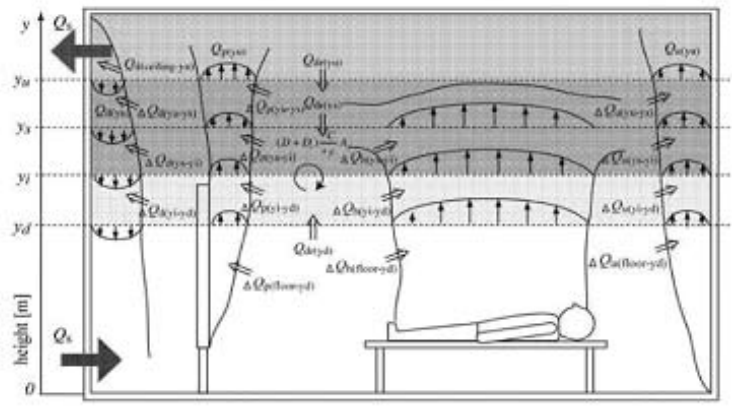
B.M. Jones, R. Kirby and M. Kolokotroni, for "Quantifying the Performance of a Top-Down Natural Ventilation Wind Catcher."

Measurements and smoke tests show that the quadrants of a Windcatcher with a positive pressure across them act as supply ducts, while those with a negative pres-

Continued on page 14

AIVC in brief…

The Air Infiltration and Ventilation Centre (AIVC), set up in 1979, is an ECBCS project. The AIVC offers industry and research organisations technical support optimising ventilation technology. A range of services and facilities on offer includes comprehensive databases on literature standards, and ventilation data.



Displacement ventilation in combination with radiator panel in a sick room.

30th AIVC Conference and BUILDAIR

Berlin, 1st - -2nd October 2009
Best Western Premier Hotel Steglitz International

The combined conferences aim to focus on key items of today's ventilation challenges:

30th AIVC Conference – "Trends in High Performance Buildings and the Role of Ventilation" and

Buildair - "International Conference on Building and Ductwork Airtightness"

Since 1980 the AIVC Conferences have been the meeting point for presenting and discussing interesting developments and results regarding ventilation in buildings. For each conference a specific theme is selected and a substantial part of the presentations relate to this theme.

The two themes this year are:

- Building and ductwork airtightness - from theory to large scale application
- Energy efficient ventilation and other innovations for high performance buildings

Conference Topics

- Treatment of building and ductwork air-tightness in standards and regulations, legal aspects
- Parameters and limit values for building air-tightness
- The role of airtightness in individual countries
- Measuring instruments for building and ductwork airtightness
- Airtightness of the building envelope and of ductwork measuring practice, interpretation of measuring results, test reports, special measurements
- Certification of measuring devices and teams, sealing compounds and buildings
- Planning of building airtightness and air-tightness concepts
- Airtightness measurement and building thermography
- Airtight building envelope and building ventilation
- Airtightness – energetic and economic efficiency
- Building airtightness and mould – structural damages
- Handling of ventilation in high performance buildings handling of the energy performance regulations
- Energy for transport of air
- Innovative ventilation systems and energy performance regulations
- Impact of regulations on the ventilation market
- Good indoor climate and energy performance
- Commissioning and inspection of ventilation systems
- Ventilation related challenges for the existing building stock
- Ventilation aspects in warm and cold climates
- Economics of indoor climate
- Trends for high performance buildings and their measured or calculated energy performance
- Comparison of energy performance requirements for high performance buildings with national requirements

More information: www.aivc.org/Conferences/conferences.html and www.buildair.de

Ventilation 2009

9th International Conference on Industrial Ventilation, Clean Industrial Air Technology Systems for Improved Products and Healthy Environments
18th - 21st October, 2009, Zurich, Switzerland

Aim and scope

The tasks and aims of industrial ventilation are to guarantee high product quality, to protect human health, and to prevent environmental pollution. These must be achieved in an energy-efficient way with minimal environmental impact and greenhouse gas emissions. Papers are invited for the following topics:

- Industrial workplace, emission and exposure control, target values, and energy efficiency
- Clean room environments
- Exhaust gas treatment
- Indoor / outdoor environmental air quality related to industrial production
- Occupational health, standards, and policies
- Innovative sensors for ventilation applications
- Specialized ventilation technologies (data centres, mining, tunnelling, commercial kitchens, ships, hospital OP).

Contributions on other topics directly related to industrial ventilation are also welcome.

Focus on future trends

The Ventilation 2009 Conference in Zurich will focus on future trends. A new concept with interactive participant involvement will be introduced. Besides plenary and parallel technical sessions with presented papers and posters, “Interactive Forums” will be held where the specialists have an opportunity to discuss technology-specific problems, solutions, and future trends.

The conference will bring together world leaders in research, technology developers, engineers, equipment suppliers, practitioners and government officials to showcase leading-edge technology for the industrial and business communities. The conference will include technical presentations, poster sessions and informative and interactive round-table discussions on selected topics.

More information: www.ventilation2009.org

Continued from page 12

sure across them act as exhaust ducts. However, analysis of the side and leeward Cp values shows that they do not necessarily balance mass flow in and out of the Windcatcher, indicating that either the pressure in the supplied room drops or there is an amount of infiltration through the building fabric initiated by the Windcatcher. In order to better understand the Windcatcher performance, a simple analytic model was developed that utilises experimental data to estimate the losses in the system. Two different scenarios are considered for the room adjoining the Windcatcher: (i) this room is perfectly sealed; and (ii) air infiltration is allowed into the room so that the pressure in the room remains atmospheric. Here, it is observed that, for those values of Cp reported for a square Windcatcher in the literature, the overall volume flow rate of air out of the room always exceeds that coming into the room. Based on this data, the analytic model may be used to estimate the losses in the Windcatcher, from which it is then straightforward to derive a simple relationship between the overall area of the Windcatcher and the volume flow rates into and out of the Windcatcher in order to predict Windcatcher performance for a given application.

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45 Energy-Efficient Future Electric Lighting for Buildings
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47 Cost Effective Commissioning of Existing and Low Energy Buildings
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