# Public Interest Report

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## CONSTRUCTING HIGH-PERFORMANCE BUILDINGS FOR THE 21ST CENTURY

Constructing High-Performance Buildings for the 21st Century Building standards need to improve to increase U.S. environmental, energy, and security independence. Though the economic stimulus package has designated billions of dollars to improve the energy efficiency and safety of buildings, much work remains to create a high performance building standard.
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## IMPROVING RESIDENTIAL ENERGY EFFICIENCY WITH STRUCTURAL INSULATED PANELS

More and more people are turning to buildings to realize energy savings. The construction market is moving more and more toward sustainability and "green" building codes, guidelines, and rating systems. At the forefront of the energy efficiency movement are those who believe buildings can produce more energy than they use, constructed at no additional cost to the owner.
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## AFTER THE STIMULUS: HOW TO MODERNIZE DOE'S WEATHERIZATION ASSISTANCE PROGRAM (WAP)

Among all the spending provisions in the economic stimulus bill, there was one in particular that stood out for advocates of greater energy efficiency. The WAP, which helps insulate the homes of low-income families to lower their energy bills, was given $5 billion of stimulus money. That funding commitment shows the Obama administration is serious about improving energy efficiency in buildings
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**About FAS**

The Federation of American Scientists (FAS), founded on 8 December 1945 as the Federation of Atomic Scientists by Manhattan Project scientists, works to ensure that advances in science are used to build a secure, rewarding, environmentally sustainable future for all people by conducting research and advocacy on science public policy issues. Current weapons nonproliferation issues range from nuclear disarmament to biological and chemical weapons control to monitoring conventional arms sales and space policy. FAS also promotes learning technologies and limits on government secrecy. FAS is a tax-exempt, tax-deductible 501(c)(3) organization.

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Phone 202.546.3300
Fax 202.675.1010
E-mail fas@fas.org.

**EDITORIAL STAFF**
Editor: Henry Kelly
Managing Editor: Monica A. Amarelo

## PRESIDENT'S MESSAGE

# The Challenge of Nuclear Poliferation and of an Effective Energy & Climate Policy

The Obama presidency has opened many doors to progress. This volume explores two issues where ongoing FAS work can be directly relevant: the path to zero nuclear weapons and aggressive programs to cut energy use in buildings.

Speaking in Prague on April 5th, the president said: "...today I state clearly and with conviction America's commitment to seek the peace and security of a world without nuclear weapons." He backed this statement with specific commitments to immediately begin negotiations with the Russians to achieve "sufficiently bold" reductions in nuclear stockpiles in an agreement that will be signed this year, noting "And this will set the stage for further cuts, and we will seek to include all nuclear weapons states in this endeavor". He committed to push hard for a Comprehensive Nuclear Test Ban Treaty, negotiations to end the production of fissile materials, and to strengthen the Nuclear Non-Proliferation Treaty including efforts to secure all of the world's vulnerable nuclear materials in four years.

This is a refreshing and bold commitment, backed with practical and achievable initial steps. But success won't be easy. Ignorance of the most basic facts about nuclear weapons makes it easy for misleading demagoguery. Howls from the hawks predictably equate the pursuit of zero nuclear weapons to unilateral disarmament. But even moderate commentators are skeptical, emphasizing grave risks and implying that U.S. efforts to cut its own arsenals would somehow accelerate work on weapons development in North Korea and Iran. Eight years of an administration that increased the scope of nuclear missions – including claiming the right to use nuclear weapons preemptively against non-nuclear nations – and constant attempts to restart U.S. nuclear weapon production have clearly not been able to slow proliferation but mere facts haven't slowed the enthusiasm these pundits have for trying the same tactic over and over again.

There is, however, a growing consensus among people who actually have thought about nuclear weapons policy that these arguments are nonsense. Henry Kissinger, George Shultz, William Perry and Sam Nunn began a powerful movement two years ago arguing that our current nuclear posture actually made the U.S. and the world less safe. The risks of accidents and mistakes involving nuclear weapons are grave and real, while the purported benefits of using them in any practical situation are vanishingly small. And of course conventional weapons might actually be used while introducing nuclear weapons into any conflict would be an act of desperation.

The work by Hans Kristensen and Ivan Oelrich of FAS, and Robert S. Norris of NRDC summarized in this volume focused directly on the most obvious, most important, and least examined issue in nuclear weapons policy: what is its mission? It's hard to have a discussion about the appropriate size or capabilities of our weapons without an answer to this question. These authors make the powerful case that the number of scenarios where nuclear weapons are superior to conventional weapon alternatives is limited to attacking hardened targets such as enemy missile silos and bunkers (assuming that we know where they are and aren't deep enough to protect them from even a nuclear attack). This mission justifies the large U.S. inven-

tory of weapons but the article argues convincingly that they make no sense in today's world. The notion that a nuclear attack of military targets would minimize fatalities is a dangerous illusion – nuclear strikes at strategically important targets would always result in huge numbers of direct and indirect casualties. A "minimum deterrence" strike against 12 oil and metal producing facilities in Russia could cripple the Russian economy and obliterate the economy of a smaller nation. But even this attack could kill 2 million people and be an act of appalling desperation.

Achieving the president's goals will require patient negotiation and persuasion. And it will rely on a careful focus on the facts. No solution is possible if pundits are willing to argue from an unreasoning assumption that reducing U.S. nuclear arsenals weakens national security. The analysis presented here argues forcibly that the reverse is true. Secretary Gates has proposed dramatic cuts in a number of weapons designed for cold war missions that live on only because of the power of defense lobbying. In effect, the president is saying that nuclear weapons belong on the same list – and he's right.

This issue also explores another area where it's refreshing to restart policy in a critical area where obvious questions have been largely ignored for years: **energy efficiency in buildings**.

We've known for years that energy use in buildings is one of the key drivers of U.S. and world energy use and greenhouse gas emissions, and are a place where large increases in efficiency are possible at a price far below the cost of producing energy from any new source. Buildings consume 40% of U.S. energy (more than half if the energy embodied in the materials used in buildings is counted), produce approximately the same fraction of U.S. greenhouse gases, and consume more than 70% of U.S. electricity. FAS Board Chairman Art Rosenfeld was one of the first to realize the importance of building energy use and began a serious focus on the problem in the early 1970s, launching a research enterprise that has paid spectacular returns as his group drove the invention of high efficiency lighting, efficient windows, and a variety of other product and design ideas.

"No solution is possible if pundits are willing to argue from an unreasoning assumption that reducing U.S. nuclear arsenals weakens national security."

But while large opportunities for savings remain, momentum was lost in recent years as the U.S. refused to take leadership in climate change and continuous budget battles sent confusing signals to the research community. While the battles will continue, the new Congress and administration have created a unique opportunity to mount a balanced and aggressive program in energy research, demonstration, testing and evaluation. It's particularly important to seize the opportunity in building technology. The American Recovery and Reinvestment Act provides more than $10 billion in funding for building-related activity – mostly on the retrofit of existing residential and commercial buildings. A number of committees in the House and Senate are considering very aggressive new programs establishing efficiency standards and providing subsidies for efficiency investments in buildings.

FAS has been active in many of these areas and has paid particular attention to the challenge of retrofitting the existing stock – a priority in part forced by the huge increase in federal appropriations in the American Recovery and Reinvestment Act. This emphasis was completely appropriate given that energy and climate goals can only be met by addressing efficiency in existing buildings. Buildings built new each year represent less than one percent of the floor space of the existing stock. Our work, described in articles by Colin McCormick, Joe Hagerman, and Brian Dougherty, concentrates on three themes:

- Ensuring that the people auditing existing buildings, inspecting and commissioning the buildings after retrofits, and performing the work in the buildings are properly trained and certified. FAS work in technology-based training will be helpful in achieving rapid expansion of high quality programs.
- Creating software tools that can be used on-site with wireless devices and provide design assistance to auditors based on building parameters observed by the auditor.
- Creating a national database that can be continuously updated by people performing the retrofits in the field that will provide guidance about the cost and performance of different retrofit measures and provide data for analyzing the success of the program (at present no consistent records are kept of the costs and impacts of retrofits).

The challenge of nuclear proliferation and the challenge of designing an effective energy and climate policy are in no way new. FAS and its members have worked in these areas for many years. We may not achieve all we hope for but windows have been opened and there's real reason to hope that we've reached one of those precious moments when iron triangles can be broken and questions can be asked about policies long shielded from a thoughtful debate. FAS

# Constructing High Performance Buildings for the 21st Century and Beyond

By Kelly Shultz, Federation of American Scientists

As a contributor to US energy, security, and environmental problems improving buildings' performance has become an elevated policy push in the past decade. In particular, Section 914 of the 2005 Energy Policy Act and Section 401 of the 2007 Energy Independence and Security Act address the need to improve building standards by developing a "high performance building standard."[1] Discussed below is FAS's investigation into the successes and shortcomings of past efforts to develop high performance building standards, a review of the need for improved standards, and policy proposals to accelerate the creation of US high performance building standards.

## The History and Success of High Performance Buildings

The 109th Congress defined a high performance building in the Energy Policy Act of 2005 (EPAct) as a "building that integrates and optimizes all major high-performance building attributes, including energy efficiency, durability, lifecycle performance, and occupant productivity."[2] Congress highlighted the need for future buildings to comprehensively integrate the best available, and arguably cost effective, building technologies.

EPAct assigned the National Institute of Building Sciences (NIBS), a non-profit non-governmental organization that researches "innovative solutions for the built environment," to survey building practices.[3] Specifically, Congress directed NIBS to assess if current standards and rating systems reflect the best use of technology, determine if and what additional research is required to advance high performance buildings, and recommend steps to accelerate the development of consensus based standards for high performance.[4]

Two years later, the 2007 Energy Independence and Security Act (EISA) passed by the 110th Congress reiterated the need to develop a high performance building standard and revised the legislated definition. According to EISA, a high performance building is "a building that integrates and optimizes on a life cycle basis all major high performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations."[5] These "performance attributes," originally conceived at NIBS for the Whole Building Design Guide, were specifically adopted by the 110th Congress to emphasize the need to focus on more than just a building's energy efficiency and environmental impact.[6]

In 2008, after three years of research, NIBS published the "Assessment to the US Congress and US Department of Energy on High Performance Buildings." This thirty-five page document attempted to assess all current building standards and propose actions to the US Congress and Department of Energy to accelerate the development of a high performance building standard. The report identifies several obstacles associated with each building attribute, as shown in Table 1, and also proposes that a "performance metric and verification method" be developed for each building attribute.

The NIBS assessment called attention to the importance of building high performance buildings throughout the country in an effort to increase US environmental, energy, and security independence. Since the NIBS's report was published, Congress created the High Performance Building Congressional Caucus, with a corresponding private sector coalition providing guidance and support to the caucus. This Caucus and Coalition work to keep both policy makers and Congress informed about the importance of building high performance structures.[7] In addition,

| Building attribute | Obstacles found by NIBS |
|---|---|
| Accessible | • As the average age of US citizens increases, every year a larger portion of the population is disabled. |
| Aesthetic | • Intangible attribute. |
| Cost-Effective | • High performance buildings will initially be more expensive than standard buildings. |
| | • Traditionally owners pay upfront costs. |
| Functional/Operational | • Intangible attribute.<br>• Every owner has different building goals and needs. |
| Historic Preservation | • Old buildings are not necessarily worth preserving. |
| Productive | • Not enough research on productivity exists to make clear conclusions. |
| Secure / Safe | • Optimizing safety often compromises functionality of other attributes.<br>• Safety needs to vary geographically. |
| Sustainable | • There are many options to measure a building's sustainability. |


the economic stimulus package designated billions of dollars to improving the energy efficiency and safety of buildings, and funded the establishment of the Office of Federal High-Performance Green Buildings within the General Services Administration. All these actions have strengthened the movement to make the next generation of buildings high performance. However, much work still remains to achieve the creation of high performance building standards.

## Public Policy Recommendations

Congress and the new administration must continue enacting policies to advance the development of a high performance building standard. These include funding for research related to high-performance buildings at federal labs and universities, grants for standards organizations to develop a comprehensive standard, and incentives for state and local governments and the private sector to adopt and utilize the standard. Without these actions, the US government will be advancing the performance of federal buildings alone, while the private sector will remain skeptical of the worth and value of high performance buildings.

***Recommendation #1:***
***Fund NIBS to complete its survey.***

The work conducted by NIBS clarified the purpose of each of the 8 chosen building attributes and identified future obstacles, yet none of the committees truly evaluated the current existing standards or technologies related to their topic. To create the best high performance building standard possible, a complete survey of all current building standards and technologies is necessary. Without an extensive understanding of present building practices, it is impossible to further the progress of the creation of a high performance building standard. Knowing how standards are lacking and where improvements are needed, as well as the status of building-related technologies, will allow future policy decisions to be most useful and appropriate.

To expedite this process, Congress should provide NIBS with the financial resources necessary to finish its past research efforts entirely. With established connections with industry and relevant government organizations, NIBS has the capacity to successfully execute this task if fully funded by Congress.

***Recommendation #2:***
***Fund an independent standards development organization to create a high performance building standard through a consensus process.***

Congress should fund an experienced independent standards organization, such as the International Code Council, to devise a high performance building standard through a consensus process. Unlike the traditional standards process, however, Congress should also explicitly direct that the NIBS survey serve as a guiding document, and should authorize the federal government to play a supporting role in the consensus standard's development. For example, the US government may consider explicitly directing and funding a federal organization, such as the Department of Energy's Building Energy Codes Program or the National Institute of Standards and Technologyto provide technical assistance to the standards development organization's consensus committee. This is not far from the technical evaluation these organizations currently provides to Standard Development Organizations, but would be more explicitly directed and funded. This would provide analysis of the impacts a proposed addition, change, or modification to the standard has on factors such as life cycle cost and energy efficiency. Having a collaborative environment where NIBS provides a research basis, an independent Standards Development Organization devises metrics and code measures, and a federal government organization assesses the impacts of proposals, will insure that the high performance build-

*See **Constructing High Performance Buildings**, p. 6*

***Constructing High Performance Buildings**, from p. 5*

ing standard represents the best integration of technologies and that Congress' original objectives are met.

Below are more specific suggested actions and roles for NIBS, the selected standards development organization and federal government organization to assume:

1. *The standards development organization should first simplify the definition of a high performance building by differentiating between the tangible and intangible building attributes.*

The current Congressional definition of a high performance building highlights eight building design objectives: accessible, aesthetics, cost-effective, functional, operational, historic preservation, secure and safe, and sustainable. Although this list is comprehensive, most of these building design objects are unquantifiable, subjective and difficult to benchmark. Creating a way of measuring each of these categories, as well as determining what should be considered "high performance," according the Congress' definition, is crucial to the successful development of a comprehensive standard. Differentiating between those attributes that can be measured with a clear metric from those that cannot (or between the tangible and intangible attributes) will simplify the creation of a high performance building standard.

2. *The standards development organization should devise metrics to measure the tangible attributes and let the federal organization use these metrics to assess the impact of proposals.*

Clear metrics to measure the tangible building attributes should be developed. When possible, it is important to use actual performance data to devise a metric. From the 8 attribute definitions, a building's level of sustainability, cost-effectiveness, and safety can be measured using performance data. Currently the U.S. Census Bureau and Energy Information Agency publish data on the performance of homes, offices, schools, hospitals, and retail facilities, and the Federal Energy Management Program provides cost-effectiveness assumptions for current building code analyses.[8] With this information, the standards development organization must create some quantifiable, open-source metric to define what qualifies a building as "high performance." The federal government organization can then use these metrics to assess and report the impacts of specific standard proposals.

| Tangible attributes | Intangible attributes |
|---|---|
| Cost-effective | Accessible |
| Secure and Safe | Aesthetic |
| Sustainable | Functional/ Operational<br>Historical preservation<br>Productive |

Table 3: Tangible versus Intangible Building Attributes

3. *The standards development organization should form committees of recognized experts to evaluate the intangible attributes.*

For the intangible attributes, the most progressive existing standards identified in NIBS's research should be assessed by recognized experts. These experts, brought together by the standards development organization, should form sub-committees for each intangible building attribute. Because the most progressive existing standards may not reflect the best available technologies,the best thinking in the field, or a reasonable, cost-effective solution, these sub-committees must thoroughly review existing standards and propose amendments that will achieve high performance levels.

## Conclusions

The 109th and 110th Congress made initial steps to tackle the current problems with

building policy in both EPAct and EISA by defining a "high performance building." However, this is only the beginning of a long and complicated process.

Developing a high performance building standard can be expedited and simplified greatly by granting adequate funding to NIBS to fulfill the tasks in EPAct and EISA and by providing funds for a standards development organization to create a standard through a consensus process. To ensure that this standard is truly high performance, however, it is important that Congress mandates that a federal government organization supplements the regular standards consensus process by conducting technical analyses of the impact of proposals on the quantifiable attributes of high-performance buildings. By taking these steps, we can continue the movement to improve the US building stock and reduce national energy, security, and environmental problems. FAS

1 This paper is condensed from its full length for this publication. For the full paper, see http://www.fas.org/programs/energy/btech/ index.html

2 Energy Policy Act of 2005. 8 August 2005. 109th U.S. Congress. 29 January 2009 http://www.doi.gov/iepa/EnergyPolicyActof2005.pdf

3 "About the National Institute of Building Sciences." http://www.nibs.org/aboutnibs.html

4 Energy Independence and Security Act of 2007. 4 January 2007. 110th Congress. 29 January 2009 http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf

5 Energy Independence and Security Act of 2007. 4 January 2007. 110th Congress. 29 January 2009 http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf

6 Assessment to the US Congress and US Department of Energy on High Performance Buildings. 2008. National Institute of Building Sciences. 2009 http://www.wbdg.org/pdfs/hpb_report.pdf

7 "High Performance Buildings Congressional Caucus Coalition." 2009. ASHRAE. http://www.ashrae.org/advocacy/page/1867

8 New Residential Construction. http://www.census.gov/const/www/newconstindex.html.

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# Improving Residential Energy Efficiency with Structural Insulated Panels

By Chris Schwind of the Structural Insulated Panel Association

Attention in the environmental and energy-efficiency communities is now turning towards buildings as more and more people realize their enormous potential for energy savings. Studies by the Environmental Protection Agency and other advocacy groups have declared this emphatically, pointing to both their dramatic percentage of national energy consumption (40 percent), and the cost-effectiveness of energy reductions. Currently Federal money is pouring into building efficiency programs, such as the Department of Energy's Weatherization program, and the building market is moving more and more in the direction of sustainability with the emergence of different "green" codes, guidelines, and rating systems.

The current focus of this movement is on reductions in building energy use in the range of 20 to 30 percent. Yet those at the forefront of the building energy-efficiency movement want to go much further: buildings that produce more energy than they use, constructed at no additional cost to the owner.

## Zero Energy Homes Start with SIPs

In 2002, the Department of Energy's Building America program announced a directive to develop cost effective zero energy homes by 2025. Their criterion for affordability was that any incremental cost, when amortized over a 30 year mortgage, would be offset by the monthly utility savings at the end of the first year of ownership.

Jeff Christian, the Director of the Building Technologies Center at DOE partner Oak Ridge National Laboratory (ORNL), started this quest for an affordable zero energy home by specifying a high performance building envelope. After evaluating several envelope options, Christian chose structural insulated panels (SIPs). SIPs consist of an insulating foam core sandwiched between two structural facings. The panels are fabricated offsite, are quick to assemble, and can cut framing cost by over 50 percent. Although SIPs can be used in a variety of applications, from low-rise commercial buildings to custom homes, one of the most promising future markets is mid-size, high performance homes.

Christian's testing revealed that SIP homes have significantly less air leakage and superior insulating properties compared to traditional wood frame construction. Minimizing air leakage is a priority in energy-efficient construction, Christian notes. SIPs are ideal for this task because they are produced in large sections, up to 8' x 24', with impermeable outer facings. Joints are easily sealed during installation using a specialty adhesive. Tests of the completed homes showed that SIPs cut air leakage by 50-80 percent compared to traditional stick construction.

"If installed correctly, the airtightness is there in one fell swoop," said Christian. "It is much more difficult to get wood frame construction as airtight as SIPs."

Based on this research, Christian designed and constructed five SIP test homes in a Habitat for Humanity subdivision in Lenoir City, TN. Each home experimented with a different combination of high performance technologies, such as geothermal heat exchangers, efficient windows, and photovoltaic (PV) solar collectors. Yet the centerpiece to each home's energy-package was SIPs. A cost analysis conducted during the design phase of the project concluded that 50 to 60 percent of the zero energy equation needed to come from efficiency improvements for the home to function under the DOE affordability model.

*See **SIPs**, p. 9*

***SIPs**, from p. 8*

Much of this efficiency comes from the SIP building envelope. On average, heating and cooling are responsible for 40 percent of a home's energy use. Using SIPs cut the heating and cooling loads in each home by roughly 50 percent.

Following construction, families occupied the homes and Christian closely monitored energy consumption with sensors installed during construction. After a year of occupation, the net utility costs for the five homes ranged from $0.41 to $1.16 per day, compared to $3.20 for the control home built with the Habitat chapter's standard building practices. The fifth zero energy home, dubbed ZEH5, was the largest home at 2600 sq. ft., with the four others in the 1,000 sq. ft. to 1,200 sq. ft. range typical of Habitat for Humanity homes. Occupied by a family of six, ZEH5 claimed the highest utility expenses at $1.16 per day, but is still 67 percent more energy efficient than the base home.

Further reducing the homes energy use to achieve true zero energy status would require more than the modest 1.98 – 2.2KwP PV arrays for onsite generation. Although continuing research and development has reduced the installed cost of PVs by an average of 3.5 percent per year since 1998, solar generation remains one of the challenges to affordable zero energy homes.

All five research homes in Tennessee were part of the Tennessee Valley Authority's (TVA) Green Power Generation Partner program. TVA offers to purchase all the energy generated by residential PVs whether it is used in the house or not. The homeowner's account is credited for all the solar power produced by the on-site PV system. TVA and many other utilities subsidize this process by purchasing the power at a slightly higher rate than they charge their customers.

Zero energy homes also have the potential to assist utility companies like TVA in reducing peak demand. For utility companies, generation capacity has to meet their customer demand at its highest point. When peak demand exceeds generation, utility companies are often forced purchase power from other utilities at high rates.

> **"A variety of energy measurement technologies, such as Google's PowerMeter software, will soon be entering the marketplace to help homeowners reduce their energy use and save on utility costs."**

Christian argues that the home's ability to reduce peak demand is enough of a benefit to utility companies to offer incentives on an energy management system to customers that have energy efficient homes. Combined with a small 10 kW battery, the energy management system can sell power back to utilities during peak demand.

"If the utility could pay for the batteries along with the energy management system and inverters, and the homeowner takes advantage of available solar incentives, this could become the only way to build a house," said Christian. "It would make economic sense," he added.

"Using this package of technologies, if 200,000 homes were aggregated on the internet they could equal the peak capacity of large nuclear power plant," said Christian. "The homes can't produce as much energy as a nuclear plant on an annual basis; in fact they would only produce about one-fifteenth as much, but at about one-fifteenth the cost."

Onsite generation is a major benefit for homeowners as well. With the cost of energy rising, a home that produces an increasingly valuable commodity is a wise investment. A variety of energy measurement technologies, such as Google's PowerMeter software, will soon be entering the marketplace to help homeowners reduce their energy use and save on utility costs.

## The Future of Zero Energy Homes

Christian is currently working on applying the lessons learned from the first five test homes to more marketable designs. His latest 2,600 sq. ft. design has more popular aesthetics and higher end finishes than the simple Habitat for Humanity homes. Despite their larger size, the new designs are even more energy efficient than their predecessors. Christian hopes that federal tax incentives on PVs will push zero energy homes into mainstream home building.

A 2006 report published by the National Renewable Energy Laboratory estimates that market adoption of zero energy homes could begin as early as 2012. At the projected rate of market diffusion, zero energy homes could save 2.55 percent of the nation's energy use by 2050, or more using Christian's battery system.

Between now and 2050, there will be many more technological advances that will improve the efficiency and lower the cost of zero energy homes. Solar technology has the most to gain, and is one of the most expensive elements in current zero energy homes. While these measures will bring a home over the edge, constructing a high performance building envelope that is well insulated and air-tight is a critical element in making affordable zero energy homes for the average homebuyer. FAS

1 *Buildings and the Environment: A Statistical Summary.* U.S. Environmental Protection Agency Green Building Workgroup, December, 2004.

2 http://www1.eere.energy.gov/buildings/goals.html

# After the Stimulus: How to Modernize DOE's Weatherization Assistance Program

By Colin McCormick, Federation of American Scientists

Among all the spending provisions in February's economic stimulus bill, there was one in particular that stood out for advocates of greater energy efficiency. The Department of Energy's Weatherization Assistance Program (WAP), which helps insulate the homes of low-income families to lower their energy bills, was given $5 billion of stimulus money. That funding commitment helps show that the Obama Administration is serious about the idea of improving energy efficiency in buildings, both as a response to climate change and as a way to create green jobs – a refreshing change from the previous eight years (see the recent report by FAS senior advisor John Millhone for more detail on WAP's history ).

But money isn't everything. A lot now depends on how the Department of Energy decides to scale up WAP to spend the new stimulus money, which is over twenty times its recent annual budget. DOE should think about this stimulus money as an opportunity to modernize the program's operation, so that as it weatherizes more, it also weatherizes smarter.

Here's what needs to happen. WAP works with states and local non-profits known as Community Action Agencies (CAAs) to audit the energy use of low-income homes, install weatherization measures, and inspect the results. To support the CAAs, DOE's Oak Ridge National Laboratory (ORNL) developed two software tools, the National Energy Audit Tool (NEAT) and the Manufactured Home Energy Audit (MHEA). NEAT and MHEA are used by the CAAs to help them conduct home energy audits and determine what measures a weatherization team should take in a specific home, given its structure, age, construction, and location. Audits are a key part of the weatherization process, and the stimulus bill indirectly made their role even more important, by doubling the average amount that can be spent by WAP on each home. The new, larger amount will allow "deeper" retrofits (the installation of measures previously considered too costly) and save more energy, but since most CAAs don't have experience with evaluating these new measures, they will have to rely even more on NEAT and MHEA in considering them.

> **"A lot now depends on how the Department of Energy decides to scale up WAP to spend the new stimulus money, which is over twenty times its recent annual budget."**

To better support the CAA audits, DOE should immediately update the NEAT and MHEA tools. Working with the National Institute of Standards and Technology (NIST), which has expertise in software design for energy decision-making in federal buildings, ORNL should quickly convert NEAT and MHEA into web-based applications. This would eliminate problems with backward compatibility with computers at many CAAs, and allow for instant updates without having to push out new software releases. It would also allow DOE to start directly collecting information on what weatherization measures are actually being installed and how much they cost, by including functionality in the software that would transmit information entered by the auditor and the inspector directly to a central database at DOE (similar to the Building Energy Compilation & Analysis, or BECA, database formerly hosted at Lawrence Berkeley Laboratory). This collected information could then be analyzed by DOE building scientists to learn more about what works and what doesn't when it comes to retrofits. Since the last comprehensive survey by DOE of installed weatherization measures was based on weatherizations that were conducted in 1989, this is badly needed.

Ideally, the information collected through the web-based audit tools would be supplemented by utility bills for the weatherized homes, although there are important privacy concerns to be addressed before doing this. (One possible short-term solution to the privacy problem is to use the utility bills already collected by DOE's Energy Information Agency during its Residential Energy Consumption Survey, in cases where the bills are from weatherized homes.) Adding this piece of the puzzle would help put home energy retrofitting on a more technically sound footing. A lot has happened in the twenty years since the 1989 study, and the lack of current information about how modern technologies perform in homes can lead to incorrect recommendations by NEAT and MHEA and major missed opportunities for energy savings.

Central collection of retrofit information would also let DOE monitor the program for waste, fraud and abuse. On the basis of direct collection of information from the CAAs, DOE could watch for anomalies in costs, installation decisions, or other areas that could be indications of inappropriate use of the stimulus funds. Currently DOE has no direct way to do this, and it has to rely on self-reporting from CAAs and states.

*See **After the Stimulus**, p. 11*

***After the Stimulus**, from p. 10*

The modernization of WAP also needs to include a better system for training auditors and weatherization crews. The existing training infrastructure is haphazard and varies widely in quality from state to state. DOE needs to establish standards about what training is required, and it also needs to begin making use of sophisticated simulation tools to improve and accelerate training. For several years, firefighters and other first responders have used computer simulations to learn about operations in buildings. These lessons are difficult, dangerous, or costly to teach in real buildings. The success of these simulations is remarkable, and a large body of building simulation software now exists. DOE should adopt and adapt some of these existing simulations to help auditors and crews quickly come face to virtual face with a large array of construction types, appliances, HVAC systems, and other aspects of building energy use that would take far more time and expense to do in reality. This won't eliminate the need for hands-on training, but it could significantly reduce it and shorten the overall training time needed. To deliver the simulations to trainees across the country, DOE should work with the National Guard to start using the Guard's existing network of technology-enabled classrooms (part of its Distributive Training Technology Project). The Guard currently uses these classrooms to teach its personnel technical and mechanical skills, but the network has extra capacity that could be used for weatherization training. A program using Guard classrooms could also recruit Guard members returning from overseas deployments, 19 percent of whom are unemployed, to become energy auditors and weatherizers.

Scaling up any program by an order of magnitude is an enormous challenge, and WAP is no exception. Program managers at DOE and the states facing this challenge may not be interested in software or data collection, and may resist innovative ideas. But the opportunity of this weatherization stimulus is too large to ignore, and modernization is essential. After all, the stimulus itself is about no more business as usual – and weatherization shouldn't be any different. FAS

1 http://www.fas.org/programs/energy/btech/policy/Weatherization%20Article.pdf

# China Rebuilds After the 2008 Earthquake – FAS Presents Research at U.S.-China Green Energy Conference

By Brian Doherty, FAS Research Assistant for the Building Technologies Program

In November 2008, Joe Hagerman, project manager of the Building Technologies Program at the Federation of American Scientists, and I traveled to China to present building material and emergency housing research at the U.S.-China Green Energy Conference in Beijing. Standing at the top of Jingshan Park, looking out over the city of Beijing, the impetus for our trip was strikingly clear. Or rather, it was oddly opaque.

Thick air hung over the city as a stark reminder of the environmental impacts of human behavior, China's rapid industrialization, and the need for immediate global action. After a dramatic rise in the rate of energy demand in China between 1980 and 1996, the rate of increase has slowed. Yet China is still one of the leading energy consumers globally. In 2002, China accounted for 10 percent of world energy use and is projected by 2025 to account for 15 percent of global energy use. China is estimated to emit 13 percent of global carbon emission from fossil fuels, which is projected to rise to 18 percent by 2025.

While these numbers may seem staggering, the United States contributes more and with far fewer people. It is from this place at the top of the "CO2" producers list that the U.S. - China Green Energy Conference was formed.

Organized by the U.S.-China Green Energy Council, a joint coalition of leaders from both countries, the conference was a meeting of business, technology, academic, and government leaders from both China and the United States to discuss energy issues of mutual interest, including innovative energy technologies, energy efficiency, and models for China/US business ventures.


*Keynote speaker Xu Ding Ming, Director of the National Energy Expert Consultative Committee of the National Energy Administration*

Joe and I traveled to China to participate in the conference, and to discuss our work and ideas with colleagues in Chengdu and Mianzhu. The recipient of FAS's 2008 Public Service Award Mark Levine, who is also the group leader of the China Energy Group and former director of the Environment Energy Technology Division at Lawrence Berkeley National Laboratory, invited us because he saw a valuable connection between the FAS building materials research and China's need to rebuild safe, energy-efficient housing after the devastating Sichuan Earthquake.

The conference speakers included a keynote by FAS Board Member Shankar Sastry, Dean of the College of Engineering and Professor of Electrical Engineering, Computer Science, and Bioengineering at the University of California, Berkeley.

During the final session of the conference, we presented "Rebuilding After the Sichuan Earthquake." The session was moderated by Levine and included presentations by Wu Yong, Deputy Minister of the Ministry of Construction in Beijing; Li Bixion, a professor at Sichuan University; and FAS's Joe Hagerman.

Our session was very well attended and sparked an intense discussion. Wu Yong presented the current state of rebuilding efforts by the government in the Sichuan area, and Professor Bixion presented her research into the structural reasons for and the extent of the earthquake damage. Joe's presentation focused on FAS's past work with CSIPs, including demonstration homes and seismic research, as well as experience with emergency relief housing work. We believe CSIPs are an ideal candidate for

rebuilding in Sichuan. The group fielded questions well past the scheduled end of the session, with a clear air of concern and optimistic enthusiasm from the audience.

After the conference, Joe and I traveled to Chengdu, a city of 11 million in the Sichuan Province and one of the economic hubs of southwest China. Members of Sichuan University's International Office introduced us to officials from the Engineering School and the International Office of Sichuan University.

University representatives also led a tour of the earthquake-damaged areas and of the temporary relief housing in Dujiangyan, a town roughly 20 kilometers from the earthquake's epicenter and an area of extensive destruction. Our tour focused on a group of buildings in varied stages of construction during the earthquake, which provided us with a snapshot timeline of how typical Chinese construction reacted to the natural disaster.

The results were discouraging.

Strewn with rubble, most buildings on the site suffered massive failure with several toppled over entirely. However, it did offer a good learning opportunity and we were able to pick up on many of the shortcomings of Chinese building. These ranged from building techniques and typical construction approaches to measures lacking in the Chinese seismic code.

On our way back to Chengdu, we stopped at a temporary housing village. The large village was comprised of small white buildings with blue roofs. We spoke with an older couple whose home had been destroyed and was relocated to the village. The living arrangement was small and bare, but they were very happy and felt they were being well taken care of in their time of need and that the Chinese government had acted quickly. The couple will be living in the village for at least two more years.

*See **China**, p. 14*

## The 2008 Quake

On May 12, 2008, the 19th deadliest earthquake of all time hit the Sichuan region of China. Tremors from the 8.0 Ms magnitude quake were felt as far away as Russia, with surveys showing over 170,000 square miles affected at a level of "slightly damaging", and over 1200 square miles on the level of "devastating". Numbers are still being updated, but there are roughly 70,000 dead, 375,000 injured, and 20,000 missing.

With such excessive damage, rebuilding is required on a massive scale. Roughly 5 million people are homeless and 15 million are displaced. At the time of our trip, nearly 2 million households across the Sichuan region still needed to be rebuilt or repaired. In the town of Mianzhu, roughly 100,000 homes need to be rebuilt – a process that will take several years.

***China**, from p. 13*

The next day we traveled to Mianzhu, a town near the earthquake's epicenter, to meet with the Director of Reconstruction. The damage was extensive, with roughly 100,000 households needing homes. The meeting was an exploratory one, where we presented our past research on CSIPs to the director.

CSIPs are an ideal candidate for the rebuilding as they are energy efficient, easy to construct, and seismically robust. A successful demonstration project in Mianzhu could mean significantly safer and more comfortable housing in the region, as well as a significant reduction in energy use. FAS also sees this as the first step towards the broader creation of a CSIP industry in China. FAS is currently seeking funding for this initiative.

Departing Mianzhu for the familiarity of the U.S., I felt a sense of challenged optimism. While the conference in Beijing left me hopeful that the values of sustainability were shared among all partners, seeing the front lines of rebuilding in China and the thick air left me overwhelmed by the size and scale of the road ahead.

I am hopeful that our research and the partnerships created during this trip will help those affected by the earthquake, those living in the thick hanging air above Beijing, and all those impacted by U.S. and China carbon emissions. FAS

*Brian Doherty is a research assistant for the FAS Building Technologies Program where he works to advance issues of energy efficiency, affordability, and building safety within the building industry.*

1 http://www.brookings.edu/~/media/Files/rc/papers/2005/12globaleconomics_mckibbin/200512.pdf

2 More information on the conference can be found at http://ucgef.org/en/activities/beijing08/overview

# FAS Tool Teaches Scientists to Engage the Public

By Monica Amarelo

Most scientific research goes largely unnoticed by the general public until media reports reveal major scientific breakthroughs or biosafety accidents. The most recent module in the FAS Case Studies in Dual Use Biological Research series examines the public reaction to scientific research. It is designed to increase scientists' awareness of the general public's perception of their research, the possible consequences, and how scientists can engage the public to address their concerns.

"Scientists have to realize that some people are afraid of research being done in their community," said Michael Stebbins, FAS Director of Biology Policy. "They need to do a better job of reaching out to the public and communicating the benefits of science."

Susan Ehrlich, a former Judge in the Arizona Court of Appeals, is the public representative on the National Science Advisory Board for Biosecurity (NSABB) and featured in the new module released today. In a series of video clips, she stresses the importance of scientific research and explains why scientists need to engage the public and address their concerns.

"I want scientists to be evangelists," Ehrlich says in one video segment. "My fear is that if there is not a bridge over the chasm between scientists and the public, that the scientific enterprise will be harmed."

Following the anthrax letter attacks in 2001, concern has grown over legitimate scientific work that could be misused to threaten public health and national security. Members of the general public often express concerns about high containment facilities operating or being built in their neighborhoods and the apparent lack of transparency and oversight of biodefense research. People want to know that dangerous pathogens are secure and that they and their families are not in danger simply because a research facility is located nearby. While it may be easier to ignore or diminish public concerns, this may have greater consequences than many scientists realize.

The "Public Reaction to Science Research" module is the latest addition to the FAS Case Studies in Dual Use Biological Research multimedia online education material. The series illustrates the implications of dual-use biological research through case studies of researchers and provides a historical background on bioterrorism, bioweapons and the current laws, regulations and treaties that apply to biodefense research. Continuing development and expansion of the Case Studies in Dual-Use Biological Research is funded in part through a grant by the Carnegie Corporation of New York.

Visit the new module on the public reaction to scientific research: http://www.fas.org/biosecurity/education/dualuse/FAS_Ehrlich/index.html. FAS

## Call for Articles

Attention FAS Members

In our continuing effort to provide the FAS community with timely articles about national security policy, learning technologies, building technologies, and other areas of science and technology policy, we are inviting members to submit proposals for articles (maximum of 1,500 words).

Selection of articles is at the discretion of the editor and completed articles will be peer-reviewed.

Editor, PIR
Federation of American Scientists
1725 DeSales Street, NW
Washington, DC 20036
Or email press@fas.org.

**The Federation of American Scientists**
1725 DeSales Street, NW, 6th Floor
Washington, DC 20036



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