OPTIONS AND OPPORTUNITIES FOR ONSITE RENEWABLE ENERGY INTEGRATION

FIELD HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

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CONTENTS

November 15, 2010

OPTIONS AND OPPORTUNITIES FOR ONSITE RENEWABLE ENERGY INTEGRATION

MONDAY, NOVEMBER 15, 2010

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Chicago, IL.

The Committee met, pursuant to call, at 9:30 a.m., Dirksen Federal Courthouse, 219 S. Dearborn Street, Chicago, Illinois, Ceremonial Court Room 2525, Hon. Russ Carnahan presiding.

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Hearing on

Options and Opportunities for Onsite Renewable Energy Integration

Monday, November 15, 2010
9:30 a.m. – 11:30 a.m. CST
2525 Ceremonial Courtroom
Dirksen Federal Courthouse
Chicago, Illinois

Witness List

Mr. Joseph Ostafi IV
Regional Leader for the Science and Technology Division
Group Vice President
HOK

Mr. Michael Lopez
Director of Facility Operations
Bolingbrook High School

Mr. Daniel Cheifetz
Chief Executive Officer
Indie Energy Systems Company

Dr. Jeffrey P. Chamberlain
Department Head, Electrochemical Energy Storage
Energy Storage Major Initiative Leader
Chemical Sciences and Engineering Division
Argonne National Laboratory

Ms. Martha G. VanGeem, PE
Principal Engineer & Group Manager
Building Science and Sustainability
CTL Group

FIELD HEARING CHARTER

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

Options and Opportunities for Onsite Renewable Energy Integration

MONDAY, NOVEMBER 15, 2010
9:30 A.M.–11 A.M. CENTRAL STANDARD TIME
DIRKSEN FEDERAL COURTHOUSE
219 S. DEARBORN STREET
CHICAGO, ILLINOIS
CEREMONIAL COURT ROOM 2525

Purpose

On Monday, November 15, 2010 the House Committee on Science & Technology will hold a field hearing entitled "*Options and Opportunities for On-site Renewable Energy Integration*."

The hearing will examine the integration of renewable energy systems in the built environment. Witnesses will discuss the state of the building industry and how federal research programs can help continue the industry's efforts to adopt renewable energy into their designs and practices. Opportunities for the adoption of simulation-driven design, storage integration, and measurement and verification technologies will also be discussed. Furthermore, the hearing will consider research, development, and demonstration needs that are not currently being adequately addressed by the industry or the U.S. Department of Energy (DOE).

Witnesses

- **Mr. Joseph Ostafi IV** is the Regional Leader for the Science and Technology Division and also Group Vice President of HOK a global architectural firm that specializes in planning, design, and delivery solutions for buildings and communities. Mr. Ostafi will provide a broad overview of what it means to integrate renewable energy into buildings and discuss some technical issues which need additional research to ease integration.
- **Mr. Michael Lopez** is the Director of Facility Operations for Bolingbrook High School, the first Leadership in Energy and Environmental Design (LEED) Certified School in Illinois and the third high school in the United States. Mr. Lopez will discuss the environmental and energy efficient initiatives of the Valley View School District.
- **Mr. Daniel Cheifetz** is the Chief Executive Officer of Indie Energy Systems Company, which is a global leader in smart geothermal technology for heating and cooling both existing and new buildings. Mr. Cheifetz will discuss the incorporation of geothermal energy and related system integration technologies into the built environment.
- **Dr. Jeffrey P. Chamberlain** is the Department Head for Electrochemical Energy Storage and is also the Energy Storage Major Initiative Leader of the Chemical Sciences and Engineering Division at Argonne National Laboratory. Dr. Chamberlain will discuss how research in vehicle storage technologies relate to stationary storage technologies used in buildings.
- **Ms. Martha G. VanGeem, PE**, Principal Engineer & Group Manager of Building Science and Sustainability of CTL Group a industry leader in engineering and scientific services. Ms. VanGeem will discuss the role of industry and federal research programs in developing technologies and standards to integrate renewable energy into buildings.

Background

In 2009 the Department of Energy (DOE) reported that buildings accounted for 80 percent (or $238 billion) of total U.S. electricity expenditures. From 1980 to 2006, total building energy consumption in the United States increased more than 46 percent, and is expected to continue to grow at a rate of more than 1 percent per year over the next two decades. Carbon emissions from buildings in the U.S. approximately equal the combined carbon emissions of Japan, France, and the United Kingdom. This is about 38 percent of the emissions emitted in the country. Tackling public concerns about the high costs of energy, the looming threat of global climate change, and the nation's economic wellbeing requires continual assessment of federal building technology programs.

The importance of energy efficiency and sustainability in buildings has been recognized in various federal laws, executive orders, and other policy instruments in recent years. Among these are the energy policy acts (EPAct) of 1992 and 2005 (P.L. 102–486 and P.L. 109–58), the Energy Independence and Security Act of 2007 (EISA, P.L. 110–140), and the American Recovery and Reinvestment Act of 2009 (P.L. 111–5). Through these laws the DOE is authorized to carry out a range of activities to increase energy efficiency in a number of economic sectors.

While these programs continue to demonstrate success in developing technologies and practices for high-performance buildings, advancing the state of technology far beyond what is currently available will require the programs to incorporate entirely new technologies and approaches into their R&D agendas.

Steps to first reduce total energy consumption, and then to use the remaining energy more efficiently, have been and continue to be the country's first line of defense to reduce the cost of energy and to cut carbon emissions in the building sector. As the country has become more effective in using these techniques, new approaches to drastically reduce traditional energy consumption by integrating on-site renewable energy into the built environment have garnered more attention and have been incorporated into public law and into practice.

Modern practices of using energy efficient technologies and addressing other environmental concerns have generally been termed "green building design." While the concept has existed for a long time, the practices did not really emerge until the 1990s. Since then terms such as "green building," "high-performance building," and "high-performance green building" have been defined in public law, both by several different Federal agencies and by stakeholders in the building community. For example, a "high-performance building" is defined by EISA as 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. To move beyond energy efficiency and into integrating renewable energy into building design, new terms have been developed, such as "net-zero energy," which also has been defined in many ways.

Net-Zero Energy

In general, a net-zero energy building produces as much energy as it uses over the course of a year. Some building scientists intended for these buildings to have no net environmental impact or even a "minus-impact" which would mean the building would provide a net environmental benefit. The National Renewable Energy Laboratory (NREL) has studied four different definitions including: net-zero site energy, net-zero source energy, net-zero energy costs, and net-zero energy emissions (*Box.1*). The diversity in these definitions illustrates that these are fairly new concepts still under discussion by the building community.

Net Zero Site Energy: A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site.
Net Zero Source Energy: A source ZEB produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site. To calculate a building's total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers.
Net Zero Energy Costs: In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.
Net Zero Energy Emissions: A net-zero emissions building produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources.

Box.1 NREL Zero-Energy Buildings: Definitions.[1]

[1] Torcellini, P.; Pless, S.; Deru, M. (NREL); Crawley, D. (U.S. DOE). (2006). Zero Energy Buildings (ZEB): A Critical Look at the Definition. NREL/CP–550–39833. Golden, CO: National Renewable Energy Laboratory.

DOE's Net-Zero Energy Commercial Building Initiative aims to realize marketable net-zero energy commercial buildings by 2025. The program brings architects, engineers, builders, contractors, owners, and occupants together to optimize building performance, comfort, and savings through a whole-building approach to design and construction. The program is divided into three interrelated strategic areas designed to overcome technical and market barriers: research and development, equipment standards and analysis, and technology validation and market introduction. Key research areas include: commercial lighting solutions; indoor environmental quality; building controls and diagnostics; and space conditioning. These types of research will help decrease the cost of integrating renewable energy in the built environment.

Federal programs to deploy renewable technologies have helped owners incorporate renewable energy systems into their buildings. For example, financing the cost of a residential photovoltaic (PV) system through home equity loans, mortgage loans, or cash in combination with state and utility incentives has helped reduce the cost of systems. Nevertheless, right now not every owner is ready to make the necessary up-front financial investment in a renewable energy system.

Renewable Ready Buildings

One concept which may help ease the adoption of renewable energy systems for building owners who are not ready to make the up-front investment is the idea of "renewable ready" buildings. As with many of the approaches in the green building sector, "renewable ready" is not well defined, but some builders are beginning to take this approach into consideration as they look toward "greening" their building designs. In general, this means that the construction of new buildings or renovations of buildings should be constructed "ready" for future renewable energy installations. Advocates of this approach believe that planning ahead for a renewable energy system maximizes the potential of that renewable energy source in the future.

It is in the planning for a renewable energy system where there is a wide variety of elements that could be considered to make a building "renewable ready." The variety of elements is highly dependent on the kind of renewable energy system to be installed in the future. The design and element differences between making a building ready for solar panels versus a geothermal energy system may be very different.

Moreover, there are building codes which may impede the ability to design and adopt renewable energy systems for buildings. For example, codes pertaining to roof heights and slopes could be barriers to the adoption of PV. In contrast, some building codes could also be used to encourage the adoption of "renewable ready" designs. For instance, in March of 2010 the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) released *Standard 189.1—Standard for the Design of High-Performance, Green Buildings*. This new standard includes a provision for "renewable energy ready" elements and is the first set of model codes and standards for green building in the U.S.

Finally, another barrier to the adoption of "renewable ready" buildings is the siting of the building. For example, the orientation and location of a building's axes and surfaces, and the building's proximity to trees and other plantings, affect its heating and cooling requirements. Siting may also impact the ability to incorporate renewable energy generation on the building or on-site.

Community Planning

Consequently, renewable energy experts including scientists at NREL have been working on "net zero-energy communities" which are defined as "one that has greatly reduced energy needs through efficiency gains such that the balance of energy for vehicles, thermal, and electrical energy within the community is met by renewable energy." In some cases, planning a community where the renewable energy systems can be sited in a variety of ways may ease the adoption of renewable energy systems. For example, NREL has explored siting renewable energy system within the built environment (rooftop), on-site (parking structure, along roadways, etc.) or on unbuildable areas such as brownfield sites. This flexibility could also allow for the adoption of a variety of integrated renewable energy systems such as solar PV and a wood biomass boiler.

Systems Integration

Even after building completion, systems are rarely optimized together to improve overall energy efficiency and environmental performance. A typical building is comprised of a complex array of components (wood, metals, glass, concrete, coatings, flooring, sheet rock, insulation, etc.) and subsystems (lighting, heating, ventilation and air conditioning, appliances, landscape maintenance, IT equipment, electrical grid connection, etc.), all of which are developed individually by independent firms that do not often design and test their performance in conjunction with other components and systems. Adding renewable energy generation as well as storage capacity to these systems is complicated, yet is already being done. But the inefficiencies attributable to this fragmentation of the building components and systems, and the lack of monitoring and verification of a building performance, point to a critical need for a more integrated approach to building design, operation, and technology development. An approach that couples buildings sciences, architecture, and information technologies could lead to entirely new buildings with subsystems that are able to continuously communicate with each other and respond to a range of factors including renewable energy generation. Wide-scale deployment of these types of net-zero energy high performance buildings may require federal programs to play a larger coordinating role in the development of the common technologies, codes, and standards.

Mr. CARNAHAN. Good morning. I think we'll get started. Just by way of introduction, my name is Russ Carnahan. I am a Member of Congress from St. Louis, Missouri, and I serve on the Science and Technology Committee with my colleague, Mrs. Biggert, who's here in her hometown. So I'm glad to join her here this morning and, really, to kick off this field hearing on Options and Opportunities for Onsite Renewable Energy Integration. Thanks for joining us. I'd also like to thank the staff here at the Dirksen Federal Courthouse for hosting today's hearing.

As many of you know, our nation's buildings have a surprisingly large environmental footprint, consuming about 70 percent of all electricity off the grid, emitting almost 40 percent of all carbon emissions, and using roughly 60 percent of all raw materials in the U.S. However, with these challenges also come, I believe, great opportunities.

According to a recent U.S. Green Building Council report, greater building efficiency can be about 85 percent of our future U.S. demand for energy. And a national commitment to green building has the potential to generate two and-a-half million American jobs. These opportunities and a desire to bring a greater awareness to these issues are what led Congresswoman Biggert and I to found the Bipartisan High-Performance Buildings Caucus in 2007. To date, the Caucus has over 30 Members of Congress and works with over 150 building trade associations, private companies, and design firms to heighten awareness and inform policymakers and their staffs about major impacts buildings have on our economy, our environment, our energy future, and companies' bottom line.

I want to thank Congresswoman for her strong leadership and support over the past years on these issues that are so important to both of us, to Members on the Science Committee, on the High-Performance Buildings Caucus, but also to our constituents. I look forward to working with her and all of our other colleagues in the new Congress to continue these issues.

As our nation continues on the road to recovery, we have a real opportunity to make lasting investments in our nation's future by rethinking our built environment and investing in high-performance buildings. In April of last year, this Committee held a hearing focused on building and industrial energy efficiency. This was a very informative hearing, and reconfirmed for everyone who attended energy efficiency is the number one priority when it comes to addressing our energy crisis. That being said, we're here today to talk about another vital part of the solution; integrating renewables into our built environment.

As our witnesses will explain, we are already integrating renewables into our built environment, yet there are far too many barriers to integration that can be overcome through better technology. However, we cannot rely on improved technology alone to solve these problems. We must have a combination of technology, smart federal policy, and targeted investments for us to reach our goals. I look forward to hearing suggestions and ideas on what specific research and development needs exist to help overcome these barriers and what the federal government's proper role is in encouraging these activities in the private sector and academia.

I also want to thank today's witnesses for taking time out of their busy schedules to be here to join us today, this week in Chicago, during the big GreenBuild Conference going on. I look forward to seeing that successful conference, and you know we have a big delegation from St. Louis here, from my home city.

[The prepared statement of Chairman Carnahan follows:]

PREPARED STATEMENT OF CHAIRMAN RUSS CARNAHAN

Thank you all for joining us at today's hearing on "Options and Opportunities for Onsite Renewable Energy Integration." I would also like to thank the staff of the Dirksen Federal Courthouse for hosting today's hearing.

As many of you know, our nation's buildings have a surprisingly large environmental footprint consuming 70 percent of all electricity off the grid, emitting almost 40 percent of all carbon emissions and using roughly 60 percent of all raw material in the U.S. However, with these challenges also comes great opportunity. According to a recent U.S. Green Building Council report, greater building efficiency can meet 85% of future U.S. demand for energy, and a national commitment to green building has the potential to generate 2.5 million American jobs.

These opportunities and a desire to bring greater awareness to these issues led Congresswoman Biggert and I to found the bipartisan High-Performance Buildings Caucus in 2007. The Caucus has over 30 Members of Congress and works with over 150 building trade associations, private companies and design firms to heighten awareness and inform policymakers about the major impact buildings have on our economy, the environment and our energy future.

I want to thank the Congresswoman for her strong leadership and support over the past years on these issues that are so important to the both of us and I look forward to continuing our efforts here today and in the future.

As our nation and continues on the road to recovery we have a real opportunity to make lasting investments in our nation's future by rethinking our built environment and investing in high-performance buildings.

In April of last year, this Committee held a hearing focused on building and industrial energy efficiency. This was a very informative hearing and re-confirmed for everyone who attended that energy efficiency is the number one priority when it comes to addressing our energy crisis. That being said, we are here today to talk about another part of the solution: integrating renewables into out built environment.

As our witnesses will explain, we are already integrating renewables into the built environment. Yet, there are many barriers to integration that can be overcome through better technology. However, we cannot rely on improved technology alone to solve these problems—we must have a combination of technology, smart federal policy and targeted investments for us to reach our goals. I look forward to hearing suggestions on what specific research and development needs exist to help overcome these barriers and what the federal government can do to better encourage these activities.

I want to thank today's witnesses for taking time out of their busy schedules to join us here today and I look forward to hearing how we can best proceed in these endeavors.

Mr. CARNAHAN. And I want to recognize Congresswoman Biggert now for five minutes for her opening statement.

Mrs. BIGGERT. Thank you, Mr. Chairman, and welcome to all of our witnesses. We appreciate your efforts to be here and participate in today's important hearing. I am also particularly pleased that my good friend and colleague, Russ Carnahan, was able to be here today to chair this hearing and kick off the festivities for the U.S. Green Building Council's annual international conference expo. As Congressman Carnahan just mentioned, we have the distinct honor of leading, I think, the most exciting Caucus in the House of Representatives.

Officially known as the High-Performance Building Caucus, we have hosted over 50 lunch meetings in the last two years on every subject important to the definition of a high-performance building.

So, today's hearing isn't just a twist in our usual Caucus collaborations, but it is just a way to—another way to take our show on the road and raise awareness for the importance of high-performance buildings, and nowhere is the concept of high-performance buildings more important and more evident than right here in my own backyard. I don't live right in Chicago, but I'm part of the metropolitan suburban area.

But Chicago is the home to many high-performing building firsts, like the Chicago Center For Green Technology, the first rehabilitated municipal building in the nation to achieve the LEED platinum status. And, in 2007, the Exelon Headquarters and Chase Tower became the largest office space to earn the LEED platinum rating for commercial integrators. Another great example, and one that you will soon hear more about, is Bolingbrook High School, located in the suburban district. Bolingbrook High School is among the first of new construction LEED-certified high schools in the nation.

So, what do these building project examples have in common, and how is renewable energy integration important to them? Well, these building projects have been constructed with a comprehensive building efficiency program. Once in place, an efficiency program can help reduce energy demand and the need for new energy capacity over the life of the project, improve building efficiency, begin coordinating design and construction to accommodate changes in technology and building function.

As the demand for electricity, costs, and materials rise over the next two decades, the building projects I previously mentioned have the foundation in place to utilize existing renewable technologies or incorporate technologies that have yet to be deployed. Such an advantage can save homeowners, building managers, or school districts precious time and resources. The existing applications of renewable technology, LEED-certified buildings are already paying off. Some case studies show solar panels with geothermal heating systems will lead to a 15 to 20 percent savings in energy costs with payback occurring two to five years earlier than anticipated.

So the long-term renewable technology options, however, hold great promise, but need more work. An energy storage solution, such as solar thermal heating or on and off-site stationary batteries can offer a significant savings for both the end users and generation of electricity. So this technology has been demonstrated in limited amounts that need more development before deployment on any broad scale.

While successful at policy, some renewable technologies still encounter other challenges that prevent more widespread implementation. State laws or outdated local statutes have not been updated to accommodate neighborhood planning or renewable energy site planning. So, in order to enjoy the fruits of renewable energy integration, we need to cultivate a culture of adoption for those technologies. So we're going to have some really interesting testimony today.

And, with that, I want to thank you all for being here this morning, and look forward to your testimony, to working with you to advance renewable energy integration in buildings when Congress returns to the energy issues in the coming year. I again thank the

Chairman for being here and for all his work on the Caucus, for all that has been accomplished and will be accomplished. I hand it back.

[The prepared statement of Mrs. Biggert follows:]

PREPARED STATEMENT OF REPRESENTATIVE JUDY BIGGERT

Thank you, Mr. Chairman. And, welcome to each of our witnesses. We appreciate your efforts to be here and participate in today's important hearing. I am also particularly pleased that my good friend and colleague, Russ Carnahan, is able to join me to chair today's hearing and kick off the festivities for the U.S. Green Building Council's annual International Conference and Expo.

As Russ just mentioned, we have the distinct honor of leading the most exciting Caucus in the House of Representatives. Known officially as the High Performance Building Caucus, we have hosted over fifty lunch briefings in the last two years on every subject important to the definition of a high performing building. So, today's hearing isn't just a twist in our usual caucus collaboration—it is another way to take our show on the road and raise awareness for the importance of high performance buildings.

No where is the concept of high performance buildings more important—and more evident—than right here in my own backyard. Chicago is home to many high performing building "firsts", like:

The Chicago Center for Green Technology, the first rehabilitated municipal **building** in the nation to achieve LEED Platinum status.

And, in 2007, the Exelon headquarters in Chase Tower became the largest office space to earn a LEED Platinum rating for Commercial Interiors.

Another great example—and one we will soon hear more about—is Bolingbrook High School, located in my suburban district. Bolingbrook High School is among the first of new construction LEED certified high schools in the nation.

So, what do these building project examples have in common—and how is renewable energy integration important to them?

These building projects have been constructed with a comprehensive building efficiency program. Once in place, an efficiency program can help reduce energy demand and the need for new energy capacity over the life of the project.

Improved building efficiency begins with a coordinated design and construction plan to accommodate changes in technology and building function. As the demand for electricity—and cost of materials—rise over the next two decades, the building projects I previously mentioned have the foundation in place to utilize existing renewable technologies, or incorporate technologies that have yet to be deployed. Such an advantage can save homeowners, building managers, or school districts precious time and resources.

Existing applications of renewable technologies in LEED certified buildings are already paying off. Some case studies using solar panels or geothermal heating systems report a fifteen to twenty percent savings in energy costs, with payback occurring two to five years earlier than anticipated.

Long-term renewable technology options, however, hold great promise but need more work. Energy storage solutions, such as solar thermal heating or, on and off-site stationary batteries can offer significant savings for both the end-users and generators of electricity. These technologies have been demonstrated in limited amounts and need more development before deployed on any broad scale.

While successful, or promising, some renewable technologies still encounter other challenges that prevent more widespread implementation. State laws or outdated local statutes have not been updated to accommodate neighborhood planning or renewable energy site planning. In order to enjoy the fruits of renewable energy integration, we need to cultivate a culture of adoption for those technologies.

With that, I would like to thank you all for being here this morning. I look forward to your testimony and to working with you to advance renewable energy integration in buildings when Congress returns to energy issues next year.

Mr. CARNAHAN. Thank you.

It's my pleasure, now, to introduce our panel. Really, we have a great, excellent, and accomplished, and diverse group that's here today, so we appreciate you being here. I want to start with Mr. Joseph Ostafi. He's the regional leader for Science and Technology Division and the group vice president for HOK, which is headquartered in my home city of St. Louis. Welcome.

Mr. OSTAFI. Thank you.

Mr. CARNAHAN. And, next, Mr. Daniel Cheifetz is the CEO for Indie Energy Systems Company. Welcome.

Next, Dr. Jeffrey Chamberlain. He is the department head of Electrochemical Energy Storage and the Energy Storage Maker Initiative Leader of the Chemical Services and Engineering Division at Argonne National Lab. That is one long title. Welcome.

And, next, Ms. Martha VanGeem. She is the Principal Engineer and Group Manager for Building Science and Sustainability at CTL Group.

And, for our last introduction, I want to recognize Congresswoman Biggert to introduce our last panelist.

Mrs. BIGGERT. Thank you, Mr. Chairman.

It is now my pleasure to introduce Michael Lopez, director of Facility Operations for Bolingbrook High School and the Valley View School District. Just a few weeks ago, I had the pleasure of touring the Bolingbrook High School with Mr. Lopez and Principal Mitchem. I think we had a very informative behind-the-scenes tour of the school building and its high-performing attributes. I'd like to point out that their use of water-condensed recovery system and the excellent implementation of day-lighting throughout the school is so impressive as sustainable solutions. Mr. Lopez has worked in the construction, academic, and architectural field, and is presently responsible for the comprehensive energy management of 20 schools in the Valley View School District.

So, welcome, Mr. Lopez.

Mr. CARNAHAN. Thank you.

Welcome all.

We will start with Mr. Ostafi. Pleased, and I want to recognize you. And, just to remind the witness, we'll recognize you for five minutes. Your full written testimony will be placed in the record, and we'll follow that up with questions from myself and Mrs. Biggert.

So, Mr. Ostafi.

STATEMENT OF JOSEPH OSTAFI IV, REGIONAL LEADER, SCIENCE AND TECHNOLOGY DIVISION, GROUP VICE PRESIDENT, HOK

Mr. OSTAFI. Thank you. Good morning. And I thank you, Chairman Carnahan and Congresswoman Biggert, for the opportunity to discuss innovations and opportunities for on-site renewable energy integration. I appreciate the opportunity to testify here today.

Architects, engineers, and planners are implicitly center stage in the design, construction, commissioning, and validation processes. We actively engage and coordinate with building owners and occupants, as well as operators and maintenance staff, to apply their goals to collectively forge environments which meet their current and future needs. We not only have the ability to influence the incorporation of a renewable energy system into the built environment, but also the social obligation to design high-performance buildings for today and net-zero buildings for the future.

Perhaps, surprisingly, one of the most frequent obstacles that impede integration of renewables into the built environment remains political and financial. Even though the federal government and many states have chosen to lead by example, there still remain many states and privately funded organizations which have fewer mandates and incentives to comply. Without continued and increasing governmental mandates and subsidies or drastic breakthroughs in efficiencies, the equation will remain lopsided. The clear solution in this case includes measures which make renewables more cost-competitive compared with traditional fossil-based energy sources. This could be eased by continued advancements in renewable manufacturing processes or through significant advancements of their efficiency. Until these technological advancements are in place, continued federal and state subsidies, as well as policy mandates which encourage their integration, shall remain in place.

On a more applied level, on-site renewable energy sources are ultimately directly tied into complex building and management systems. Real-time monitoring and optimization controls which constantly measure and communicate information from vast mechanical, electrical and information-based technology systems to its operators and users with the anticipation of aggregation will ultimately optimize performance results.

The environmental and energy modeling technologies available to the design community rarely can account for the human condition with accurate results. We find that with high-performance buildings, many incorporated renewable technologies do not perform the way they were intended to. To this end, additional applied research and better computational modeling tools could enhance our understanding of the physiological human needs and the complex interplay of measurement verification and control systems which ultimately moderate high-performing building outcomes.

Three additional areas, briefly, in which applied research could further enhance renewable integration and overall building performance include on-site renewable systems which specifically address dense urban environments, including solar wind and solar thermal. As the majority of commercial and office buildings are located in urban environments, it's difficult to repeatedly and reliably harness renewable energy sources on-site.

Secondly, most buildings and infrastructure do not run on DC power, which is the predominant output of renewables. Control systems, micro inverters, and meters need to better adopt to swing between DC and AC power voltages in a more efficient and real-time, cost-effective way. This, coupled with the ability to store solar energy, could drastically contribute to better all efficiency integration.

An importance is placed on natural daylight in the built environment today. Oftentimes, this increases the demand for glass facades while reducing the artificial interior lighting loads. Exterior glazing systems are traditionally the worst-performing elements in the building's exterior envelope system, and artificial light loads consume a significant amount of building energy load.

More research needs to address higher thermal-performing curtain wall systems, to include face change or self-regulating systems in which the ability to store heat when needed, reflect solar gain and glare when not, and are thermally resistant to harsh exterior temperatures, which can, in turn, ultimately mitigate energy use for interior lighting consumption. To this end, more reliable, qualitative research can be applied to interior renewable lighting concepts, such as solar fiberoptic systems, which use daylight and fiberoptic technology to naturally light spaces.

In summary, to take renewable energy technology integration to the next level, we must apply research which looks at each system as more than just a part of the whole.

We need multi-disciplinary research that applies optimization to renewables which can benefit the entire infrastructure of a building, a campus, and even a municipality. Finally, we need research with comprehensive and scaleable results which encompass all sciences, from political, economic, and behavioral to the core physical sciences and engineering.

Thank you for the opportunity to testify today.

Mr. CARNAHAN. Thank you, Mr. Ostafi.

[The prepared statement of Mr. Ostafi follows:]

PREPARED STATEMENT OF JOSEPH OSTAFI IV

Chairman Gordon and Members of the Committee, thank you for the invitation to discuss "Opportunities for Onsite Renewable Energy Integration." I appreciate the opportunity to testify today at this important hearing.

Many of you are probably aware that buildings account for 40% of energy use and emissions in the US. Without stepped-up renewable integration this trend is expected to outpace that of any sector. To curtail this, it is essential that buildings' energy use be significantly reduced. What I would like to outline today are significant challenges and obstacles which hinder the design community's ability to integrate innovative renewable energy technologies into the built environment.

Architects, engineers and planners are implicitly center stage in the design and building process. We actively engage and coordinate with building owners and occupants, as well as operations and maintenance staff to apply their goals to collectively forge environments which meet their current and future needs. At a minimum, compliance with building and energy codes is necessary, though the preference is to exceed those minimum standards. Buildings, as well as campuses and communities, are a dynamic interplay of complex cybernetic systems. It is through this interaction of society and technology that the ultimate outcome of how a building or environment performs is demonstrated. Often times, design consultants have not only the ability to influence the incorporation of renewable energy systems into the built environment, but also the social obligation to design high-performance buildings, ultimately reducing the demand the built environment has on our natural resources as well as our dependency on foreign resources. With that responsibility also comes accountability when buildings do not perform as originally intended.

At the onset of building design, the opportunities to produce "greener" buildings are rarely hindered by the ability to incorporate higher-performing technologies, but rather are often challenged by financial and political issues. Even when renewable energy systems are incorporated the positive net effect is sometimes compromised by the building location, user behavior, or by the overall building operational subsystems not effectively communicating amongst themselves and the occupants. All of these factors contribute to marginalize design intent and ultimately building performance. I would like to articulate those inherent issues and provide some insights into additional areas which could provide enhanced building performance benefits through further technological innovation and applied research.

Challenge: Financial/Political

One of the most obvious and frequent obstacles which impede the integration of renewables into the built environment remain political and financial. Though many States and the Federal government have chosen to lead by example, requiring new and renovated government buildings to meet stricter energy standards, there still remain many State and privately funded organizations which have fewer mandates and incentives to comply. As of September, 2010 there are seven US States which do not have simple energy standards or executive orders to develop or encourage high performing buildings beyond basic energy codes such as the 2004 or 2007 ASHRE 90.1. Likewise, only about half of the US States and Territories have tax credits, rebates, grants, or even local utility involvement to incentivize and offset the initial costs of incorporating renewable technologies. Even government-mandated policies like the *Federal Energy Management Plan* which is designed to encourage the use of on-site renewables on Federal projects, often establish conditional requirements tied to life-cycle cost analysis. Too often the first cost decisions outweigh simple payback durations which lead to short-sighted fiduciary decisions outweighing long-term performance issues.

Today, many renewable technologies including solar, wind, and solar thermal are much more expensive to utilize and employ than conventional fossil-based utility sources, and many current building project stakeholders are quickly overlooking the long-term benefit. Without governmental mandates or forms of continued subsidy the equation is lopsided. The clear solution in this case includes measures which make renewables more affordable and cost competitive compared with traditional energy sources at the outset of a buildings conceptualization. This imbalance could be eased by continued advancements in their manufacturing costs and overall efficiency of performance, and further reinforced by continued Federal and State subsidies, as well as policy mandates requiring their integration.

Challenge: Technology and the Inability to Predict Unpredictable Human Behavior

As Americans forge ahead in their quest for more sustainable built environments, there are fewer technical limitations when conceptualizing better performing buildings. Downstream from the design concepts and design intents are some of the technical challenges which do not allow them to operate or perform to their best ability. One of those challenges is related to the interface between people and technology; essentially the behavior of its occupants.

On-site renewable energy sources are ultimately directly tied into complex building management systems. As a result, a higher dependence is placed on integrated building management and energy systems technologies. Real-time monitoring and optimization controls are constantly measuring and communicating information from vast mechanical, electrical, and information-based technology systems of a building to its operators and users with the anticipation that they will produce highly optimized and reliable results. Unfortunately, the measurement science of predicting the outcome is lacking, and hardware and software compatibility of these components and systems are not designed to interact with themselves or the end users.

To this end, two areas which would have compounding benefits from increased research are enhanced computational environmental and energy modeling tools and more open sourced building management systems architecture. Environmental and energy modeling technologies rarely can account for the human condition; that is, how users really behave in their environments when complex indoor-outdoor and mixed-mode strategies interact with more capricious factors such as day-light, natural ventilation, and building occupancy utilization. For example, we can make predictions that might account for a building occupant opening a window to let in a breeze, but it would be difficult to determine very specifically when he/she might do that, under what temperature conditions, or that on the same day, someone else might have turned on all the lights on a building floor during daylight hours on a sunny day.

Challenge: Lack of Integration Among Building Modeling Systems

What furthers this lack of predictable modeling is a deficiency in the inability of complex heating, cooling, ventilation, IT, and electrical systems of effectively and efficiently interacting amongst themselves when factoring in the human condition. This whole building systems and occupant science could be enhanced by creating more open-source measurement and verification technologies which are designed to interact and predict with whole building systems complexities. And as we look toward achieving net zero milestones, these enhanced technology needs should also incorporate emissions measurements of their source energy.

From a more direct technological standpoint, some additional areas in which research could further enhance efficiencies and overall building performance include:

1. On-site renewable systems which specifically address dense urban environments including solar, wind, solar thermal

   As a majority of commercial and office buildings are located in urban environments often times it is difficult not only to harness renewable energy sources at the site, it is sometimes impossible to predict the long-term viability of its utilization on a site-by-site basis. Currently, most zoning regulations do not directly preserve solar access rights which would contribute to the implementation of renewables. Also, current efficiency rates of solar panel technology do not enable taller buildings with limited real estate foot prints enough space to utilize and implement on-site solar applications at ratio which has dramatic increases in energy performance.

2. Solar power

   Most buildings and their infrastructure do not run on DC power, which is the predominate output of renewables. Control systems, micro inverters, and meters need to better adapt to swing between DC and AC power voltages in a more efficient, real-time and cost effective way. Better efficiency of conversion and storage of solar energy, including DC to AC power inverters, could contribute toward better efficacy and integration with other building power needs and times of occupancy.

3. Daylighting, views and the curtain wall

   With the increased importance placed on day-light and views in built environments, often times this increases the demands for curtain wall systems (glass façade), the exterior glass system which are traditionally the worst performing elements in building envelop systems. More research needs to address higher performing curtain wall systems, even including phase change or self-regulating systems which have the ability to store solar heat when needed, reflect solar gain when not, and are more thermally resistant to harsh exterior environments which ultimately reduce energy and interior lighting consumption.

4. Supply side technologies

   Finally, we cannot look at renewable energy technologies exclusively from the demand side. On the supply side, water, is often overlooked as a renewable energy as well as a resource. Additional research and technological innovation which can safely and effectively reuse grey water into a buildings overall water demand needs could benefit from reduced off site municipal management demands by enabling on-site purification for non-potable or even ideally potable use.

While technology has been and will continue to be a critical component of the success of renewable energy integration, technical solutions alone are not sufficient to reach the goals of optimization which lie ahead of us. It is important to understand the complex relationship between technological sustainable development, the behavioral impacts of occupants and building owners, and the policy and financial costs of implementation; but more importantly, that future solutions must encompass the multitude of these challenges if we are to achieve optimal results.

Thank you again for the opportunity to testify today. I would be happy to answer any questions you may have.

BIOGRAPHY FOR JOSEPH OSTAFI IV

Mr. Ostafi has more than 14 years of architectural experience with science and technology focused clients for the clean energy, biotech, pharmaceutical, and light industrial research and development for both private and publicly funded entities. He currently serves as a managing principal and Vice President for HOK (Hellmuth, Obata + Kassabaum), a full service architecture, engineering and planning design firm headquartered in St. Louis, MO. As a regional leader of the architecture Science and Technology practice, his focus surrounds fully integrated thinking of design, planning, sustainability of research laboratories of all kinds for Federal, State, Higher education and corporate clients. The experience of serving this variety of clients in US and international markets has equipped him to work at the center of multidisciplinary teams and carry complex projects to a successful and timely completion. Joseph is a frequent speaker at various industry and technology conferences on topics related to alternative energy research and renewable energy design, planning and technology integration, including Tradeline, Labs21, CleanTech, and is a member of the AIA and USGBC.

Mr. CARNAHAN. Next, I want to recognize Mr. Lopez for five minutes.

STATEMENT OF MICHAEL LOPEZ, DIRECTOR OF FACILITY OPERATIONS, BOLINGBROOK HIGH SCHOOL, ROMEOVILLE, ILLINOIS

Mr. LOPEZ. Thank you. First, I want to thank Congresswoman Biggert for inviting me, and for Chairman Carnahan and this Committee allowing me the opportunity to provide testimony at this morning's hearing.

The perspective I would like to share with you today is the relevance and importance of integrating renewable energy systems on-site into our living environments and, in particular, the K through 12 segment of education. Sixty million people, 20 percent of our population, go to school each day as students, teachers, staff, or administrators. Collectively, they attend over 100,000 public and private schools throughout the country. These learners and educators spend a substantial amount of their daily lives interacting within a manmade environment, an environment that has a significant impact on their well-being, performance, and achievement.

More than just providing comfort and protection from inclement weather, these structures create a learning environment that can either support or detract from the mission of our educational system. The relevance of the renewable energy systems on-site for schools is significant in many respects. First, schools, represented as a market segment, are significant consumers of non-renewable energy; gas, electricity, and water. Leveraging this market has the potential to influence policy and decision-making at all levels. As an example, I mentioned in my written testimony recent legislation allowing school districts to provide energy consortiums for wind production. This is a direction that school districts have shown an interest in.

Secondly, reducing our reliance on non-renewable resource production and distribution can result in a reduction of capital investment needs for the utility providers. Utility companies currently are challenged to provide uninterrupted service during peak demands. As an example, our district currently participates in a voluntary load response program offered by our electric company, which is designed to curtail electric usage at peak times and reduce demand on the utility companies' transmission systems.

Thirdly, the reduction of school utility bill costs can result in redirecting funds into the classroom. In reference to this point, our school district spends $3.2 million annually on gas and electricity. This represents over 20 percent of our facility operation budget and almost two percent of our entire district budget. Like all school systems, we continue to be challenged by both budgets and taxpayers to find ways to reduce operation of costs in our district.

And, fourth, reducing our reliance on utility rates and ongoing rate increases, trying to reduce the tax impact on local communities. As utility costs increase over the long term, school districts, the largest taxing body in most communities, can realize budget reductions as they migrate towards renewable energy systems as the primary means of their energy sources.

These bullet points speak to the need for long-term vision regarding how we approach our reliance on energy sources, obviously, not just in our educational market, but all market segments. From the perspective of the educational market, I have witnessed the growing pledge by educational leaders to better understand and implement sustainability in school communities. As I discuss sustainability with my colleagues in various school districts and related industries, a common theme emerges: "Green is good." Our commitment to invest in technologies and systems that have a beneficial impact to our environment are evident in what we in the school industry have achieved to date.

I share with you in this testimony some positive green initiatives we have implemented in our school district. Collectively, they have produced significant financial savings and continue to reduce our usage of gas, electricity, and water. However, these initiatives continue to rely on the consumption of non-renewable resources. We are charged with continuing to optimize efficiencies in our building system and operations, but we recognize that, long term, we will begin to see diminishing returns on our investments into non-renewables.

In the case of our LEED-certified high school, which was designed in early 2000, the district explored opportunities for incorporating renewable energy systems, such as solar panels. However, the return on investment at first cost, as well as physical constraints, met us when incorporating this technology into the project. Our desire to continue to explore other renewable opportunities in current and future projects is encouraged by dialogue such as that in today's hearing. For example, renewable rate design concepts supplied large scale to demonstration of employment problems in the educational market can positively impact price points on the rate of technologies and systems.

The time for renewable resource wide-scale applications is no longer futuristic thinking. It is a technology knocking on our front doors. I would be remiss if I did not point out the myriad of other benefits that result in creating a long-term, green-schooled environment. There is substantial research that supports the correlation into the green schools, and improves student health, decreased absenteeism, improved student performance, and operating cost savings.

Additionally, evidence points to green schools increasing teacher retention, increasing property values, and, in general, providing a conduit for collaborative ventures within the community.

These benefits underscore the significance that the emerging green technologies play in our learning environments. We thought about what this Committee is charged with, and feel that your continued advocacy for renewable resource technology development and market deployment can have real impact for the 60 million children and adults that enter school buildings every day. Articulating the vision that would bring these technologies into the educational community demonstrates a commitment to our future generations.

I want to thank this Committee again for the opportunity to participate in this hearing. Thank you.

Mr. CARNAHAN. Thank you, Mr. Lopez.

[The prepared statement of Mr. Lopez follows:]

PREPARED STATEMENT OF MICHAEL LOPEZ

Sustainability is the balance of economic, environmental and social objectives in ways most likely to create long term value, without taxing the resources on which we depend.

This report discusses the implementation of a long range strategic initiative for sustainability in the secondary learning environment. In general, it focuses on the opportunities available for those in educational leadership positions to influence and shape policy and decision making at a local level, while relying on resources made available through a broad array of funding and R&D sources.

Three key components that define the success of a comprehensive initiative for sustainability include:

1. Educating decision makers and stakeholders on the relevance of sustainability.
2. Developing a strategic approach to creating healthy learning environments with available resources.
3. Defining a long range plan to reduce the dependency on non-renewable resources.

Educating decision makers and stakeholders on the relevance of sustainability

There are many factors that can impact the success (or failure) of a school district wide initiative, not the least of which is the means by which the message is communicated. Without the awareness and support of the senior leadership in a school organization, the program will not generate the impetus necessary to initiate the steps to succeed. In the case of sustainability, the factors to be communicated include an acknowledgment of *global impact*, *budgetary impact*, *impact to the learning environment*, and *educational opportunities in the classroom*.

The Global Impact of our decisions on how we build, renovate and operate facilities is tremendous: Buildings consume over 40 percent of the energy used in our country, and account for 38 percent of carbon emissions. 70 percent of electricity in the United States is consumed by buildings. As a nation, we use 5 billion gallons of water per day to flush toilets. The air pollution created from burning fossil fuels used to heat and generate electricity for buildings has an enormous negative impact on our health, environment and property. Recognizing the direct correlation between decisions we make at the local level (gas, electric and water consumption), and the global impact of these decisions, demands one to reflect on the value we can create through environmental stewardship. Our decisions relating to facilities in the school community share these consequences to the environment.

As reported in Kats' study (2006), a green school could lead to the following annual emission reductions per school:

- 1,200 pounds of nitrogen oxides, a principal component of smog.
- 1,300 pounds of sulfur dioxide, a principal cause of acid rain.
- 585,000 pounds of carbon dioxide, the principal greenhouse gas.
- 150 pounds of coarse particulate matter (PM10), a principal cause of respiratory illness and a contributor to smog.

By choosing to build, renovate and operate green schools, we assert our commitment to being conscientious leaders in our communities.

The *Budgetary Impact* to a school district on how they build, renovate and operate their facilities is equally impressive: The United States will see nearly $90 billion in K–12 school construction between 2010 and 2012, according to estimates by McGraw-Hill Construction, a leading national construction forecaster. Many school decision makers across the country will weigh the cost and value of implementing sustainable features in their projects. According to the Sustainable Buildings Industry Council (SBIC), school districts can save 30 to 40 percent on utility costs each year for new schools and 20 to 30 percent on renovated schools by applying sustainable, high performance design and construction concepts. Using less energy than conventionally designed schools, sustainable schools not only have lower utility bills, they also have the potential to lower market-wide energy costs by reducing demand (Kats, 2006). Additionally, the potential payback to the nation's power grid is enormous if schools invest in upgrading the energy performance of their new and existing facilities.

When considering implementing sustainable features in the design of new and renovated facilities, evidence suggests that there is a first cost premium to going green. This is the result of specifying higher quality materials and construction, and more efficient building systems. However, over time, these systems demonstrate a favorable return on investment, both in terms of healthier indoor environments and savings in energy and water. A 2006 study of 30 green schools nationwide showed that a 2 percent increase in first cost, about $3 per square foot, paid back $10 per square foot in energy and water savings over the course of the buildings' service lives (Kats, 2006).

Probably the most relevant information to communicate regarding sustainability in a learning institution is the *Impact to the Learning Environment*. A significant amount of research has been published correlating student performance and health benefits to the learning environment. Healthy schools have been shown to improve student focus, retention, and test scores; enhance teacher performance; and lower absenteeism among students and teachers.

Among these studies, a report published by Air Quality Sciences titled "Green, High Performance Schools" (2009) cites the following examples of school specific studies relating positive impacts from improving the indoor environment:

> "An analysis of two school districts in Illinois found that student attendance rose by 5 percent after incorporating cost-effective indoor air quality improvements" (Illinois Healthy Schools Campaign 2000).
>
> "A study of Chicago and Washington D.C. schools found that better school facilities can add three to four percentage points to a school's standardized test scores, even after controlling for demographic factors" (Schneider 2002).
>
> "A recent study of the cost and benefits of green schools for Washington State estimated a 15 percent reduction in absenteeism and a 5 percent increase in student test scores" (Paladino & Company 2005).

Many other studies supporting the positive correlation between student performance and the environmental condition of school facilities can be found in publications from the National Clearinghouse for Educational Facilities and the United States Green Building Council.

Incorporating *Educational Opportunities in the Classroom* can further underscore the relevance of sustainability; by integrating our sustainable strategies in an educational forum, we pass on our commitment to environmental stewardship to future generations. The important point to make here is that sustainable education needs to be an integral part of the curriculum, not an amendment to it. Teachers face a myriad of challenges educating students on a standard curriculum, on a daily basis; adding to their course load may not improve the overall learning experience of the students. So a successful approach should weave sustainable elements into a well balanced curriculum.

Developing a strategic approach to creating healthy learning environments with available resources

One of the greatest challenges facing school districts today is balancing diminishing financial resources with the operational needs to run the district. Staff salaries and benefits, curriculum, transportation, food service, and facility operations all compete for dwindling funds from taxing bodies. The challenge for many school districts has been to develop creative approaches to providing educational support services while trying to minimize the impact to the classroom. When it comes to facility management and other support services, making wise investments and decisions in the infrastructure and capital improvements helps the district mitigate its operational costs.

In the case of Valley View School District (in a collar county of Chicago), developing a comprehensive approach to energy and environmental management was key to alleviating the rising costs associated with the operation of an expanding school district. Faced with a growing population in the late 1990's, the district embarked on an extensive expansion program, resulting in the construction of several new schools and renovations to existing facilities. The construction of a new high school in early 2000 enabled the district to apply sustainable features to a flagship project for the district, resulting in the first LEED (Leadership in Energy and Environmental Design) certified school in Illinois, and the fourth certified high school in North America. Bolingbrook High School opened its doors to students in August 2004, and has served as a catalyst for subsequent sustainable development in the district.

In 2009, the school district gave definition to its sustainable program by terming it the Comprehensive Energy and Environmental Management Initiative (CEEMI). Through the CEEMI program, the district has developed a road map for implementing sustainable projects and initiatives that have resulted in substantial savings and improvements to the district.

The attached presentation has been used as a tool to share with various stakeholders and communities, the positive impact sustainable measures have had on the Valley View School District. [see attachment].

Defining a long range plan to reduce the dependency on non-renewable resources

The ultimate goal of a comprehensive energy and environmental management program should be to reduce the reliance on non-renewable energy sources. The aforementioned "strategic approach to creating healthy learning environments with available resources" is a viable measure to mitigate energy consumption, but as a long term permanent plan, it has its limitations. As indicated in a report to the 110th Congress, "economic and environmental concerns—namely energy security, international competitiveness, high energy prices, air pollution and climate change—are now driving policy proposals to support renewable energy R&D and market deployment".

Given the daily challenges school districts face in educating our children, it is difficult for school leaders to focus on long term strategic energy initiatives which rely on promising technologies, such as wind, solar and biomass. Nonetheless, as major consumers of energy in our country, school districts throughout the nation can have a positive influence in efforts to reduce reliance on non-renewable resources. The benefits that can be derived from leveraging the school communities' assets are tremendous:

- Reduction of carbon emissions on a national scale
- Reduction of capital investment needs for utility companies, by reducing the load on utility grids
- Reduction of school utility bill costs, which can redirect funds towards the classroom
- Reduction of need for local tax increases associated with utility costs for school systems

Many states have recognized the benefits of green design in public facilities by legislating new school construction to be LEED certified. Using this concept as momentum for long term planning, educational leaders should partner with current and future energy research programs that lead to innovative applications of renewable resources on a large scale. For example, Illinois recently passed legislation that allows school districts to form consortiums to build wind turbines to generate power off site, and receive credit from utility companies at current costs of electricity. Strategies such as this save taxpayers' dollars, preserve educational spending for the classroom, benefit the global environment, and demonstrate to children and families the importance of environmental stewardship. A continuation of this type of legislation, based on on-going research and development of emerging technologies, is vital to achieving long term initiatives in the school environment.

The opportunity for educational leaders to participate in the discussion and application of renewable energy technologies has immeasurable value, and will allow learning environments to share in a legacy of sustainability.

BIOGRAPHY FOR MICHAEL LOPEZ

Mr. Lopez is a licensed architect with 26 years experience in the design and construction of educational, institutional, commercial, and residential buildings. He graduated with a professional degree in Architecture from the University of Notre Dame in 1984, and has worked for several architectural and corporate firms over the course of his career. Additionally, he served as an adjunct instructor for Purdue University Calumet for several years, teaching courses in their Department of Construction Technology.

Prior to his current position, Mr. Lopez was a Senior Project Manager with Wight & Company, a multi-disciplined architectural and construction management firm. While at Wight, he was involved in the design and construction of Bolingbrook High School, the first LEED certified school in Illinois.

In 2008, he became Director of Facility Operations for Illinois' Valley View Community Unit School District, a district comprised of 20 schools from pre-kindergarten through 12th grade, with a student population of 18,000, and a staff of 2,500. Mr. Lopez is responsible for the school district's "Comprehensive Energy and Environmental Management Initiative", or CEEMI, a comprehensive approach for creating a sustainable environment for the district's 2.5 million square feet of facilities and 463 acres of green space.

Mr. Lopez is a member of the International Association of School Business Officials, a member of the United States Green Building Council, and a member of Rotary. He is a LEED (Leadership in Energy and Environmental Design) Accredited Professional. He is registered with the National Council of Architectural Registration Boards, and is licensed to practice architecture in Illinois, Indiana and Wisconsin.

Mr. Lopez is married to his wife of 25 years, and has three children, including one college graduate. He resides in Munster, Indiana.

Mr. CARNAHAN. I next want to recognize Mr. Cheifetz for five minutes.

STATEMENT OF DANIEL CHEIFETZ, CHIEF EXECUTIVE OFFICER, INDIE ENERGY SYSTEMS COMPANY, LLC

Mr. CHEIFETZ. Thank you. Good morning, Chairman Carnahan, Representative Biggert, staff, guests, other panelists. My name is Daniel Cheifetz. I'm the CEO of Indie Energy Systems Company. We're a leading developer of smart geothermal technology systems for heating and cooling buildings by integrating them with their on-site geothermal energy resource in a way that decreases the cost of adoption and radically increases energy efficiency. We are a private company headquartered in Evanston, Illinois. Forty percent of our staff is in R&D and engineering, while another 40 percent is in our high-tech geothermal energy field construction division.

I appreciate the opportunity to testify before you today on a subject that is important, hopeful, and exciting. How can we realistically integrate our built environment with on-site renewable energy? I hope that, in the written testimony, I've given enough detail for you. I'd like to summarize.

Our goal, as a company, is to develop technologies to change the price performance curve so that on-site renewables can become de facto standard in our built environment. We have created a set of technologies for on-site geothermal energy systems for buildings: building-ground simulation technology, a real-time data network for measurement and verification, smart servers that use real world, rich data for ongoing dynamic control and extreme energy optimization, and technology to lower the construction costs of geothermal energy fields while improving quality and feasibility.

We have focused on defining and improving the applications of on-site geothermal to national retail, multi-unit residential, educational, and corporate campuses, health care, and a number of other market segments, both new and retrofit, standalone, and district. Some of them perhaps you're familiar with. North Central College in Napierville. There's a Walgreen's that just opened in Oak Park, Illinois. There is a wonderful, senior, affordable, multi-unit facility in Pilsen, all of which are great examples of how geothermal can feasibly and practically be applied in a wide range of buildings.

They are replicated across the country. Each of these applications represents billions of square feet of buildings that will generate returns on investment of billions of dollars a year while creating thousands of jobs. This is an integrating technology since no one company can, or should, try to do this themselves. So we've created a technology that can be embedded in the practices and products and services of other organizations; architecture, engineering, construction firms, building automation systems, as well as national research initiatives.

While the technology can be applied domestically and can be exported internationally, one of the interesting things about geothermal as a renewable technology is that it must be built on site. Energy fields cannot be built somewhere else and shipped here; they need to be built where the buildings are. As we grow this industry, it cannot be outsourced or off-shored. Local workers will build local geothermal properties in their own communities.

To bring this about, we need applied R&D focused on delivering incremental breakthroughs in the short term. They would attract capital to projects and products, and have an almost immediate effect on job creation. One of the areas of this R&D that's really needed is in the construction of the geothermal energy field itself. Because no matter how much additional efficiency we can squeeze out of the system, and no matter how much we are able to reduce costs with hybrid systems and new materials, the physical construction of a geothermal energy field will remain the largest barrier to adoption, since that is where the greatest incremental cost is incurred.

The R&D required to produce semi-automated, high-speed production drilling equipment are based on, actually, things that already exist. It would be quickly amortized over the billions of dollars of value that they would generate. There's no doubt that this equipment will be developed and manufactured somewhere. Our question is, "Why can't we do it?" In a sense, that's the whole idea of our hope, amongst these panelists, and what we can do together. The foundation's been built. More work will be done by ourselves and other companies, but this is a great opportunity to pool our efforts and get some things done. Science is needed, for sure, but not rocket science.

Thank you very much for the opportunity to be here with you.

Mr. CARNAHAN. Thank you.

[The prepared statement of Mr. Cheifetz follows:]

PREPARED STATEMENT OF DANIEL CHEIFETZ

Good morning Chairman Carnahan, Ranking Member Biggert and Members of the Subcommittee, staff, and guests.

My name is Daniel Cheifetz. I am the CEO of Indie Energy Systems Company. Indie Energy is a leading developer of smart geothermal technology systems for heating and cooling buildings by integrating them with their on-site renewable geothermal energy resource in a way that decreases the cost of adoption while radically increasing energy efficiencies. We are a private company headquartered in Evanston, Illinois. Forty percent (40%) of our employees are in R&D and engineering, while 40% are in our high-tech energy field construction division.

I appreciate the opportunity to testify before you today on a subject that is important, hopeful, and exciting.

I have been asked to address four areas:

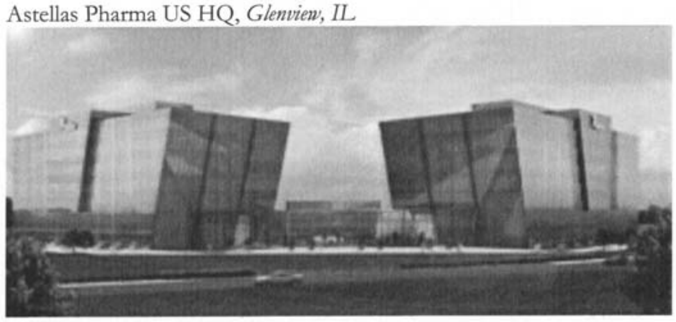
1. Examples of geothermal integration projects, including the demonstration project that was a recipient of a U.S. Department of Energy competitive funding award
2. The Smart Geothermal technology Indie Energy has developed to enable widespread adoption of geothermal-based heating and cooling systems for the built environment
3. The state of the market and the need for innovation

4. R&D recommendations for the Committee to consider related to the adoption of integrated geothermal systems in individual buildings as well as campus and district systems

Selected current projects

Walgreens' first Smart Geothermal store, *Oak Park, IL*

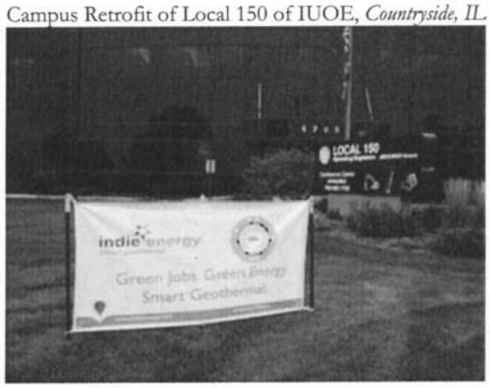
Astellas Pharma US HQ, *Glenview, IL*



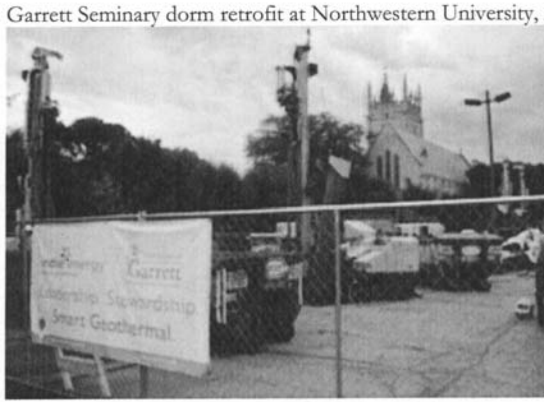
Medline Industries HQ Campus, *Mundelein, IL*

Selected current projects

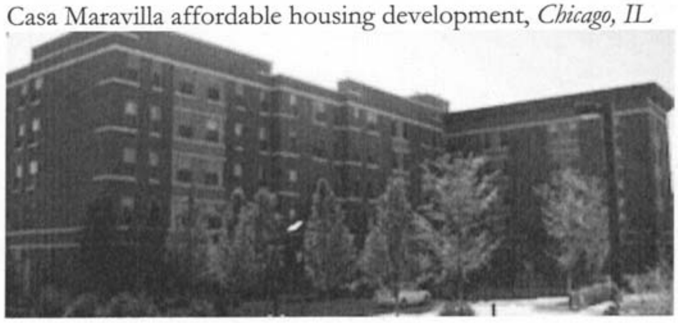
Campus Retrofit of Local 150 of IUOE, *Countryside, IL*



Garrett Seminary dorm retrofit at Northwestern University, *Evanston, IL*



Casa Maravilla affordable housing development, *Chicago, IL*

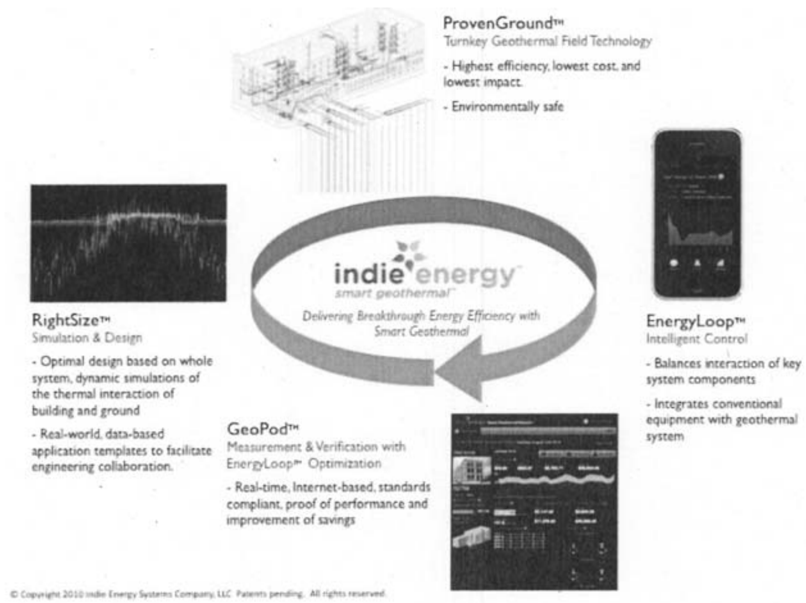


Smart Geothermal™ Technologies

The following breakthrough technologies have driven Indie Energy's market leadership in the Chicago metropolitan area:

1) RightSize™ energy field and hybrid mechanical system designs that deliver the lowest build cost with the highest energy efficiency.
2) ProvenGround™ turnkey energy fields utilize the Company's exclusive drilling technology, which provides a dramatically higher standard for quality, speed, and cost of construction.

3) GeoPod ™ measurement and verification systems monitor the Smart Geothermal system remotely, in real-time, and provide cost and carbon savings information, dashboard displays for owners and public, and maintenance alerts.
4) EnergyLoop ™ controls and adaptive optimization systems provide ongoing improvements in cost savings and energy efficiency by controlling the dynamic interactions between the building, ground and grid.



The Potential of Onsite Geothermal and the Need for Innovation

For decades, we have known a lot about geothermal for heating and cooling buildings.

We have known that geothermal energy exchange is an effective, renewable way to significantly reduce heating and cooling costs and greenhouse gas emissions.

We have known that anything that can be done with an HVAC/R (heating, ventilation, air conditioning, refrigeration) system can be done with a geothermal system—a mechanical system that couples the building with the ground.

We have known that geothermal-based heating and cooling has been successfully used in every climate, and in every building type. In fact, a DOE report at the end of 2008 stated that these systems ". . . use the only renewable energy resource that is available at every building's point of use, on-demand, that cannot be depleted (assuming proper design), and is potentially affordable in all 50 states."

However, what we know is not always consistent with what we do. Less than one-tenth of one percent of buildings make use of their onsite earth resource for heating and cooling. It is as if our rooms are still illuminated by kerosene lamps because we have not been able to deploy a technology for electric lighting.

This is due to technical, financial, and educational gaps. Innovation is the key to bridging those gaps, and Indie Energy's mission is to develop and deliver the technology innovations needed to enable a widespread transformation of our built environment to one much more healthy economically and environmentally through the use of smart geothermal technology systems.

Beyond First Generation Geothermal

Compared to conventional, first generation geothermal, Indie Energy Smart Geothermal ™ technology provides substantial economic benefits on two fronts: lower build cost, and radically higher operating efficiencies. Indie Energy has developed high-resolution state-of-the-art technology for understanding the dynamic thermal exchange between the building, its use, and the earth (the geothermal energy field).

This has allowed Indie Energy to develop and prove a range of innovative products and solutions for simulation, measurement, verification, control and optimization which are currently powering Indie Energy's turnkey systems and which can also be embedded by channel partners in third-party-built systems.

These innovative technologies enable extremely energy efficient geothermal heating and cooling systems whose performance can be proven. Even more importantly, these technologies overcome the most significant barrier to adoption [2]—the high first cost of the system with inadequate return on investment.

Indie Energy has proven its enabling, embeddable technologies for integrating onsite renewable geothermal energy in millions of square feet of commercial, public, and institutional geothermal building systems, both new and existing, in the Chicago metropolitan area.

A number of R&D initiatives have been undertaken:

Indie Energy has been awarded a $2.45 million matching competitive grant by DOE to demonstrate what the DOE called its "transformative technologies" at a retrofit of a 166,000 square foot, three-building campus. Some of the technologies demonstrated are a district system (in which one geothermal energy field is shared by three buildings), Indie Energy's GeoPod™ for real-time measurement and verification utilizing a moving baseline, and Indie Energy's Smart Geothermal Network™ and EnergyLoop™ Controls.

In order to help develop standards for smart geothermal system technology, Indie Energy has engaged the Oak Ridge National Laboratory to evaluate its GeoPod™ technology.

In order to assist in the development of shared research databases, Indie Energy is working with the National Renewable Energy Laboratory to make Indie Energy's Smart Geothermal Network™ available to researchers and projects nationwide.

In order to push the envelope in materials science to develop breakthroughs in thermal transfer and storage media, Indie Energy has entered into an R&D relationship with the University of Illinois at Chicago.

In order to advance the state of the art in geothermal energy field construction, Indie Energy has entered into a multi-year joint R&D agreement with GeaWelltech, the Swedish manufacturer of the specialized geothermal drilling equipment used by Indie Energy.

Is There a Market?

There is no well-defined onsite geothermal heating and cooling industry in 2010. Rather, it is a fragmented landscape populated by engineering and architecture firms, drillers, HVAC installers, and equipment manufacturers with occasional ESCO and utility companies making appearances.

There are many data points and trend lines that point to the possible emergence of an industry that could drive large scale growth of an onsite geothermal industry for renewable heating and cooling:

In 2005 the geothermal heat pump market was a $2.5 billion industry [1] in the United States. Since then, there has been significant growth driven in large part by rising energy costs, policy changes for greenhouse gas curtailment, and federal tax incentives passed in the American Recovery and Reinvestment Act. Manufacturers of geothermal heat pumps shipped 36,439 units in the U.S. in 2003, and 63,683 units in 2006. Data posted in 2005 show more than 600,000 geothermal heat pumps in operation in the U.S. alone.

A market report published by the U.S. Department of Energy in 2008 suggests that geothermal technology for heating and cooling buildings could become a major contributor to the national energy policy movement, with the potential to save $38 billion annually in energy costs [2]. The report identifies key technologies required for this to take place. (These are the technologies that Indie Energy has developed and proven.)

The City of Chicago Climate Action Plan has recently (September 2010) published recommendations of the Environmental Law and Policy Center's Clean and Renewable Energy Working Group [3] that the City undertake geothermal projects for one hundred million square feet of existing buildings over the next ten years to reduce 0.271 million metric tons of greenhouse gases. While Indie Energy discounts these figures in its own projections of near-term market size, they suggest that the poten-

[1] Galst, Liz, NY Times, *With Energy in Focus, Heat Pumps Win Fans*, August 13, 2008

[2] Hughes, Patrick, Oak Ridge National Laboratory, *Geothermal (Ground-Source) Heat Pumps:Market Status, Barriers to Adoption, and Actions to Overcome Barriers*, December, 2008

[3] *http://elpc.org/2010/10/19/report-of-the-clean-and-renewable-energy-working-group-released*

tial market in the top ten metropolitan areas in the U.S. is approximately $4 billion for its Smart Geothermal™ technology alone.

A Way Forward through Applied R&D

I come out of the software industry. We bet our futures on exponentially accelerating price performance ratios. We saw the power of DARPA and the resultant Internet. It's the technology wave my company rode, and if you have ridden a wave like that, you get to feel its characteristics in your bones. Renewable energy and clean technology is such a wave.

As Ray Kurzweil has pointed out in his *Law of Accelerating Returns*, ". . . technology, particularly the pace of technological change, advances (at least) exponentially, not linearly, and has been doing so since the advent of technology, indeed since the advent of evolution on Earth." And that rate of exponential growth itself grows exponentially.

About half of the growth in the U.S. GDP since World War II is related to the development and adoption of new technologies. That fact has not been lost on the rest of the world. So, it's not a question of whether there will be technological change in onsite renewable energy technology, or even when it will start. It has started in earnest in many places around the world that are starting to ride up the exponential innovation curve. The only question is whether we in the U.S. will participate before the curve gets too steep for us to earn our place as technology pioneers once again.

In addition to longer term, very high dollar "pure" research, we can achieve exponential improvements with a combination of additive steps as long as we think and design with a whole systems approach, and as long as we are not driven so much by the competition of others as by the prospect of a competing, unhappy, alternate future.

To bring this about we need a significant portion of our nation's R&D to be applied R&D, focused on delivering incremental breakthroughs in the short term. These are breakthroughs that could be market-ready Of not "shovel-ready") and quickly move into the supply chain. They would attract capital to products and projects and have an almost immediate effect on job creation.

Here are some of the things that are opportunities for onsite renewable energy integration:

We would like to see low-grade-heat combined heat and power engines that we can plug into our systems to make them more energy efficient and the grid smarter.

We would like to see variable speed compressors; better heat exchangers; and low temperature (140F and below) heating systems standards so that systems can be incrementally more efficient and feasible for demanding applications.

We expect more—in fact we are planning on seeing more—in-building wireless sensor and actuator networks from companies such as EnOcean so that we can implement more affordable systems and healthier, more productive, ground-coupled buildings.

Even relatively simple things like infrared smarter "thermostats" that can measure more than just dry bulb temperature would help us and our engineering and architecture partners create more comfortable and efficient micro zones in buildings that we could then interactively balance with all the other energy flows in the building and between the building and ground.

All these things will further enrich our building/energy simulation technology, populate our Smart Geothermal Network with real-time data for measurement and verification while providing our EnergyLoop™ Engine with rich data for ongoing dynamic control and extreme energy optimization.

Additional investments need to be made in technology to lower the construction cost of geothermal energy fields while improving quality. No matter how much additional efficiency we can squeeze out of a system, and no matter how much we are able to reduce costs with hybrid designs and new materials, the physical construction of the geothermal energy field will remain the largest barrier to adoption since that is where the greatest incremental cost is incurred. It is indicative of the underdeveloped state of onsite geothermal that almost without exception the equipment (drill rigs and compressors) used to construct the geothermal energy field has not seen a significant technological breakthrough. The R&D required to produce semiautomated high-speed production drilling equipment would be quickly amortized over the billions of dollars of value that they would generate. There is no doubt that this equipment will be developed and manufactured somewhere. Why not here?

Wherefore Art We?

It is not clear at this point if onsite renewable energy for buildings has found its real home in Washington D.C.. ARPA–E is a terrific new entity, but it may be more oriented to the "pure and big" than the "small, distributed, and now". Onsite geothermal has had an identity crisis vis-à-vis geothermal power, but it is not clear how well its relocation to the Office of Energy Efficiency and Renewable Energy's (EERE) Building Technologies Program is working. Wherever the program ends up, it should lose the "Geothermal Heat Pump Program" tag. As instrumental as some of the equipment manufacturers have been in getting incentives for "GHP systems", developing a real science and industry to integrate buildings with onsite renewable geothermal energy will not get the support it needs if it continues to be thought of as a collection of "heat pumps", "wells", and "loops".

Conclusion

It used to take twenty years for a new technology to really become ubiquitous. We don't have twenty years for this new technology to become the standard for how we build our new buildings and fix our existing ones. Fortunately, this is not the kind of disruptive innovation that requires a whole new delivery mechanism, or the unseating of historical incumbents. This new energy infrastructure plugs into almost all the engineering, architectural, and construction channels that exist. These are channels that are actually motivated by, and have a hunger for, breakthroughs that can be effectively and pragmatically designed and delivered to their clients with lower risk than the status quo. This is not a technology where we have to create the need in order to build demand. The need is recognized, and there is a huge pent-up demand.

Indie Energy has created a set of technologies that enable the widespread adoption of onsite geothermal renewable energy systems for buildings. It is an embeddable technology that can work with the offerings and practices of engineering and architectural firms. In fact, that kind of collaboration is how many of our projects came about in the Chicago area. While the technology can travel, geothermal energy fields must be built onsite, where the buildings are—they cannot be built somewhere else and then shipped here. As we grow this industry, it cannot be outsourced or off-shored. Local workers will build local geothermal properties in their own communities. It will take a number of decades for us to fix our existing building stock; by then, we will be building new buildings again, and the standard for their mechanical systems will be based on onsite renewable smart geothermal.

Thank you very much for the opportunity to be with you here today.

BIOGRAPHY FOR DANIEL CHEIFETZ

Daniel Cheifetz, *CEO and Founder, Indie Energy Systems Company*

Mr. Cheifetz is an experienced technology entrepreneur, whose achievements include a leadership role in the successful IPO of Open Text (Nasdaq: OTEX) in 1996. With more than 30 years of executive leadership in technology companies, he brings an extensive track record to the growing clean energy industry.

Experience

Indie Energy Systems Company, CEO 2006–present
Open Text (OTEX), Exec. VP, Development, Board member
Odesta Systems Corporation, Founder and CEO

Education

Grinnell College, BA

Mr. CARNAHAN. And next, Dr. Chamberlain.

STATEMENT OF JEFFREY P. CHAMBERLAIN, DEPARTMENT HEAD, ELECTROCHEMICAL ENERGY STORAGE RESEARCH, ENERGY STORAGE INITIATIVE LEADER, CHEMICAL SCIENCES AND ENGINEERING DIVISION, ARGONNE NATIONAL LABORATORY

Dr. CHAMBERLAIN. Thanks. Good morning, Chairman Carnahan, Congresswoman Biggert, and Committee staff. My name's Jeff Chamberlain. I am the Department Head for Electrochemical Energy Storage and Energy Storage major initiative leader at Argonne National Laboratory. I have a Ph.D. in physical chemistry from the Georgia Institute of Technology. And, before I came to Argonne, I worked as a researcher, developing products for private industry at Cabot Microelectronics, now Oak Chemical, and Angus Chemical Company, now owned by the Dow Chemical Company.

I'm honored to be here to talk with you today about the need for energy storage technology for renewable energy systems for on-site generation, both for individual buildings and small community-based systems. Thank you for inviting me to this hearing to offer my testimony. Thank you, also, for holding this particular hearing. The questions you are asking are critically important. A portfolio of renewable energy balanced with nuclear and coal-generated power, combined with the electrification of the U.S. vehicle fleet, will ultimately enable a new era of energy security for the citizens of the United States, as well as have an enormous impact on America's economic prosperity and our environment.

I'll first answer your query directly now, then supply some more background with the remainder of my time. There is, indeed, a gap in the research portfolio in the U.S. and the need for energy storage technology for on-site renewable energy generation. This gap could be filled by a coordinated research effort across the national labs, and connected directly to industry. The research that is being performed in the U.S. and around the world for this application is essentially aimed at testing existing technologies that were developed for other applications. Specifically, for example, batteries that are used in automobiles may be repurposed, at the end of their useful life, for transportation as stationary batteries.

The second example is that modules from large, megawatt systems that are being developed with a grid are also being tested for the smaller scale applications in question. But it is vital to perform research to develop technology directly for a given application. For example, small, light-weight, lithium ion batteries have been developed for portable application, such as for cars and electronics. While the implications and technology needs for the stationary systems are different, size and weight are not nearly as important for stationary applications. Here, efficiency, durability, and cost are the main drivers.

Some energy storage solutions for stationary applications include large tanks of chemicals, called flow batteries, where we see the pumping of entire lakes where the water inclines for later electricity generation as it is passed, using gravity, through a turbine. The point is, not all energy storage technologies are the same, and it is not sufficient to hope that a technology developed for one application might fill the need of another.

Right now, the U.S. is a world leader in developing energy storage technologies for vehicles, thanks to our investment in energy technology research at the Department of Energy's national laboratories. At Argonne, Lawrence Berkley, and other national labs, we invent new materials using both theory and experiment scaled at their useful level, put them in battery cells, and test them. The battery technologies developed at Argonne are being used by industry to power electric cars that will soon be on the road. BASF, Toyota America, and the Silicon Valley start-up Columbia systems are already basing to commercialized materials developed at Argonne.

Looking forward, we expect our technology to power millions of cars in the coming years, and expect our continuing research to bring down the price of those cars while increasing their range in power. However, the United States has not made the same continued investment in larger battery technologies intended for both grid scale and on-site stationary applications. We do perform world-class research developing systems that generate electricity from wind and solar sources, but we do not currently have the technology to save that electricity to light, heat, and cool the buildings at the times when the wind doesn't blow and the sun doesn't shine.

The work we've done on transportation scale batteries is useful in creating larger energy-scaled storage systems, to a point. We're working to validate battery technologies that have been developed for other applications. For example, car batteries that reach the end of their useful life in a vehicle might still be useful for stationary applications. But that approach, although it may yield some useful results, is not as effective as full-scale research and development addressed in energy storage as a whole, from cell phone batteries all the way up to grid storage.

Right now, we have real gaps in our storage research portfolio, and we cannot fill those gaps without large-scale, long-term, well-funded, and well-coordinated research programs that bring together the best and most innovative scientists and engineers in academia, industry, and the national laboratories. The good news is that, at present, no other countries have succeeded in creating large-scale energy storage technology. Japan, Korea, and China are ahead of the U.S. in developing large, coordinated R&D efforts to address the stationary energy storage need. Even so, we have a real opportunity to take international leadership in this field, which has been identified as a $200 billion opportunity, as I noted in my written testimony. But we must act swiftly and efficiently to create a nationwide, fully coordinated effort to address energy storage at every level, with a portfolio that's balanced across need and across laboratories and universities, and coordinated with industry. And the funding for this research must reflect the scope of our mission and the potential value of this technology to our national security, our economic future, and our environment.

Lastly, we already have a model of success through DOE's Vehicle Technologies Program and EERE. A variety of research projects have been funded across the laboratory complex and coordinated with industry in a way that is resulting in commercialization of enabling storage technology for transportation applications. A comparable program can be and should be developed throughout the Department of Energy, with a focus on stationary energy storage systems. The seeds for such an effort are already coordinated through the Office of Electricity Delivery and Energy Reliability. Ultimately, success will require fully funded, long-term, national vision of a fully integrated system at every scale.

I'd be pleased to answer any questions from the Committee. Again, thank you.

Mr. CARNAHAN. Thank you, Doctor.

[The prepared statement of Dr. Chamberlain follows:]

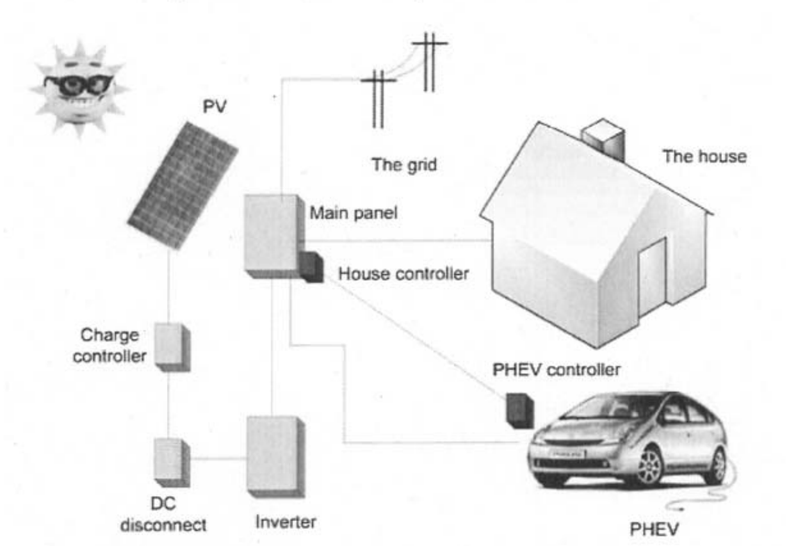
PREPARED STATEMENT OF JEFFREY P. CHAMBERLAIN

It is widely recognized that the continued and increasing reliance on fossil fuels by the citizens, businesses, and government organizations in the U.S. is not sustainable over the long term. One concept that is gaining popularity among scientists and engineers, businessmen, and policymakers is that of integrating renewable energy generation into a distributed use model, in which sun and wind energy is converted into electricity and used locally, at scales from individual buildings up to and including communities that include both buildings for residential and business or government use.

There are a wide variety of technologies and business models that are being considered to enable the adoption of an integrated, on-site energy generation and use model. Energy must be harnessed, either by solar cells and arrays, or by wind turbines, and then either inverted from DC to AC for immediate use, or stored for later inversion and use. "Smart grid" technologies are also capable of being used to ensure efficient use of energy, and the individual buildings and communities must still be integrated effectively into the larger regional grid. Although there are significant complexities regarding the integration of the various required technologies, the attractive prospect of reducing overall energy consumption as well as significantly reducing the consumption of fossil fuels is driving both policy makers and businesses around the world to carefully examine and develop both the technologies and the business models needed to make on-site renewable energy generation and use a reality.

Below is a simple diagram (figure 1), illustrating the essence of a Cornell project, "CU Green," (*http://www.news.cornell.edu/stories/May08/cugreen.hawaii.aj.html*) developed for an experimental setup in Hawaii in June 2008. Even in this simplistic illustration, one can see the importance both for new technology development, as well as the importance of integrating the technologies across the system.

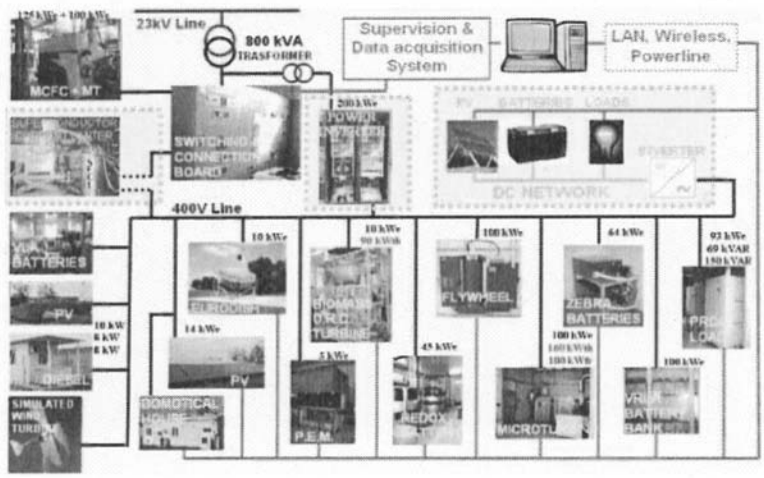
Figure 1. CU Green, by Cornell, in Hawaii



This testimony focuses on one aspect of the variety of technologies needed to enable the adoption of on-site renewable energy integration: **Energy Storage**. In figure 1, outside of the battery in the PHEV, there is a notable lack of energy storage listed as a requirement for this microgrid environment. Taken from the European Union Microgrid Project, figure 2, below, shows in great detail the complexity and variety of energy storage technologies that can be used in on-site renewable energy generation. Note the wind and solar indicators in the lower left-hand corner, and how the energy can flow into various storage devices for end use. Of course, no single system will have this great number of energy storage devices, but this particular

European project was set up to test the various technologies available on the market today.

Figure 2. August 6, 2010, EU Microgrid Project (http://www.microgrids.eu/index.php?page=index)



The role of Energy Storage in on-site renewable energy generation.

At its essence, the main role of energy storage in on-site renewable energy generation is to mitigate the intermittent nature of electricity generated by conversion of sun or wind energy. Power generated by coal-burning or nuclear plants is ramped up and down according to consumer demand. Such is not the case for either wind or solar energy conversion, and, in the case of on-site renewable energy generation without the ability to store energy, the consumer would be left only having useful electricity when there is either substantial wind or sun to convert to electricity. When an effective energy storage technology is integrated into the on-site generation system, electricity generated by the solar or wind conversion can be stored and used when the demands warrants its use.

As storage technologies are adopted for on-site renewable generation, they will be used for other applications as well, thereby increasing the total value of both the investment into the systems' development and the value of the systems themselves. Energy storage systems that will be of use to the microgrid application can also be used for grid load management and as back-up power supplies for communities. If integrated to the grid properly, utilities will be able to use battery systems to store electricity generated during off-peak periods to supplement demand during high-peak usage. Likewise, such energy storage systems can also be used during power outages or during natural disasters to supply electricity when grid operation is interrupted.

The table in figure 3, below, shows in detail the relative value of storage technologies in grid applications. This table is from an article by John Peterson, of Alt Energy Stocks, entitled "Grid-Based Energy Storage; a $200B Opportunity." Peterson's estimates are based in great part on the 2010 Sandia report, entitled "Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide; a Study for the DOE Energy Storage Systems Program," by Jim Eyer and Garth Corey, of Sandia.

Figure 3: projected capacity, benefit, and economic value of grid storage

#	Benefit Type	Discharge Duration* Low	Discharge Duration* High	Capacity (Power: kW, MW) Low	Capacity (Power: kW, MW) High	Benefit ($/kW)** Low	Benefit ($/kW)** High	Potential (MW, 10 Years) CA	Potential (MW, 10 Years) U.S.	Economy ($Million)† CA	Economy ($Million)† U.S.
1	Electric Energy Time-shift	2	8	1 MW	500 MW	400	700	1,445	18,417	795	10,129
2	Electric Supply Capacity	4	6	1 MW	500 MW	359	710	1,445	18,417	772	9,838
3	Load Following	2	4	1 MW	500 MW	600	1,000	2,889	36,834	2,312	29,467
4	Area Regulation	15 min.	30 min.	1 MW	40 MW	785	2,010	80	1,012	112	1,415
5	Electric Supply Reserve Capacity	1	2	1 MW	500 MW	57	225	636	5,986	90	844
6	Voltage Support	15 min.	1	1 MW	10 MW	400		722	9,209	433	5,525
7	Transmission Support	2 sec.	5 sec.	10 MW	100 MW	192		1,084	13,813	208	2,646
8	Transmission Congestion Relief	3	6	1 MW	100 MW	31	141	2,889	36,834	248	3,168
9.1	T&D Upgrade Deferral 50th percentile††	3	6	250 kW	5 MW	481	687	386	4,986	226	2,912
9.2	T&D Upgrade Deferral 90th percentile††	3	6	250 kW	2 MW	759	1,079	77	997	71	916
10	Substation On-site Power	8	16	1.5 kW	5 kW	1,800	3,000	20	250	47	600
11	Time-of-use Energy Cost Management	4	6	1 kW	1 MW	1,226		5,038	64,228	6,177	78,743
12	Demand Charge Management	5	11	50 kW	10 MW	582		2,519	32,111	1,466	18,695
13	Electric Service Reliability	5 min.	1	0.2 kW	10 MW	359	978	722	9,209	483	6,154
14	Electric Service Power Quality	10 sec.	1 min.	0.2 kW	10 MW	359	978	722	9,209	483	6,154
15	Renewables Energy Time-shift	3	5	1 kW	500 MW	233	389	2,889	36,834	899	11,455
16	Renewables Capacity Firming	2	4	1 kW	500 MW	709	915	2,889	36,834	2,346	29,909
17.1	Wind Generation Grid Integration, Short Duration	10 sec.	15 min.	0.2 kW	500 MW	500	1,000	181	2,302	135	1,727
17.2	Wind Generation Grid Integration, Long Duration	1	6	0.2 kW	500 MW	100	782	1,445	18,417	637	8,122

*Hours unless indicated otherwise. min = minutes. sec = seconds.
**Lifecycle, 10 years, 2.5% escalation, 10.0% discount rate.
†Based on potential (MW, 10 years) times average of low and high benefit ($/kW).
†† Benefit for one year. However, storage could be used at more than one location at different times for similar benefits.

The information presented in the table, and the extensive study by Eyer and Corey, show both the tremendous economic value of storage for the grid, and the wide array of valuable applications in the grid. The salient take-home points of the information in figure 3 are:

1) assuming adoption of energy storage technology onto the future grid, the economic value of such technology is over $200B
2) the value of storage technology for on-site renewable generation (contained in rows 15, 16, and 17) are relatively modest, but still in the billions of dollars
3) most research in the area of storage for the grid focuses on on-grid applications, not off-grid (or tangent-grid) applications as would be the case for storage for on-site renewable energy generation.

Energy Storage R&D for transportation applications: useful for the grid?

As the automotive industry moves from purely internal combustion propulsion to hybrid-electric, plug-in hybrid electric, and pure electric vehicles, businesses are commercializing new battery technologies that go beyond the standard lead-acid technology used by consumers today. OEMs have successfully integrated nickel-metal hydride (NiMH) battery systems into HEVs (e.g. Toyota Prius or Ford Escape Hybrid), and are beginning to integrate lithium ion batteries into some HEV applications as well (e.g. Johnson Controls-Saft lithium ion batteries for Mercedes' S400 hybrid). For PHEV and EV applications, OEMs are adopting a wide variety of lithium ion battery technologies. Notable and timely examples include the Chevy Volt and the Nissan Leaf, both of which are entering the market at the end of 2010. Both cars contain advanced lithium ion battery packs for propulsion.

Research at the DOE National Laboratories, and around the world, is ongoing in a race to develop the best performing lithium ion battery technology, to enable full penetration of PHEV and EV automobiles into the consumer market by decreasing cost and improving the performance of the battery systems, in terms of how much energy can be safely stored and retrieved in a given battery.

For over 40 years, Argonne has been a leader in performing research into electrochemical energy storage systems. Notably, this research has focused in the last 10–14 years on lithium ion battery systems, including basic materials research and development, systems and cost modeling, diagnostics of materials and systems, and performance testing of electrochemical cells and complete systems. Argonne also evaluates the performance of hybrid electric systems in vehicles as a complete system.

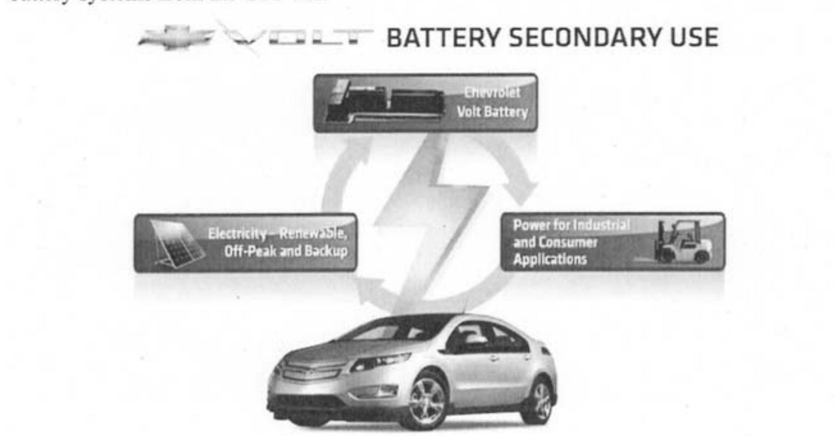
DOE's battery research programs managed by the Office of Vehicle Technologies in EERE span multiple national laboratories as well as universities and industry. Through DOE's programs, Argonne works in concert with Lawrence Berkeley National Laboratory, Sandia National Laboratory, Idaho National Laboratory, Brookhaven National Laboratory, the National Renewable Energy Laboratory, and Oak Ridge National Laboratory, as well as the Army Research Laboratory, NASA, and the Jet Propulsion Laboratory. Likewise, the National Laboratories involved in DOE's battery research programs interact directly with industry, from materials suppliers like Dow Chemical, DuPont, 3M and BASF, to battery manufacturers such as Johnson Controls, A123 and Ener1, to the OEMs (GM, Ford, Chrysler), through the U.S. Advanced Battery Consortium (USABC).

The work performed by the group above has a primary focus on developing and testing new materials for advanced battery systems for use in transportation applications. Separately, DOE, though the Office of Electricity, has a variety of funded programs focused on enabling known technologies for use in a variety of stationary applications, mostly at megawatt scale.

Many businesses are now working to determine the technical and financial potential for aftermarket use of these large car batteries, particularly for grid storage. The concept is that, 1) at the end of useful life in an automobile, a lithium ion battery still has the capability of storing energy, but not in a useful way for automobile propulsion, and 2) by extracting further value from the expensive battery system (currently between $5000 and $15,000), the upfront cost of the battery system can be offset, and in a way subsidized by the extraction of value at the end of its useful life in a car.

A pertinent example (figure 4) of such an effort is being made by General Motors. GM has recently signed a Memorandum of Understanding with ABB Group, a Swiss-Swedish consortium, to investigate and quantify the value of a "used" Chevy Volt battery system for application on the grid (Energy Matters, September 22, 2010).

Figure 4: GM will work with ABB group to determine the most beneficial way to re-use battery systems from the GM Volt



This serves merely as one example of how the automotive and battery industries are rapidly moving to determine if their automotive batteries can cross over for effective use in grid applications. In the U.S., A123 Systems (an MIT startup), Johnson Controls (world's largest battery maker), and Ener1 (an Indianapolis battery maker) are all working quickly to adapt their battery technologies either for direct use on the grid, or for after-market use, when the effective life in an automobile ends. Outside the U.S., Panasonic-Sanyo, GS Yuasa, and NEC in Japan, and LG Chem, Samsung, and SK in Korea, as well as Lishen and ATL in China are all working quickly toward adapting their vehicle-use batteries for grid application.

In all likelihood, advanced batteries intended originally for use in automotive applications will have use and value in grid applications, including for individual buildings. However, this current focus by advance battery manufacturers and OEMs exposes the primary weakness in the U.S.'s R&D portfolio aimed at filling the energy storage need for on-site renewable electricity generation: the PHEV and EV battery systems were developed specifically for transportation applications, where a primary driver in the technology development is energy density, both gravimetric and volumetric. Batteries for electric cars must be as lightweight and small as possible. However, for on-site, stationary applications, the size and weight of the battery system is of significantly less importance. Instead, efficiency and cost are the primary drivers for stationary applications.

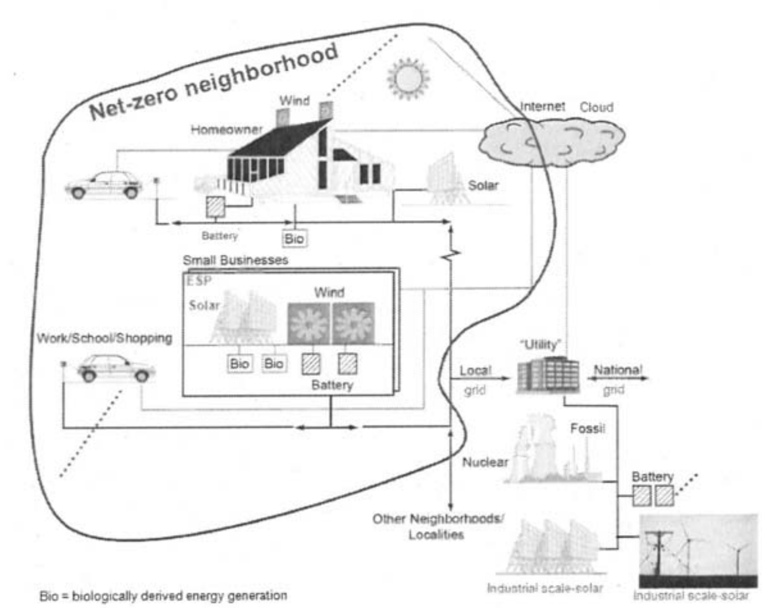
Energy Storage research for stationary applications is primarily focused on demonstration projects

As the U.S. endeavors toward net-zero communities, including on-site renewable energy generation and energy storage, the question arises: what is the best technology for storing energy locally, for individual buildings or small communities?

To answer this question, DOE's Office of Energy Efficiency and Renewable Energy and DOE's Office of Electricity have sponsored multiple projects across the laboratory complex and directly with industry. For example, as a result of Energy Independence and Security Act of 2007, DOE formed the National Laboratory Collaborative on Building Technologies, in which Argonne, Lawrence Berkeley, NREL, Oak Ridge, and Pacific Northwest National Laboratory are to work together on building efficiency improvements, including investigating energy storage as part of the answer. A more direct example is the case in which DOE has funded American Electric Power in Ohio, to install at test a 25-kW lithium ion "neighborhood" battery to reduce strain on the grid during peak load demands. Likewise NEDO in Japan has sponsored similar demonstration projects that utilize known lithium ion and flow battery technologies for microgrid applications. Separately, DOE's Office of Electricity actively participates in the international cooperation known as Energy Conservation through Energy Storage, or ECES. European, North American, and Asian governmental offices participate in the activity.

Figure 5 below (Gil Weigand, Oak Ridge, in Green Car Congress, May 5, 2010) illustrates how on-site renewables generation will fit into an overall net-zero neighborhood architecture. Note that there are several places and needs for energy storage technology. One technology alone will not fill each of these needs.

Figure 5: Net-zero neighborhood as part of a larger grid



In every example project described above, the primary objective seems to be to determine whether a known technology can be utilized for grid and microgrid applications. Technologies being tested and validated include lithium ion, lead acid, sodium sulfur thermal systems, pumped hydro, flywheel, ultra capacitor, sodium metal halide, and flow batteries. Until very recently, the primary focus around the world in energy storage for stationary applications has been an attempt to apply or adapt known energy storage technologies for these emerging applications. During the last several years, efforts have begun, to enable fundamental research on new materials and systems aimed specifically for use in stationary applications. These efforts are relatively small; this is where the largest gap exists that would prevent the most effective adoption of storage technology for on-site renewable energy generation.

DOE's Office of Electricity has begun to fund small materials research projects at Sandia National Laboratory and Pacific Northwest National Laboratory, and DOE's ARPA–E has funded over 10 new high-risk, high-reward materials-based projects aimed specifically at stationary storage applications. One example is 24M technologies, a spin-out from A123, with Professor Yet-Ming Chiang, MIT, as a founding partner. This project aims to develop entire new battery systems for both transportation and grid applications, starting from fundamentally new developments in materials physics and chemistry.

Coordinated Research and Development can address the existing gap

The opportunity before us today is to perform groundbreaking research to develop innovative, efficient, and low-cost energy storage technologies that will enable the most effective use of on-site renewables generation. The clear gap in our research in the U.S., and even across the globe, is that almost all materials research has been aimed either at transportation applications, or at megawatt-sized stationary applications.

State of research in U.S. for stationary storage for buildings and small communities:

- there are already multiple programs
- focus is on adapting automotive technologies, and integrating megawatt-scale technologies (e.g. pumped hydro)
- focus exists on integration technologies, modeling, "smart" grid creation
- Lacking: direct work on new energy storage technologies

Europe's programs—same gap as U.S.
Asian programs—same gap as U.S.

In both Europe and Asia, though, it appears there is a more advanced strategy for coordinating the effort with respect to storage.

It is the opinion of the author that the best method for addressing the gaps described above is to combine a new strategic investment by DOE in research and development in the U.S. focused directly at the development of energy storage systems for buildings and small communities, and, importantly, to coordinate the research effort effectively with the resources already available to DOE. Specifically, the talent and skills needed to develop advanced energy storage technologies, from inception, to modeling and theory, through materials and systems development, and performance and full utilization testing, already reside in the DOE National Laboratory system. Also, there a both startups and large-cap businesses ready to commercialize any technology developed in the laboratories. If developed and managed properly, R&D funds could be utilized with great efficiency, if the various organizations worked in concert, collaborating toward a singular, well-defined mission. Further, a particular project on energy storage for on-site small-scale stationary applications could be incorporated into a larger, coordinated national effort at developing knowledge and technology for energy storage across a large variety of both stationary and portable applications.

BIOGRAPHY FOR JEFFREY P. CHAMBERLAIN

Department Head, Electrochemical Energy Storage
Energy Storage Major Initiative Leader

Jeffrey Chamberlain is the Manager of the Battery Research Department in Argonne National Laboratory's Chemical Sciences and Engineering Division. The work in the battery department at Argonne spans from the basic materials science for discovering and designing new materials, to modeling new electrochemical systems, to engineering operating test cells, all the way to testing of materials, cells, and entire energy storage systems. The battery testing facilities are world-class, and serve as a lead lab for DOE in performance analysis for advanced batteries.

Jeff also is the leader of the laboratory-wide Energy Storage Initiative. The work involved is coordinated into four research areas: Advanced Battery R&D, Process Engineering for pilot-scale studies of battery materials, Energy Storage studies for power grid management, and Energy Storage R&D in advanced power train systems.

Prior to joining Argonne, Dr. Chamberlain performed industrial research at several companies, notably Cabot Microelectronics, Nalco, and Angus (purchased by Dow), focusing his work on the chemistry at the interface between suspended metal-oxide particles and their surrounding solutions. Products developed from Jeff's work in industry have been applied in semiconductor processing, coatings manufacture, and mineral processing.

Dr. Chamberlain studied vacuum-based surface chemistry at the Georgia Institute of Technology, and received his Ph.D. in Physical Chemistry. Prior to his graduate studies at Georgia Tech, Jeff received his Bachelors of Science in Chemistry from Wake Forest University.

Mr. CARNAHAN. And, finally, Ms. VanGeem.

STATEMENT OF MARTHA G. VANGEEM, PRINCIPAL ENGINEER AND GROUP MANAGER, BUILDING SCIENCE AND SUSTAINABILITY, CTL GROUP

Ms. VANGEEM. Thank you for this opportunity to testify before you today. I will be speaking to you on the genesis of the renewable-ready requirements and their advantages and disadvantages in the ASHRAE USGBC/IES Standard 189.1, the standard for the design of high-performance green buildings. I've been a member of this committee, responsible for drafting the language in the Standard, since its inception in 2006.

However, today, I'm speaking for myself and not for ASHRAE or the Counsel.

The intention of the renewable-ready provision in the Standard is to assure that building design includes a plan to accommodate future installations of common renewable energy systems, such as PV, solar, thermal, and wind. The renewable- ready requirements were appealing to the Committee because renewable energy is expensive and, therefore, less cost- effective when compared to other energy-saving measures required by the Standard. While cost-effectiveness was not a criteria for requirements in the Standard, the future usability of the Standard is somewhat dependent on practicality and economics.

The Committee Members and the public had a spectrum of views on this issue, from not having a mandatory requirement, due to their cost, to mandating a portion of energy from all buildings be renewable. Those in favor of renewable energy requirements said they were in place in some European countries, and that the way to drive down cost is to mandate it. Furthermore, in order to meet the goal of net-zero energy buildings, on-site renewable energy will be necessary.

Requiring a small amount now will cause designers to start incorporating on-site renewable energy systems, and experience will be gained. The renewable-ready requirements were included as a compromise provision. The basis of this was that, once a building is constructed, the future installation of renewable systems could be prohibitively expensive, even if the costs of the renewable systems decrease.

Installation of these systems as a retrofit is more expensive if the initial building design did not account for the additional structural loads or did not provide readily available space for the renewable system, its pathways, conduit, and piping.

In addition, the structure of the Standard lent itself to the renewable-ready requirement compared to a rating system such as LEED. In a rating system, it's straightforward to have a point that requires on-site renewable energy. The user of the rating system can then decide whether or not to implement on-site renewable energy. It's the user's choice.

In a standard written in mandatory language, such as 189.1, if on-site renewable energy is in the mandatory section, it's required for all buildings and is not a choice. Although the requirement was based on PV arrays on the roof, other methods of meeting the requirement include PV arrays within fenestration and on opaque walls, PV arrays on racks above parking or on window shades, solar-thermal hot water systems located on roofs or elsewhere on the site, or wind turbines designed for use on roofs or on the ground.

Recognizing that some building projects do not have sufficient access to solar resources, an exception was added for buildings located in areas without a certain amount of annual solar energy for buildings or for buildings shaded by other buildings or structures, by hills, by mountains, or by trees. This exempts portions of Western Oregon and Washington, the upper Midwest, New England, and buildings on shaded sites.

Some of the advantages or disadvantages of renewable- ready have been discussed. It is also challenging to design for a renewable energy system before that system is chosen.

The requirement will encourage the least expensive renewable-ready pathways in infrastructure, and not necessarily the method that is most appropriate or cost-effective for that building.

Another disadvantage is that the term "associated infrastructure" in the Standard is not specifically defined. It's not clear how much detail needs to be included in the design or on the design drawings.

Renewable-ready can be viewed as an interim solution. The 189.1 Committee made a consensus decision on how far they could reach with a green building standard given the current state of renewable energy technologies, including their costs and designer awareness.

The country's goal should be that the entire sunlit surface of all future buildings be a converter of sunlight to electricity or hot water.

In summary, the renewable-ready portion in ASHRAE 189.1 is a compromise position between cost effectiveness and the ultimate goal of having on-site renewable energy in all buildings. Thank you.

Mr. CARNAHAN. Thank you.

[The prepared statement of Ms. VanGeem follows:]

PREPARED STATEMENT OF MARTHA G. VANGEEM

Thank you for this opportunity to testify before you today. I will be speaking to you on the subject of "renewable ready." I will discuss the genesis of renewable-ready requirements of *ANSI/ASHRAE/USGBC/IES Standard 189.1–2009, Standard for the Design of High Performance Green Buildings*, as well as its advantages and disadvantages.

I have been a member of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and Standards Project Committee (SPC)[1] 189.1 (the committee responsible for drafting the language in the standard) since its inception in 2006. I have been a member of ASHRAE since 1984 and have been involved in standards project committee work at ASHRAE since 1987. However, today I am speaking for myself and not for ASHRAE nor the SPC 189.1.

Renewable ready—What does this mean?

"Renewable ready" in *ASHRAE 189.1–2009* requires that the building site include provision for future installation of renewable energy systems. Specifically, the language from *ASHRAE 189.1–2009* states:

> **7.3.2 On-Site Renewable Energy Systems**. Building projects shall provide for the future installation of on-site renewable energy systems with a minimum rating of 3.7 W/ft^2 or 13 Btu/h·ft^2 (40 W/m^2) multiplied by the total roof area in ft^2 (m^2). Building projects design shall show allocated space and pathways for installation of on-site renewable energy systems and associated infrastructure.
>
> **Exception**: Building projects that have an annual daily average incident solar radiation available to a flat plate collector oriented due south at an angle from horizontal equal to the latitude of the collector location less than 4.0 kWh/m^2·day, accounting for existing buildings, permanent infrastructure that is not part of the building project, topography, or trees, are not required to provide for future on-site renewable energy systems.
>
> © ANSI/ASHRAE/USGBC/IES Standard 189.1–2009, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (*www.ashrae.org*).

The intent of this provision is to assure that the building design includes a plan to accommodate future installations of common renewable energy systems such as

[1] The SPC became a Standing Standards Project Committee (SSPC) after the standard was published in early 2010. I was a member of SPC 189.1 and am now a member of SSPC 189.1.

photovoltaic, solar thermal, or wind. By definition in *ASHRAE 189.1–2009*, on-site renewable energy systems also include geothermal energy but not the energy associated with ground-source heat pumps. The requirement is for the building design documents to indicate the space, pathways, conduit, and piping for the planned future renewable energy system.

Why a requirement for renewable ready and not a renewable energy requirement?

The Compromise. The renewable ready requirements were appealing to the committee because renewable energy is expensive and therefore less cost effective when compared to other energy-saving measures required by the standard. While cost-effectiveness was not a criteria for requirements in the standard, the future usability of the standard is somewhat dependent on practicality and economics. The committee members and the participating public[2] had a spectrum of views on this issue—from mandating that a portion of energy from all buildings be renewable to not having a mandatory requirement due to the cost of these systems. The renewable-ready requirements were included as a compromise position.

The basis of this compromise position was that once a building is constructed, the future installation of such systems could be prohibitively expensive even if the costs of the systems themselves decrease. Installation of these systems as a retrofit in an existing building is more expensive if the initial building design did not account for additional structural loads or did not provide readily available space for the renewable system and its pathways, conduit, and piping. Accounting for structural loads and providing space for these systems in initial building design reduces the cost compared to adding them to the building in the future. In addition, the capital costs of renewable systems are expected to decline as their use increases. Costs are anticipated to decrease due to production on a larger scale and technological improvements that are gained from mass scale production.

Mandatory provisions versus a rating system. In addition, the structure of the standard, with mandatory, prescriptive, and performance requirements, lent itself to the renewable-ready requirement compared to a rating system such as LEED–NC©.

ASHRAE 189.1–2009 is written in mandatory language[3] so that the requirements are clear and it can be adopted by building codes and used in design specifications. *ASHRAE 189.1–2009* is currently a jurisdictional compliance option of the *International Green Construction Code (IgCC)*™, which is a model code under development by the International Code Council (ICC)[4]. As a document in mandatory language, *ASHRAE 189.1–2009* differs significantly from the LEED©[5] family of point-based rating systems wherein one or more points are achieved for implementing a measure. In point-based rating systems, any particular measure generally does not need to be implemented. Historically, the least expensive measures are implemented and more expensive measures are ignored.

Conversely, codes or standards written in mandatory language generally have two paths. All projects must comply with either (1) all mandatory plus all prescriptive requirements (the prescriptive path), or (2) all mandatory plus all performance requirements (the performance path). The prescriptive path generally offers a simpler method of compliance with little or no calculations whereas the performance path often involves complex calculations.

In a rating system, it is straightforward to have a point that requires on-site renewable energy requirements. The user of the rating system can then decide whether or not to implement on-site renewable energy; it is the user's choice.

In a standard written in mandatory language, such as *ASHRAE 189.1–2009*, the implications are different than in a rating system. If on-site renewable energy is in the mandatory section of the standard, it is then required for *all* buildings complying with the standard and is not a choice. *ASHRAE 189.1–2009* has a requirement in the prescriptive section 7.4.1.1 for on-site renewable energy systems (with an exception for shaded buildings) but no such requirement in the mandatory or performance sections.

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[2] The committee before publication had up to 34 members with some being added and removed at various times. The meetings of the committee were open to the public. Four public review drafts of the standard received over 2800 comments from interested parties.

[3] It is not a guide or guideline, which often contain advice, considerations, or background information. ASHRAE will soon publish a user's manual for ASHRAE 189.1–2009 with this type of guidance.

[4] *www.iccsafe.org*

[5] *www.usgbc.org*

Previous unpublished versions. The 189.1 committee through ASHRAE released four drafts for public review. The 2nd public review draft included a mandatory requirement for on-site renewable energy power systems:

> **7.3.2 On-site Renewable Energy Power Systems**. Building projects shall contain on-site renewable energy power systems with an electrical rating not less than 1.0% of the service overcurrent protection device rating. The rating of the on-site renewable energy power system shall be the nameplate rating in kVA (dc).
>
> **Exceptions to 7.3.2**:
>
> (a) Building projects with an on-site solar water heating system that provides 100% of the domestic hot water needs or has a peak capacity equivalent to not less than 2.5% of the service overcurrent protection device rating for the building project. The system shall be certified in accordance with SRCC OG–100.
>
> (b) Building projects that demonstrate compliance using the Performance Option in 7.5 and provide any combination of energy cost and CO_2e savings achieving a minimum of 10.0% total.
>
> © ASHRAE Proposed Standard 189.1P, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*, Second Public Review, February 2008, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (*www.ashrae.org*).

This required that (1) approximately 1% of the energy use of the building be renewable, (2) as an exception, approximately 2.5% of the energy use be solar-thermal (at the solar-thermal peak) or solar-thermal provide all of the hot water needs, or (3) as an exception, the building had to save additional energy. In response to comments from the public reviews and a change in some of the members of the committee, the committee changed the language to the current language in the 2009 standard, previously cited.

Although it must be recognized that each member of a committee votes yes or no for a particular reason that is generally not documented, the issues with the mandatory language from the 2nd public review were threefold.

First, to many on the committee, the requirement for on-site renewable energy was a severe cost burden. These members expressed opinions that each dollar that could be invested in on-site renewable could be invested in other energy-saving measures that were much more cost-effective. Those in favor of mandatory renewable energy requirements expressed opinions that mandatory on-site renewable energy requirements were in place in some European countries and that the way to drive down costs of renewable energy is to mandate it. Once mandated, costs would come down due to volume efficiencies and technological gains as demand increased. Furthermore, in order to meet the goal of net-zero energy buildings, on-site renewable energy will be necessary. Therefore, requiring a small amount now will cause designers to start incorporating on-site renewable energy systems and experience will be gained.

Second, the alternative requirement for 2.5% solar-thermal in the first exception seemed like a large amount for some buildings. Also, the requirement for 100% of the hot water demand seemed problematic for times when and locations where the solar-thermal has traditionally been required to have conventional back-up hot water.

Third, the alternate requirement for increased energy savings in the second exception meant that a whole building energy analysis would need to be performed. Without this provision, the standard allowed a prescriptive path that did not require a whole building energy analysis. These analyses generally cost at least $30,000 and often considerably more. It also seemed burdensome to require these analyses for building projects that did not have adequate access to solar or wind resources—the most common sources of renewable energy.

As a result, the committee developed the renewable-ready text in the mandatory section as a less-expensive, compromise position. Since the prescriptive section has requirements for on-site renewable energy (with an exception for shaded buildings), the only way to avoid using on-site renewable energy generation when using *ASHRAE 189.1–2009* is to use the more complicated energy performance path.

More on what renewable ready requires

The phrase "renewable ready" does not occur in the mandatory requirements in section 7.3.2 of *ASHRAE 189.1–2009*. To meet the mandatory requirement, provided above, the building design drawings must show allocated space, pathways, and associated infrastructure for generating electricity or solar-thermal of 3.7 W/ft^2, as a minimum rating, multiplied by the roof area.

Whereas the 2nd public review draft considered approximately 1% generation of energy from on-site renewables as sufficient, the requirement in *ASHRAE 189.1–2009* is based on how many photovoltaic arrays could reasonably be placed on a roof. This was calculated by assuming that photovoltaic arrays generate approximately 8 to 10 W/ft^2, and that slightly less than 50% of the roof area is available for photovoltaic arrays, assuming the other 50% of the roof space is for pathways and mechanical equipment. Although the calculation is based on photovoltaic arrays on a roof, the renewable energy source can be placed anywhere on the site. For a one-story building, the 3.7 W/ft^2 requirement can be 30% or more of the energy use of the building. For some one-story buildings, the renewable-ready requirement is three times more than that required in the prescriptive path. ASHRAE is currently in the process of changing the renewable-ready requirement so that it does not exceed the requirement in the prescriptive path in section 7.4.1.1 of *ASHRAE 189.1–2009*.

Although the requirement was calculated based on photovoltaic arrays on the roof, other methods of meeting the renewable-ready requirement include provisions for:

- Photovoltaic arrays within fenestration and on opaque walls, although these systems are generally not as efficient as optimally oriented systems on a roof
- Arrays on racks above parking or on window shades
- Solar thermal hot water systems located on roofs or elsewhere on the site
- Wind turbines designed for use on roofs or on the ground

The renewable-ready design for photovoltaic arrays, solar thermal hot water systems, and wind turbines must account for the additional structural loads of these systems. Solar-thermal systems require the design of associated tank(s) and piping between the collectors and the tanks. Wind turbines on roofs require the structural design of the building accommodate the appropriate loads and serviceability requirements, including lateral loads, torsion, and vibration.

Pathways from the energy source to the electrical panel (or to the point of hot water use for solar-thermal) are required. For photovoltaic arrays, this requires identifying pathways for the conduits from the arrays to the inverter, and then from the inverter to the electrical panel. Shading of one portion of an array can lead to significant losses in power generation from other arrays when they are connected in series. Therefore, shade is an important consideration when designing a photovoltaic system.

Exception to the renewable-ready requirement

Recognizing that some buildings projects do not have sufficient access to solar resources, an exception was added for buildings located in areas without specified amounts of annual solar energy and for buildings shaded by other buildings or structures, hills or mountains (topography), or trees. Specifically, it exempts building projects that have an annual daily average incident solar radiation, measured a specific way, of less than 4.0 kWh/m$^2\cdot$day. This exempts portions of western Oregon and Washington, the upper Midwest, and New England, as shown below.

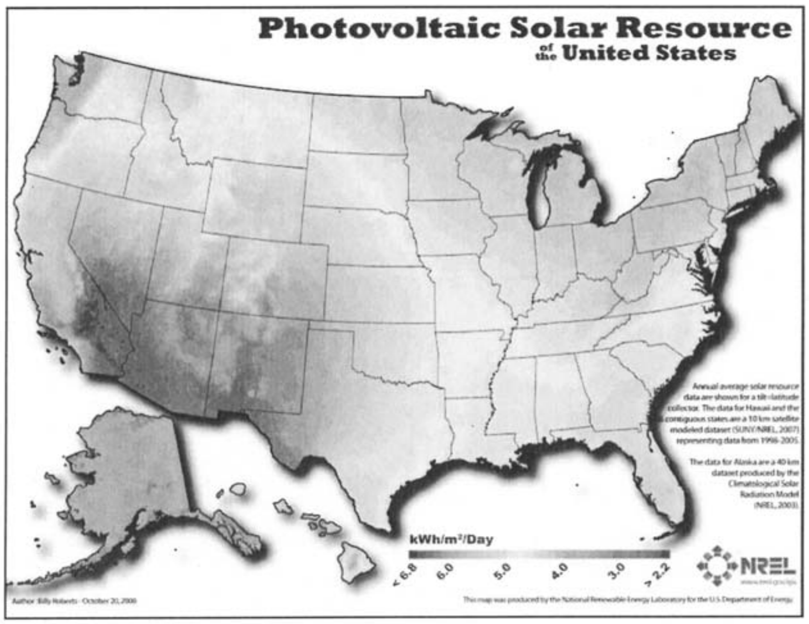
Additional advantages and disadvantages

In addition to the advantages and disadvantages of renewable-ready previously discussed, it is challenging to design for a renewable energy system before that system is chosen. The renewable-ready requirement will encourage the least expensive "renewable ready" pathways and infrastructure and not necessarily the renewable energy method that is most appropriate or cost effective for that building. Another disadvantage is that the term "associated infrastructure" in the standard is not specifically defined. It is not clear how much detail needs to be included in the design or on the design drawings.

Renewable ready can be viewed as an interim solution. The 189.1 committee made a determination on how far they could reach with a green building standard given the current state of renewable energy technologies—their costs, designer awareness, existing laws, and financial incentives. To meet the longer term objective of on-site energy generation, the U.S. government could support greater research in photovoltaic cells that can be applied/installed as the surface for all building materials, with the possible exception of vision glazing. The country's goal should be that the entire sunlit surface of all future buildings should be converting sunlight and daylight in general to power (e.g. electricity) or thermal energy (e.g. domestic water heating or swimming pool heating).

The U.S. government could also require that all new federal buildings, as well as substantial remodels to existing buildings, have on-site renewable energy power generation. This percentage could be steadily increasing over time.

In summary, the renewable-ready option in ASHRAE Standard 189.1–2009 is a compromise between cost-effectiveness and the ultimate goal of having on-site renewable energy in all buildings.



Source: www.nrel.gov/gis/solar.html

BIOGRAPHY FOR MARTHA G. VANGEEM

Martha VanGeem is a principal engineer and manager of CTLGroup's Building Science and Sustainability Group. She serves as a project principal investigator and specialized in-house consultant in the areas of green buildings and infrastructure, energy efficiency, energy codes, thermal mass, mass concrete, and moisture migration. Since joining CTLGroup in 1982, her experience has included over 500 large and small consulting, testing, and research projects. Ms. VanGeem has investigated moisture problems and performed energy analyses for numerous concrete, steel and wood framed buildings. In the area of sustainability, Ms. VanGeem serves as principal investigator on LEED™ projects and others, and has developed environmental life-cycle inventories (LCIs) and life-cycle assessments (LCAs) of cement, concrete, and other construction products. Ms. VanGeem is a licensed professional engineer, a LEED™ Accredited Professional, and a Registered Energy Professional for the city of Chicago. She received her bachelor's degree of civil engineering from the University of Illinois–Urbana and her MBA from the University of Chicago. She is a member of many energy and green building standards committees including ASHRAE energy standards (SSPC 90.1 and SSPC 90.2), ASHRAE/USGBC/IES High Performance Green Building Standard (SSPC 189.1), the GBI Green Building Standards Energy and Resources Subcommittees, ACI 130, and ASTM E60. She presents on various aspects of green buildings on a regular basis, and has authored 93 articles and published reports. Two of her articles have won awards—the Charles C. Zollman Award from the Precast/Prestressed Concrete Institute in 2006 and the F. Ross Brown Award from Construction Canada in 2005.

Discussion

Mr. CARNAHAN. And I want to start. I'll recognize myself for five minutes to start, and then we'll switch back and forth between myself and Congresswoman Biggert.

Economic Considerations and Job Creation

I guess I want to focus a little bit on what Mr. Cheifetz's talked about with regard to impact and the economy. I think it's important. We all talk about so many benefits. We've heard about benefits to the kids in school, to the environment, the bottom line of companies. I guess the thing I want to ask—and I'll start with Mr. Cheifetz, since you make the point so well—the impact on the economy and jobs and local firms. We've seen lots of statistics about so many of the technologies and equipment that have been put in these high-performance buildings and pilots that are made by U.S. small companies. And the more we're encouraging the use of these products, the more telling those small companies are in their creating of jobs, and the multiplier effect of that. But I guess I want to ask every one of you to just focus on the job creation possibilities that are involved with many of these technologies, and how we'd be best to run that.

Mr. CHEIFETZ. Thank you. Our view of it, and our experience, has been that these systems drive a lot of jobs in a lot of different areas. They drive direct construction jobs. What we're doing is that we're taking people who are now, let's say, underemployed in the construction sector, and whether it's retraining water well drillers to do geothermal, whether it's getting construction people back in the field to do work, these projects get people back to work and create new jobs, because we're talking about a new kind of energy infrastructure, and new skills and jobs are required. We've seen that with our own experience here in the Chicago area.

At the same time, it pulls a lot of work from existing trades. The folks who do HVAC work are doing retrofits. All these things have an additive effect that is significant in terms of job creation. In addition, we create jobs in engineering and technology, as well, because as you heard, we invest a lot in our own folks to develop the instrumentation and systems that are needed. And then, as we enable other firms that we work with to get back to work and do more work, that just brings more people to the table. It seems that there's no question that we want and need these technologies. We've just been waiting to see how we can do it. As we unlock that door, we're going to see thousands, we think tens and tens of thousands of jobs, being created in rather short order.

We're not talking about a new infrastructure that has to be put in place to transmit energy. We're not talking about something that has to be created over five or ten years. And we're not talking about systems that require long payback periods. The payback periods of the systems, especially with the American Recovery and Investment Act incentives, are now under five years. So, even the most risk-averse and capital-constrained firms, whether public or private, see their way to make this investment in a very short term.

Mr. CARNAHAN. Thank you. Start with Mr. Ostafi.

Mr. OSTAFI. I think one of the interesting things about renewable energy is that many of these systems are manufactured all over the world, I think the least of which is here in the United States. I mentioned, and other people on the panel here have mentioned, the manufacturing process of renewable energy. Let's take PV, for an example. If it could be optimized and made more efficient, could we possibly be manufacturing more solar panels here in the United States as opposed to being manufactured in China or elsewhere?

I think the manufacturing process of PV is one of the reasons it makes it so expensive. So, if there are some technological breakthroughs that can allow us to make that process less expensive, bring more of those panel manufacturers here in the United States, I think that's an opportunity to create more jobs. I think you can take that argument and apply it towards wind turbines, curtain wall system facades, and many other things mentioned here today.

But that's certainly an opportunity to bring more jobs here.

On the installation and maintenance side, a lot of these systems require people with skills that don't necessarily translate from traditional mechanical and electrical and ventilation system opportunities. So, is there a way to train new workforce that specifically has knowledge for portable tanks or for wind turbines for solar thermal applications? So that they can verify commission and install those different systems here in the U.S. and create new jobs for our diverse new use of componentry?

Mr. CARNAHAN. I see my time is up, so I'm going to recognize Congresswoman Biggert for five minutes.

TECHNOLOGY DEMONSTRATION TO COMMERCIALIZATION

Mrs. BIGGERT. Thank you, Mr. Chairman.

Just thinking back, and having been on the Science Committee since 1999, it's taken a while to get to this point where you're all here and we're hearing so much about the environment and the high-performance building, which is great. But, again, I'd like to know—well, I know we did the EPAct in 2000—that was a bill in 2005, which really was looking at the alternatives of alternative energy and how we were going to do this. And I can remember having a meeting at Argonne with the then-Secretary Bodman and looking at the fuel cells and how big they were and saying, "How soon can you get them small enough to, you know, fit in a car?" And I think talking about the fuel cells and the stationary fuel cells was kind of like maybe we skipped that and we went right to vehicles and how to do that.

And this is off story, but what can we do now to really move forward with this in this economy to really—what's happening why we aren't—you know, this is so important now that people, I think, realize in the school districts and people that are, you know, building a home are realizing they can do more, and the commercial buildings. But how do we get from the demonstration technology? You know, we always talk about, in the—so many of the companies that are starting, and they've got their research labs and universities or are developing themselves, but then they get to what we call the value gap. You know, the demonstration, but they can't quite push over to the commercialization of these technologies, and some of them go under because of lack of capital. So, how do we move from that to—and I don't know who wants to try and get into that, but——

Dr. CHAMBERLAIN. I'll take a stab at that. That's a very big question. I think that's why we're all hesitating here. Thanks for that question.

Coming from industry into the laboratory, I notice that same gap, and several of us notice that same gap; that valley of death that exists, particularly for high-technology products like the ones in this field, and also particularly when you look at the difficulty of the economy that we're in currently.

My personal belief is, the answer is investing in a way that's sensible. And by that, what I mean, particularly coming from a laboratory perspective, is if Congress, through the Department of Energy, continues to invest in technologies like the ones described in the panel today, it can be done in a way that directly engages industry to shorten that gap, to bridge that valley of death, to encourage the collaboration directly with industry and the performance of R&D. That, in short, would be my answer to a number of ideas that are methods and vehicles that are contractual vehicles that are demonstrated to move high-tech R&D at Argonne and other labs and universities directly to industry through one-on-one collaborations.

Mrs. BIGGERT. It was interesting what you said in your testimony, that we're really trying to use technology that was developed for something else to make it apply to something rather than starting with an idea and carrying it through for that particular need. How can we change that? I—you know, we've had the *America COMPETES Act*, and we passed that out of our Committee and out of the House, but it hasn't gone through the Senate, and probably will not this year as we start over again. That's, you know, where we really are looking at; the innovation and creativity that we need to do this.

Mr. CHEIFETZ. If I may give it a shot.

A few things, frankly, is that, whether you're public or private, decision-makers don't like risk and they don't like uncertainty. So I think it's great that this Committee and Subcommittee is developing a shared language and a shared vision, that people can start having confidence in going forward. And that's very important, because I hate to put it this way, but when it comes to business or the public, when mommy and daddy are fighting, everybody's paralyzed.

So we need to know, as soon as possible, that we have enough of a consensus and a shared vision and the will to go forward year over year and decade after decade, if possible, to get us from here to there. It would help us with things like access to capital because, as you know, that's frozen up right now, and it's for that reason.

So if we could develop a shared language that we could commit to that still allowed us to be faithful to our own principles, I don't see why that's not possible. If we could give the finance community an understanding that these are investments that we're serious about and that are safe and have good returns, and if we could identify some specific and realistic, pragmatic things that we can do in common to get things done and prove them out in short term to build our confidence, that would bring more capital to the market in, I think, a whole new way.

So it's not a one-answer-fits-all, but I think it's a set of small things that we can do. We're in a dynamic now that's not moving, and sometimes very subtle things can make a very big difference. If you look at this panel, you've got a world-class architectural firm, you have a true user representing schools across the country, you have people talking about storage technology—and we know that the ground is a leaky storage battery—and we have the evolution of standards right here at this one table. You have a microcosm of how we can make a difference and go forward. I think that's going to be required to really, kind of, crack the door open. And then, with your help, I'm sure we can go forward.

Mrs. BIGGERT. Thank you.

Okay. Ms. VanGeem.

Ms. VANGEEM. Well, coming from the codes and standards arena, I would say that you could continue to help push renewable requirements and energy codes and standards. All high-performance building requirements take methods that are available and not common and push them to be more common.

And, as we heard, energy saved over the life of the school or the company can then be used to help that school do other investments, or help the company hire more people or do more research itself.

So, the only other thing I could think of would be some sort of tax incentives or financial incentives for the buildings that do go ahead and do this large, initial cost; this would be helpful.

Mrs. BIGGERT. It's interesting that, in 2005, there were those, but people didn't use them.

Mr. Lopez.

Mr. LOPEZ. Just from the applications that I've said, educating the end user is a key component, particularly when you're talking about—you know, speaking from the school segment. They represent a large segment of our community, and then I think as they become educated in the benefits to renewable resources in research and technology, by leveraging their combined power/buying power, will have an influence on R&D.

You know, just small examples, I know the Illinois Department of Energy currently has a LEED for Schools project, and I think having that component, which combines energy efficiency with the educational segment, I think that also tends to drive our need, recognizing that schools want to be part of that, and the industry sees that, and they develop based on those needs.

But just building on a small scale. We get to our high school, we were interested in using highly recycled content in our products, and the manufacturer that produced the brick block for our building didn't have that available at the time, but he went ahead and retooled his manufacturing process to incorporate a higher recycled content in his product, and we forwarded that and marketed that as part of his product.

So I think end users, with their ability to leverage their combined resources, can make a difference on the R&D side, as well.

PUBLIC EDUCATION AND COMMUNITY ENGAGEMENT

Mrs. BIGGERT. Just one follow-up to that, if I might.

I would assume that you had a referendum. The school district?

Mr. LOPEZ. Yes, we did.

Mrs. BIGGERT. And that passed.

Mr. LOPEZ. It did pass.

Mrs. BIGGERT. The first time.

Mr. LOPEZ. It passed the first time, with the highest margin the second time.

Mrs. BIGGERT. So you educated—the end user would be the homeowners.

Mr. LOPEZ. Correct. Again, as we went through the process, it was an educational component for everybody involved, because it was early 2000, and we were fairly new, as far as the community and the public. And, so, a big process of implementing green technology was to educate the public to a greener use, as well as the senior leadership administration.

Mrs. BIGGERT. Well, you're very good at it. We were at your school.

Mr. LOPEZ. Thank you.

Mrs. BIGGERT. I know firsthand.

I hand it back.

Mr. CARNAHAN. Thank you.

I want to follow up on that. So, when this was sold to the voters, part of that incorporated the new technologies in that campaign?

Mr. LOPEZ. It was a component—or, I mean, there was a multifaceted campaign. It was obviously new in the area to build new. Part of that, though, was to demonstrate how we could develop new efficiently and effectively. And, again, the whole challenge brought about through the Design Committee—at the time, I was involved in the design end. We brought that to the owners of the community, that we were interested in pursuing something that was cutting edge in terms of applying technologies. And, so, it was a component of the entire cell of the referendum. I think maybe it was not very much aware, at all, of green technology like most communities at the time, and, so, there was an opportunity there to raise that awareness during the course of the design process.

Mr. CARNAHAN. And I bet there are a lot of other communities that are thinking about this that would like to know how you did that. I know because, certainly, that can be the important part of getting community volume, which can make a big difference.

Mr. LOPEZ. Absolutely. And, you know, you look at the—we continue to sell energy efficiency to our community. As I go around, I talk to the financial benefits and savings to the taxpayers. Essentially, they look at us as a consumer of their tax money, and the things we point out are actually savings. We have a sheet from year to year. Just simply last year, from 2009 to the fiscal year 2010, we've seen a 30 percent savings in electric bills by employing new technology in our school district, and that sells well to our taxpayers.

RENEWABLE-READY BUILDING STANDARD

Mr. CARNAHAN. I want to ask the—Ms. VanGeem laid out the case for the renewable-ready standards, and I want to get the other panel members thoughts about that.

Ms. VANGEEM. So, actually, the renewable-ready is in the mandatory part of the standard. In the prescriptive part, you're actually required to use renewables, unless you're in one of these shaded areas or darker areas, areas with less solar—and then you have to use it, unless you're going to do the performance path, which requires a lot of calculations. And the same thing is in the IECC that just passed—the hearings were a week or so ago. The next version of that's going to require either renewable or more efficient equipment or some other options. And there's other state codes and municipal codes that do the same thing; that you either have to be renewable or do something else; such as save a lot more energy in the building.

And, so, as we make those things in the options harder, renewable will become the easier choice, and I think that's where it's going.

Mr. CARNAHAN. Other panel members on that?

Mr. CHEIFETZ. Yeah. I think it's important, from our experience, that the standards and regulations be driven at least as much by the market than by other places. We've seen, even with things like LEED, that when there's a disconnection between the desire to come up with the right kind of prescriptive solution and the actual things, like energy efficiency in buildings, there can be a disconnect. They can also confuse the market, and what we need in the market is confidence, we need capacity, and we need to fix a fee affordable in terms of cost. And that's where I think we need to be more creative about how to develop these standards in a way that can instill that confidence and help create that capacity.

One thing that we can do better, for instance, is we could utilize the national labs, I think, in a more effective way from the private sector, not only in terms of using and commercializing what they develop on the science side, but also getting them—having them help us vet and educate the world about—what are the real-world working solutions, and how they do work. So, instead of it being theoretical, take it down to practical applications, where the national labs would have a lot of authority and are believed as such by lots of people.

If they could look at situations where these technologies have been deployed, evaluate them qualitatively, and then give their objective report on "What has saved money? What's accessible? What's renewable-ready?" Without having to re-invent the whole world, we probably could start getting case studies in the marketplace rather quickly, and they won't have to be one size fits all. We could have many things, but the national labs, if they could, could, I think, help us a lot to educate and inform the market, and help companies like ours quite a bit.

Dr. CHAMBERLAIN. Obviously, the last part I agree with, but the first part of your point I would strongly agree with. If the standards and needs in the long term teach the users and our government the long-term financial benefit, then there's a real purpose for the standards. Even though you know I'm a scientist, I would say I'm a capitalist at heart. So as long as it's correctly crafted to benefit the business, not only directly from the standards themselves, or policy, but also that it's recognized and put together in a way that, in the long term, it really does educate the user as to the long-term benefit financially.

Mr. LOPEZ. Just to the point of some standards—we'll need standards as the basis for introducing the rules. I agree with the statements that it's important to have the standards reflect the use of renewable technologies. I do think they shouldn't be too prescriptive. I like the concept of where states are going towards requiring, let's say, a LEED silver certification for new construction in new schools, and I think, again, that reflects on the interest of having public funds going towards something that's a very sustainable investment.

But being too prescriptive, saying exactly what needs to be done, doesn't allow the flexibility for the design committee to come up with different alternatives, and sometimes even more creative alternatives, to what can be applied to a particular situation.

RENEWABLE-READY BUILDINGS

Mr. OSTAFI. I would just like to add, I think, from a design community perspective, to this day, we still have many clients that want renewable energy systems integrated into their buildings, and, for a myriad of reasons that we have discussed today, they don't get incorporated today, but they still want that ability to plug into renewable energy later. And I think providing renewable-ready standards for projects built today makes a tremendous amount of sense, because the last thing we want ten years from now, when renewable energy systems become less expensive to manufacture, less expensive to install, the last thing we want are a bunch of buildings which are obsolete, that cannot incorporate them into their existing infrastructure.

So I think it makes a tremendous amount of sense, as we think ahead towards net-zero buildings, which there's a big push towards their greenhouse gas emission inventories. I think we need buildings built today that are renewable-ready for tomorrow.

Mr. CARNAHAN. Thank you all. I'll go back to Mrs. Biggert.

THE MOST EFFECTIVE MEASURES TOWARD EFFICIENT SCHOOLS

Mrs. BIGGERT. Thank you, Mr. Chairman.

Mr. Lopez, you are, I think, very fortunate to have such a community and be able to build a school like that, but there's an awful lot of school districts that don't have the resources to institute a complete range of sustainable building measures and practices. But they must be able to do some things to lend them to becoming green. How can they do that? What are some of the highest leverage or lowest cost measures that we can take to improve building energy use and efficiency that somebody in the building could do.

Mr. LOPEZ. Sure. So, with regards to non-renewables, those are more, "Turn your lights off." Simple as that. I think a lot of what we encounter are behavioral issues, like how people go to work and expectations of having a room being more comfortable than they might have their own house. I think when they're home, they turn the heat down or they turn the lights off, but I think that behavior is not always prevalent in the public places or places of employment.

And, so, kind of reteaching that or making people aware of the impact of that in the workforce and in the community is well met. Again, that's something we've done recently as part of our savings.

I mentioned that we saw a 30 percent reduction in our utility bills this last year, and a large part was just behavioral change. Telling 2,500 employees that, you know, "We're going to make the building a little cooler in the winter, a little warmer in the summer. And, you know, we're going to ask that you—we're going to start turning lights off for you at certain times of the day. We're going to turn the computers off."

You know, some of these things, it's just change in behavior. So there's low or no cost to some of these implementations. And, as we go forward, part of this program that we have is to take those low-end group type of elements, try to find a substantial savings where we can adopt little cost, and I think, for a lot of school districts and a lot of municipalities, the employees are given initiatives such as that without a lot of cost upfront.

Mrs. BIGGERT. What would be some obstacles to these measures?

Mr. LOPEZ. Buy-in of the senior leadership.

Mrs. BIGGERT. Uh-huh.

Mr. LOPEZ. That's a key component. I'm sure a lot of school districts, municipalities, a lot of commercial buildings, a lot employ these types of things, but if you don't have a senior leadership or the senior administration on board with that, it's difficult to implement some of these features.

And, so, that's sort of a process that's part of the—what's important to the processes is, backing the education component, is making the senior leadership or senior administration aware of some of the advantages of these types of elements. And I think money speaks when people start to hear the benefits that we derive from energy efficiency. It gets their attention.

We've taken the show on the road, so to speak, with identifying energy opportunities as part of that written packet that you have. And you can see there's a lot of different areas where we're able to save money; simple things, like putting frequency drives on motors, looking at more efficient mechanical equipment. All these things behind us really save a substantial amount of money, and they don't always cost a lot of money upfront. There's a lot of room out there to do things before large capital investments, and that's part of the message we're trying to get out, is to know how to do things at low cost or no cost.

SOCIAL-BEHAVIORAL FACTORS

Mrs. BIGGERT. Mr. Ostafi, you emphasized in your testimony the human factor, the behavioral factors in a building design such as the use of lights and windows or opening windows. Somebody like the big buildings here in Chicago or wherever, you can't open them. Will that change, or what are those kind of factors?

Mr. OSTAFI. I would like to think that that will change. The reason why many high-rise buildings, for example, do not have operable windows is because the building itself is heated and cooled through a central system that takes care of the whole building at once and tries to maintain a sort of even-keel temperature and humidity in the building at all times.

There's also a pressure differential issue that comes into play in high-rise buildings that sometimes prohibits the use of opening windows, because the pressure differential between the outside atmosphere and the inside atmosphere become very different.

Mrs. BIGGERT. I think that there is a new building in Chicago, The Legacy, that's being built that will have windows that open.

Mr. OSTAFI. I think that there are ways to make it happen. You have to rethink the way we heat and cool large buildings. We need more sophisticated sensors and measurements and verification systems throughout buildings that can constantly take the pressure and the humidity levels and temperature at all times in the building in various locations.

If we apply more of a zone or a systems type of look at the way we heat and cool individual spaces, that could introduce natural ventilation into buildings more. But I think, to get to your earlier point of the human factor, when we design buildings—engineers and architects—we rely on a lot of information that, quite frankly, is outdated. We think that people will open windows when it's 70 to 72 degrees outside and 60 percent humidity—you know, the perfect, ideal, human temperature conditions—and what we're learning, as I articulated earlier—is that people open windows in much more extremes than that. In fact, at night, when it's cool.

So I think what I was getting to earlier was a lot of more current research needs to be done about what is truly comfortable for humans and in today's standards and in different environments and different regions across the U.S., because I think that the window of opportunity, no pun intended, is open. Ventilated buildings are much broader than what we're currently using today.

Mrs. BIGGERT. Thank you. I give back.

CURTAIN WALL SYSTEMS AND EXTERIOR GLASS

Mr. CARNAHAN. Thank you.

I wanted to go back to Mr. Ostafi. You had mentioned in your written testimony, and oral, as well, the need for research in the area of curtain wall systems or exterior glass for buildings. Who is really doing the cutting-edge research in that right now, and can you describe some of those technologies?

Mr. OSTAFI. Much to our own chagrin, the Swiss are doing the most innovative products in that regard, and Europe, and I would say that's true for a lot of the systems that we're talking about today. A lot of renewable energy systems are much more efficient than what we're utilizing here in the United States exists in Europe, and they've been used for decades, since the '80s. What is causing that leap of that technology to be incorporated into the United States manufacturing and our own products? I don't have the answer to that. Maybe some other panelists do.

What I was articulating about curtain wall systems earlier is a product that is available in Europe, and my point was that curtain wall systems, glass facades are the worst violator of thermal conductivity in a building, yet we like glass because it allows us to view and brings in natural light; all the qualitative aspects of being in spaces.

So some of the innovative technologies that I see happening in other countries are curtain wall systems which are able to, through phase-change properties, absorb solar gain when it's not needed and able to transmit so they're gaining through a glass wall when it is needed. And there are ways to sort of regulate how that transfer of energy happens through a window system. There are solar-optic window systems that mitigate direct light coming into buildings which cause glare, which, again, is an uncomfortable human factor.

So there are these technologies and systems that certainly exist and are in use, but just not cost-effective to incorporate in the United States.

Mr. CARNAHAN. I know, even, there's a St. Louis-based, small company that has actual window shades to do some of that in maybe a more low-tech——

Mr. OSTAFI. Yes.

Mr. CARNAHAN. —way, but I'd be interested to hear from any of the other panel members about their experience or knowledge about those kinds of systems.

Ms. VANGEEM. I think——

Mr. CARNAHAN. Ms. VanGeem.

Ms. VANGEEM. Yes. I think that, as you travel abroad, or as I've traveled abroad, I notice that in Europe and in China and other places, each person really takes this whole concept of saving energy personally, and I don't know if it's because their disposable income is lower or what, but I agree that we've seen studies that 50 percent of energy use is behavioral, as he stated.

And I do want to emphasize that these all-glass facades are some of the biggest energy hogs. And, before you asked the question, I was going to say that, you know, we can control the day-lighting just by opening and shutting the curtains and different things that are behavioral that we don't do in this country.

And, so, you can limit the amount of glazing to 20 to 30 percent of the window-to-wall ratio and still get enough daylight harvest area where you can use controls to reduce your lighting. So you don't need this hundred percent glass facade; you can use 20 to 30 percent glass, and then get enough day-lighting that you can turn off the lights.

Mr. CARNAHAN. Any others?

Mr. OSTAFI. I would just add, you mentioned sort of what we would call passive strategies, Congressman Carnahan, and that are low-tech solutions to some of these problems. And we're looking at ways to incorporate portable panes as solar shading devices on the exterior of buildings.

So we're constantly looking for ways for renewable energy sources to perform, sort of, double-duty. Can they harness energy and provide shading at the same time? Yes, they can, and we can do that. I think that's the challenge for us as scientists, engineers, planners, administrators, is to look at ways for renewable energy systems to perform double-duty, to perform capabilities of doing more than just what their face value is.

Mr. CHEIFETZ. But we have to work on the double engine of market force and some regulation, because I think we've all had the experience of designing a beautifully efficient and also lovely building and have that all be value-engineered out when it comes down to the budget and getting the building built. And it often comes down to that issue, at the end, of people shaving money, and they're shaving, really, the wrong thing.

We have to change their perception of what they are allowed and not allowed to do by their tenants, by their owners, by their purchasers, by their investors, to know that they're not allowed to do that anymore. Whether it's, you know, bad glass or inefficient heating systems or poor design, cutting corners is just unacceptable. And now that it's more difficult to build lower-quality things in a more demanding environment, that's helping, but it's just one of the things that we have to keep attention on, because, by itself, things sink down to the lowest common denominator in the market.

Mr. CARNAHAN. Thank you.

Mrs. Biggert.

NEXT STEPS FOR POLICY MAKERS

Mrs. BIGGERT. Thank you.

I guess that reminds me of just like prevention. You have prevention in health, where you're not going to get sick or delay something if you know you have a genetic disposition to something. So it's the same thing with prevention, is how you show, you know, the real, true savings that you're going to have after you put the money in upfront, and how long will it take, I think.

What can we do, as policymakers, to move forward faster?

I know Congressman Carnahan and I have a bill that has been introduced to really showcase the federal buildings, to show energy efficiency, and, of course, that's turning off the lights, but that can lead to a lot more than that. And we have a bill for the Personnel Training Act, which was to provide federal workers with the know-how to maintain and to really sustain high-performance buildings. I don't know whether it's going to go, but hopefully. It's also in the Senate, so I think that the Senate has—it's passed the Senate, so hopefully we will be able to move that forward.

But I don't know if you know anything about the bill; if it's a good policy or what other policies—there's, you know, a few other bills that are out there that we're working on. But how can we move forward, or what would you see that as?

Mr. LOPEZ. Well, I mean, speaking from an engineer's point of view, the market deployment is important to cost. I think making these technologies readily available in the market is important, because I think the community is ready to implement these. As I mentioned and you've heard up here before, cost is preventing a lot of us from doing that.

We recently took advantage of a lot of grant opportunities, and the State of Illinois has offered a lot of nice grants, matching grants for funding these type of programs. And it's actually allowing us to do things that we would not otherwise be able to do.

For example, we're going to put up a new chiller plant at one of our schools with a 50 percent match grant from the state, and that's also allowed us to do a little bit more than just put in a chiller plant. We're looking at ice generation/ice storage technology as a part of that.

So, by reducing our cost by maybe 50 percent, and these other grant components, too, as we brought it to the CEO, reducing our upfront cost allows us to maybe explore some even more innovative approaches to what we want to do. Helping us get our costs down has a significant impact to how we move forward.

Mrs. BIGGERT. Glad to see the State of Illinois is funding some of that right now.

Mr. LOPEZ. Yeah.

Mrs. BIGGERT. Yes.

Ms. VANGEEM. So, as I said in my written statement, that, as far as federal policy, one thing that the government could do would be to mandate that all federal buildings—new federal buildings or major retrofits—use renewable energy.

And the concept is just to use a small percentage; you'd get one percent, or something like that, so that we can see what systems work best and are most cost effective. It doesn't have to be, something like ten percent, which is actually what the 189 standard comes out to for most buildings.

So that's what I would recommend.

Mr. CHEIFETZ. From a policy perspective, it would be interesting to see you try to help the utilities stay or become more responsive to these issues instead of saying one thing and doing another. It would be useful to look at basic regulations when it comes to building and environmental safety issues, including water safety, across the board so it's not different every time you step into another county or jurisdiction.

It would be interesting to see you develop a more clear conversation about things like federal guarantees. Everything from the SBA, who, although they try to do the right thing, have problems at the local level. The banks not knowing exactly if they are in conformance and not knowing if they can lend more. So there are many small things. Take as an example the education sector, which, by itself, if a non-profit's going to take advantage of the ARRA incentives, that suggests that one could put together power purchase agreements and energy supply agreements similar to what's been done in other sectors already and make those systems available on an energy savings basis to institutions of learning. That's still an area where that's not enough understanding, even among large financial institutions, and they don't have the appetite for looking at things on a pooled basis, project to project.

So, again, if we could develop a set of qualitative standards working in concert with the labs and other people—I don't know if, from a policy perspective, you can do anything to short-circuit what sometimes happens when we're trying to do the right thing—but we have a bureaucratic situation where it has trouble doing it. So policy, and you create teams that try to break through those issues. But those are the types of things we'd like to see.

GEOTHERMAL POWER AND DOE BUILDINGS TECHNOLOGY PROGRAM

Mrs. BIGGERT. You said in your testimony that you weren't clear how—it wasn't clear how well the relocation of the geothermal R&D activities to the DOE Buildings Technology Programs. Could you expound on that?

Mr. CHEIFETZ. Sure. I'm sure we're not the only renewable energy that has problems finding a home. Ours is particularly interesting because geothermal is often thought of as being geothermal power producing electricity, a hot-rock geothermal. And a ground-source geothermal hasn't gotten the same attention in the place where the Geothermal Program was. Now it's in Buildings, which pays a lot of attention to buildings themselves.

So, if you're talking, for instance, about developing breakthroughs, specialized building equipment to make it less expensive to get this infrastructure built in this country, it would make sense to have that in the Geothermal program. However, when it comes to what we really do, which is design a system that combines the building with the ground, that would probably more properly be in Buildings, but Buildings is interested now singularly in emerging technologies and not so much in things that they think of as heat pumps, which I think I also mentioned. As long as we keep thinking of this renewable technology as wells, heat pumps, and loops, it's going to be doomed to get understanding of what its potential is.

So I'm not saying we have to form something new. I think that the onus is more on us to reach out to those departments and have more conversations and try to begin some more kinds of initiatives so they can understand what we're doing and what's possible. It may be helpful for you to help that dialogue go forward as a result of some of the hearings we're doing. I think that would be very useful. So we're caught in a funny place, but, certainly, there's a way to get something done with something as straightforward, pragmatic, obvious, and needed as our little technology that can be deployed everywhere at a very good return on investment according to the DOE itself.

Mrs. BIGGERT. I give back.

VEHICLE AND STATIONARY BATTERY STORAGE PROGRAMS AT DOE

Mr. CARNAHAN. Thank you.

I want to turn to Dr. Chamberlain, to ask you to expand on your vision as what the stationary battery storage R&D program ought to look like. We, by most counts, have a pretty successful vehicle battery program. What part of that Vehicle Technologies Program could be incorporated, or are they so different that they really should just be standalone entities? Can you kind of give us your vision of what that ought to ideally look like? You know, take advantage of what advancements have already been in the vehicle arena, but we could really kick off the stationary research.

Dr. CHAMBERLAIN. I can comment on that. Thank you for the question. In the area of vehicle technologies, energy storage for transportation purposes, the research across the Argonne laboratory complex and our international laboratory, Lawrence Berkeley, are the two heat labs in this area. Their work runs across the spectrum from very basic research from theoretical physics of solid state materials up through inventing new materials—understanding and inventing new materials in the lab scale with gram quantities, to incorporating those in the small cells and testing them, to working directly with industry to make larger quality and quantity materials—or, improved quality and larger quantity materials for actual testing in true devices.

And, at Argonne, Argonne is the DOE lab for testing for performance of vehicle batteries from around the world—the technology from around the world. Similarly, Sandia does abuse testing, so they have the kind of bunkers available for actually destroying and exploding batteries and seeing what happens during the most catastrophic type of event. And, at Idaho National Laboratory, they actually do in-vehicle seat testing.

So the comparison I would make is, in the Vehicle Technologies Program, energy storage research across the labs and at universities, we do span the entire spectrum from the very basic to the full-out, applied, and testing full systems. By comparison, with regards to stationary storage, right now, we're only focused on that far end of the spectrum, this testing validation. As a country, we're relying almost wholly on companies to develop new technologies or to implement existing technology for stationary storage.

So, the very fundamental studies, the very basic studies of how to store energy, whether that's electrochemical or geothermal, Congresswoman Biggert mentioned earlier that all the work that went into hydrogen energy storage from the Vehicle Technology's perspective were last at A+. You could also store energy in the form of hydrogen. You could convert energy from wind and solar back into converting water to hydrogen for use in generating electricity to charge a car in your home or to charge your home.

So, the point is, that entire spectrum of research from basic to applied in stationary energy storage does not exist today in the scope of what's funded out of the Department of Energy. For the most part, it's focused, because it's a small program, on implementation. So that's a lack.

And, to your other part of your question, What could we capitalize on in the other vehicle technologies programs around the country to enable, say, a more expedited beginning of a new program in stationary storage? The answer is that the brains already exist. The electrochemists and the physicists that think a lot about charge transfer and how to structure a nano material to get an ion and an electron in and out of a material, that brain power already exists in the lab. The ability to test and validate technology already exists in the lab. The only gates that need to be opened are to open those minds in a way of actively funding and having the wherewithal in the political will for long-term investment, to fund the kind of research dedicated toward looking at new systems that would absolutely not work for a transportation-related application, but may be highly effective for a stationary one.

Does that answer the question that you were asking?

Mr. CARNAHAN. Mostly. I guess what I'm looking for—And that's good that, sort of, the brains and labs and conceptual part of that exists. And, I guess, as a practical matter, does it make sense to have those be two separate entities, or is that something that could continue in the same program; really looking at those two different models, the stationary and the vehicle——

Dr. CHAMBERLAIN. Yeah, that's a good——

Mr. CARNAHAN. —implementation.

Dr. CHAMBERLAIN. That is a good question. I don't speak for my friends at DOE, but the way I phrase it often is that the folks in the Office of Electricity Delivery and Energy Reliability would love to fund the basic research, in my opinion. They just don't have the funding, as compared to the folks in the Office of Vehicle Technologies, who have a very healthy program, but it's not in the scope of their mission to worry about any technology that can't be used for transportation-related research.

So, coming from the funding perspective, I think it has to come from separate sources. But, in terms of the actual work, I would say, on the basic side, it does make sense to have the same physicists, chemists, and engineers looking at it from a charged transport perspective. But, from the technology development side, it may or may not reside in the same pocket.

Mr. CARNAHAN. Because I think we all see the promise of the science, but, you know, we're dealing with limited funding sources, and does it make sense to expand their mission to look beyond the Vehicle Program when we're in the era of limited resources? And would that be the more cost-effective way for us to do that.

Dr. CHAMBERLAIN. Well, that is a good question. I'll offer my personal opinion. I think that's why we're here, I guess. I can't represent all of Argonne, but I believe the answer is, yes, it does make sense. Almost all of the questions, I think, center around one central theme, in my opinion, at a higher level, and that is, "Does Congress, as a whole unit, or the federal government, as a unit, have the political will to make a long-term investment."

We've heard a lot of versions of what I'm saying here now, both in your questions and on the panel. And I guess my advice or plea would be that now is absolutely the right time to do that. Even in the time of economic difficulty we're facing, if you look carefully at what's happening in Japan, Korea, China, and Europe, and the investments being made there, it's a little frightening, when you consider the automotive industry and the electronics industry; how all of our manufacturing jobs have moved to Asia. Right now, there happens to be a perfect storm brewing for us to actually manufacture these technologies on American soil. And, rather than talk about the possible negatives of not jumping on the opportunity early—and, again, I'm speaking strictly from an energy storage perspective—even though energy storage is an ancillary need of this overall on-site renewables question that you're asking, the estimations of the value, just from a gross domestic product perspective of energy storage for stationary, range in the low tens to high tens of billions of dollars, and that's strictly for making and selling batteries. It doesn't even include the overall efficiency gains an average consumer or a business would achieve by having a green building that would put storage as a piece of it.

And then, if you come at the calculation from a different perspective and look at kilowatt hours generated in a plant, say in making batteries, or you could also look at it from overall sales revenue of a given company, there are public companies out there where you could do these calculations. The market possibilities are in the tens of billions. Already there are examples, like MicroSun Technologies here in Lisle, Illinois, which is a tens-of-millions-of-dollar revenue company versus the Johnson Controls staff, which is a multi-billion dollar, multi-national company.

You can see that companies that earn, like A123 in Massachusetts, in the tens of millions—low tens of millions already employ hundreds and low thousands of both factory workers and high-end engineering- and scientist-type jobs; high, million-dollar jobs. Because you've just projected, on the back of the envelope, to the potential for the market, you're looking at an enormous infrastructure for jobs being created in this country.

I've gone off tangent a little bit from your question.

Mr. CARNAHAN. That's okay. And I've gone over time, and I just want to—I'd like to be able to follow up this kind of information that I think my colleague and I would love to have in hand to be able to continue this conversation with our colleagues, to help make the case for some of this continued research, and do we need to do a separate program or expand the mission of some of these existing programs.

And I give it to you.

SITING ENERGY STORAGE R&D IN FEDERAL AGENCIES

Mrs. BIGGERT. I guess, following up on that, if there were funding, and we don't know which on-site storage technology has the most potential to be deployed, maybe you know that, but would this type of work be best suited for the Office of Science in the Department of Energy, or are you talking about, from those two to the electricity or transportation performance arena? I'm not sure whether, you know, you would divide it that way or whether there should be something set up in DOE just for this.

Dr. CHAMBERLAIN. That's a very good question. As you both already know, there are energy storage technologies and research being funded out of a variety of offices in the Department of Energy, from ARPA–E to the Office of Science to the EFRCs, from EERE and Vehicle Technologies group, and OE. So there's a wide variety of established funding vehicles.

My personal belief is, it is a combination of those varieties of funding vehicles wherein the value of the overall program is identified. And I think it's up to the laboratories to actually integrate those programs, to have healthy relationships with industry, whether it's the power grid operators or the OEMs that make vehicles in Michigan. It is up to the labs to pull together the variety of sources of funding and make sense of them in a way that we can deliver it quickly and efficiently in the industry.

Now, obviously, I've dodged your question, but——

Mrs. BIGGERT. A lot of people do.

Dr. CHAMBERLAIN. —in this particular case, I'll go ahead and go out on a limb and say that the opportunity is now to deliver technologies. Coming from industry, I can tell you that there is enough research and knowledge out there now to focus on the more applied side.

From industry, I can tell you, stepping into the National Lab, everything we do—we say we're variants on the laboratory from basic to applied. In industry, research would tell you it's all basic. Compared to what they do in industry, what we do in the Lab is basic, and that's as it should be.

But my real point is, the opportunity for us today is to focus on the applied work that would be required to very rapidly deliver technologies to industries, say, in the next three to ten years as opposed to the next ten to twenty years. But I would still say the corporate balance, across the Office of Science and in the applied offices, would be a valuable thing.

Research Prioritization

Mrs. BIGGERT. The batteries and the energy storage is, I think, in focus right now. So I think you're right; the opportunity, you know, is there. We need to seize it. But so many times it comes back to, well, do we need a DOE or an outside organization or somebody to do a systemic assessment and prioritize the research? Now, this happened with nuclear, and I—to me—I was really working on that, and we had the opportunity to look at Ginna, and all of a sudden, "Well, there has to be this systemic assessment." And then everything folded, and there's not—nothing is moving forward right now, which I think is a tragedy. This is something long-term we need to do, too.

But is a systemic assessment necessary, or should it be?

I mean, I hope that we can do it in theory and get it done, but everybody brings this up.

Dr. CHAMBERLAIN. I think, yes, but I also think that our department's been moving very quickly in the last six months to do some of those assessments. Some reports already exist.

I refer to some in my written testimony, but I think I would say yes, but let's start with the reports that have already been written by those that are tightly wound with the grid operators and the idea of smart grid and what it means to the energy storage question with regard to where we're heading; grid both for on-site renewables and overall grid storage.

I think a lot of the information already exists, and I would start there before we even think about putting a panel together to answer those questions.

Ms. VANGEEM. I would tend to agree with Dr. Chamberlain. There are a lot of NREL and EPA and DOE reports out about the concern of lessons learned with different case studies and things. And I do want to emphasize the need for the storage. One of the NREL reports said that one of the times we need renewable energy most is when, on the hot days, the sun goes behind the clouds. And, so, we need the storage.

And then, the other thing we need is this whole concept of renewables, especially if the PVs are DC-powered. And, so, you know, how do we get that to AC? And I think there are enough reports out there that we know those needs, and you can just follow through with them.

Mrs. BIGGERT. I guess I was just considering, well, you know, we need somebody to bring all those together.

Ms. VANGEEM. Yeah. But it's—right. We may just need someone to bring it together, but I don't think you need to start over. Right.

Mrs. BIGGERT. I give back.

[Discussion held off the record.]

Encouraging Market Development

Mr. CARNAHAN. I wanted to get back to, I guess, what the federal government's role could be in moving forward as the largest owner of office space, renter, operator, using the size and the capacity to really help building the market. And I think some of that can be done with our practices, whether it's the way we look at building new buildings, looking at the life-cycle costs upfront so we're not just, you know, finding a building that costs X. When we know if we're looking at the life-cycle cost, that's always going to come out better, and it's going to help our technologies.

I guess other things that I want to just kind of open to the panel, things that you think that we can do in terms of how we operate our federal government building inventory. It could help, really, build the marketplace and drive this market, but it will also help grow the private sector in what they're doing. And I'll just start from this end, and we'll go across.

Mr. OSTAFI. Sure. Thank you for that question.

Actually, I believe the reality is the federal government is doing a lot right now, actually. Their requirements and mandates exceed ASHRAE standards by, I think, 20 percent or so, in terms of the energy performance of GSA office buildings. In fact, our firm is working on an office building in Denver for the federal courthouse, the Byron Rogers Building, and that group of constituents—the owners, and operators, and maintenance folks of that building—want that building to work towards being a net-zero building. And we're seeing this across other GSA office buildings, as well. And the reality is, it doesn't cost a lot more money to make a building perform 30 percent better than the current ASHRAE standards. It doesn't. And our bigger clients are figuring that out, finding that out, and pushing the design community to take it to the next level.

So I actually applaud what the federal government is doing, but I would say there are still loopholes in some of the federal energy management plans that say to constituents and operators of a building, "If it doesn't make financial sense, don't do it." I think we just have to mandate that they do it, and I love the idea proposed earlier that we mandate a certain percentage of renewable-energy integration into those buildings, because that doesn't exist today. I think one percent is too low. I think it should be three to four to five percent. Because, for office buildings, solar energy, for example, can produce a lot of artificial lighting, can help a lot of those systems in a building operate more efficiently at a simple payback time period.

Mr. CARNAHAN. Mr. Lopez.

Mr. LOPEZ. I like your question to the extent that it seems to be similar to the argument I'm making, that we can take a public entity, like our school systems now in the country, which represent—and I don't know the number, but it's got to be several billion square feet of space of buildings throughout the country, but take that and leverage it.

Also, I'm hearing that the research community seems to be advanced to a point where they're willing to deploy a lot of these technologies, and are able to deploy them. I think connecting that to the actual marketplace, I think, from the design community and from the end user, there's a willingness there to start to implement these technologies.

The biggest obstacle I do see is still the cost of some of these, and applying them, particularly dealing with the taxing bodies and funds of that sort, where people do look at first cost versus long-term cost. And, unfortunately, that's part of the education; showing people what the return on investment is on anything that we purchase. But part of what helps that return investment is, a lot of times, being able to tap into public money grants, funds. When we look at solar opportunities and wind opportunities, they're just not there in terms of the financial. But to see that, you know, an entity could, whether state or federal, make available funds to reduce those first costs, then the return on investment would be much more desirable, and it makes a project a go as opposed to a not-go.

So I see the financial need to provide the financing or the granting of funds for marketplace projects as significant. It would have significant impact.

Mr. CARNAHAN. Thank you. I know a lot of school districts are going to be looking at yours as an example——

Mr. LOPEZ. Thank you.

Mr. CARNAHAN. —in this evolution.

Mr. Cheifetz.

Mr. CHEIFETZ. Yes. And thanks for the question. First, I'd say set the bar very high. In keeping with what you've heard, let's not do something that we'll only have one chance to do, and it's not as good as it can be. In fact, set the bar so high that it forces all your supply chain to look at more innovative, smaller companies, ways of doing business differently than we usually do in that sector, because, typically, when you present something like this, it's the bigger companies, the established players that will do the work, and, usually, they're not the most innovative or cost-effective providers, if the truth be told.

So I'd say, in addition to the basic mandate, mandate a higher quality of outcome. In fact, make the whole thing outcomes-based from the top to the bottom. Higher standards, but also outcomes in terms of payback, in terms of quality, in terms of accountability, in terms of long-term life-cycle reporting so that it doesn't happen, and then it goes away. And let's use this as a laboratory to figure out how to improve everything beyond the federal governments' buildings and use it as a great example of how to do it.

I think, often, we don't achieve that as a goal. In fact, it's sometimes the example of doing things in a less cost-effective, more bureaucratic way. So I'd say very high standards forces the kind of tough work, forces your supply chain to do things a little differently, be more innovative, be more accountable, and be more outcome-based.

Mr. CARNAHAN. Thank you.

Dr. Chamberlain.

Dr. CHAMBERLAIN. I guess I would answer the question with a question that may be embarrassingly naive. We have standards for efficiency for vehicles, and we set goals for those, for the automotive companies. Is it too simplistic to try do that for new or retrofitted buildings? I know it's a significantly more complex question, but I would think, thinking locally, we're building buildings and retrofitting buildings at Argonne; federal buildings. Why isn't there—maybe there already is—a standard measurement of efficiency that needs to be achieved? So, I guess what I'm talking about is something simple, just setting a target and mandating that target.

Ms. VANGEEM. So I think that there are targets. They're either in the form of a prescriptive requirement or an energy use impacts-type thing, so your question is exactly where I'm coming from. You could mandate that all federal buildings have one percent renewables or up to ten percent or even higher. If it's one or two stories, you could probably go to 20 to 30 percent.

And the goal should be that the entire sunlit portion of the building, except maybe some windows used for day-lighting, should be either PV or solar thermal so that you're using the whole building shell to generate energy, and I need to figure out a way to work the geothermal in there. But I think that everything's out there that you need. And, so, just by using federal buildings as an example, you could do this.

Mr. LOPEZ. I think that——

Mr. CARNAHAN. Yes.

Mr. LOPEZ. —part of the answer is that the mindset is on non-renewable technology right now. I think the standards in the other departments—designers, users—try to achieve that through non-renewables. We say, "How can we put in more efficient equipment? How can we slow down the motors on equipment?"

So it's still—but it's still relying on non-renewables. I think the mindset needs to change as to how you make that jump from doing what we do every day to looking at a solar-panel infrastructure and wind-generated landscapes and things like that.

Ms. VANGEEM. Well, we need both, and the standards are getting—the standards are 30 to 40 percent more efficient than they were in 2004. But you need both; you need the jump in the non-renewables and the renewables to ever begin to approach net zero, which is the goal.

Mr. CARNAHAN. Okay. Very good. Thank you all. I'm going to—do you have another round?

AMERICAN COMPETITIVENESS AND JOB CREATION

Mrs. BIGGERT. I don't really have a question. I think just to close, unless a question comes out of it.

Going back to, we were talking about, you know, public policy and America competing with other countries, and it is something that we really have to focus on; you know, the gathering storm with a national heading that Dr. Augustine talks so much about, and how there's a renewable energy council, and he's on the board, as well as Bill Gates and them. I think this is something that—and I've been to one of their meetings, and I think that this is something that we really have to face, is that we have to have the creativity and innovation to compete in the global economy. And this is—I wanted to talk about why the other countries are moving forward. And the timing is really bad, obviously, with the economy as such, and I know that it's going to be very, very difficult for funding for some of this. And, to me, the creativity and innovation sciences is the most important thing next to national defense, because this is the only way that we're going to be able to create new jobs. You know, we're no longer just a manufacturing country. We have a lot of technology, but we have to have the technology to stay ahead of other countries, and our labs do a great job, our universities and industry, yet we face so many barriers that maybe we've created, as well as just, you know, the actual economy. So this is something.

I want to go out and write up about that—about this hearing that we've had today, because I think you've all brought up so many points of importance of what you're doing and how that benefits our country, but it also benefits, you know, the economy and what we're really working on right now. So, if you have any ideas, be sure, you know, to let us know, because what we've—for years, I would go into schools and talk to kids. I started where I asked, you know, what did they want to do when they grew up. And, for a while, it was, "Be Michael Jordan." So that dates me, as far as—but that was it. But then it was the president, and, now, so many of the kids really want to be engineers and scientists. And, so, we really have to tap into that, because our science and math is not at all good, and we're having reverse grade ranges. We've had, you know, the foreign students coming here. Now they're going home instead of staying here, too.

So there's so much to be done, and we're running ahead of opportunity for job creation and also, you know, helping so much with the environment. So I really applaud all of you. I just hope we can, you know, find the means to make this happen faster, and we won't if we don't participate. So, thank you all for coming.

Mr. CHEIFETZ. How would it be best to let you know, as we say? Because a little bit of encouragement goes a long way.

Mrs. BIGGERT. Okay.

Mr. CHEIFETZ. In both directions.

Mrs. BIGGERT. Well, maybe we'll have some more hearings on that, you know, to the Committee itself, in Washington. But, also, just if you have some ideas of what we should be looking at or ideas for more legislation or for whatever, I'll give you my card.

Mr. CHEIFETZ. Very good. Thank you. I'll be glad to.

Mr. CARNAHAN. I think you can see why I enjoy so much working with my colleague, Congresswoman Biggert. She not only knows the issues well, she has a great passion that she brings to this.

And, so, again, just thank you.

And to all the panelists, you really have given us some additional good ideas and inspiration. To me, it's one of the best Committees in Congress, to serve on Science and Technology, because it's the place where America has made such a difference historically; in science and technology. It's also the place where most of our economic growth has come from in this country. And we're in a place now, at kind of the crossroads, where we have an edge in some of these technologies, but we won't for long.

And, so, it's an opportunity, I really think, we have to grasp, but it's more than that; it's a race that I think we can win. But it's also strategically important to competing globally and being able to make things here at home and to be self-sufficient. It just ties into so many things. And a lot of this does—not all of it. Not certain a lot of this is driven in the private sector, but I think our public policy has to be in line with this, has to work closely with the private sector, but it's also an opportunity where, frankly, there's been a good deal of bipartisan cooperation. We've seen, you know, far too much political bickering in Washington. This is an area where I think there's some good basis for bipartisan to work together, and something I think we can actually get done.

CLOSING

So, again, just thanks to all of you. You've given us some good ideas. We welcome others, and we'll be sure you have our contact information. And we look forward to working with you in the months ahead. Thanks. And I just want to also thank Larry Collins and the Dirksen Courthouse for offering the courtroom here today.

We're going to keep the Committee record open for two weeks for any additional statements from the members or to answer any follow-up questions we may ask of the witnesses.

So, with that, we're going to wrap up the hearing, and we will be in touch.

[Whereupon, at 11:30 a.m., the Subcommittee was adjourned.]

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