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SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING

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INTRODUCTION

Mr. Chairman, Congressman Sensenbrenner, Congressman Shadegg from my home state of Arizona, and other members of the Committee: My name is Dr. Jay Golden, and I am an assistant professor and director of the EPA-designated National Center of Excellence on SMART Innovations for Urban Climate & Energy at Arizona State University.

Although our Center has a long name, our mission is straightforward. We are a group of researchers from various engineering and science disciplines that work together to provide policy makers with information about how materials affect energy use and climate, especially in urban environments.

More specifically, our work helps local and regional agencies to develop strategies to reduce vulnerability and risks associated with extreme weather events. We focus on heat waves, the urban heat island effect, and their relationship to reliable electricity delivery.

I speak to you today not only as an academic, but as former environmental-crimes detective, hazardous-materials responder, manager of a Fortune 500 company, small-business owner and, after being called upon to assist in the aftermaths of 9-11, someone who went back to school to earn his PhD and dedicate himself to make a difference for my children and for our country.

To that end, I have been dedicating my life's work towards the issues of climate change and vulnerability. First, allow me to present some of the driving factors behind my research and why I believe greater federal action needs to be taken to support state, regional, and local governments as they seek to protect our national security.

FACTOR #1 – Heat-Related Deaths

More people in the United States DIE from heat-related events than all other weather related phenomenon COMBINED.

That is, more Americans die each year from extreme heat than from lightning, hurricanes, tornadoes, and floods combined. (Weisskopf et al. 2002). Additionally, according to the US Census, the US population is aging; the population over age 65 is projected to be 13% by 2010 and 20% by 2030 (that's over 50 million people). Older adults are more vulnerable to temperature extremes, suggesting that temperature-related deaths will increase.

FACTOR #2 – Global Climate Change

Global climate change will increase human-health vulnerability as more frequent and extreme weather events, including heat waves, impact our country.

In their 2008 report, the US Climate Change Science Program and the Subcommittee on Global Change Research concluded that "abnormally hot days and nights and heat waves are very likely to become more frequent."

Since the record hot year of 1998, six of the last 10 years have had annual average temperatures that fall in the hottest 10% of all years on record for the US. Recent studies have looked at "Heat Waves" for the US and North America. These studies found that there is an increased likelihood

of more intense, longer-lasting, and more frequent heat waves (Meehl and Tebaldi, 2004; Schar et al. 2004; Clark et al. 2006). This finding is especially true in the southeastern, southwestern and western US.

In a soon-to-be published paper, Sterl and others assessed extreme high temperatures around the globe through 2100. Their research warned of dangerously high temperatures predicted for densely populated areas including the Midwest.

Their study projected heat wave events in 2100 reaching 117°F in Los Angeles, 110°F in Atlanta, and116°F for Kansas City. Those projections are for the end of the century but even going out just 40 years from now heat waves will be 3 to 5°F degrees hotter than now and will probably be longer lasting.

FACTOR #3 – Urban Climate and Urban Heat Islands

Over half of the planet's population now lives in cities, up 30% from 50 years ago, and urban areas are gaining ~67 million people per year. By 2030, approximately 5 billion people are expected to live in urban areas—60% of the projected global population of 8.3 billion (US Census 2008; UN 2002). The US grew by nearly 33 million people between 1990 and 2000, the largest 10-year population increase in our history. The fastest-growing region in the past decade was the West at nearly 20%, which added over 10 million people. The fastest-growing states in the nation were all in the West: Population in Nevada (66%), Arizona (40%), Colorado (31%), Utah (30%) and Idaho (28%) have increased dramatically. California recorded the largest numeric increase of any state, just over 4 million people. In 2000, more than 8 out of 10 people lived in metropolitan areas[i], and 3 in 10 were in metro areas of at least 5 million people (US Census 2000).

Along with increased population comes rapid change in land cover and increased use of materials. What are the consequences of the change from vegetated surfaces to engineered infrastructure? Less water evaporates from plants and buildings and other structures retain more heat during the day and time. And sustained higher night-time temperatures increase the vulnerability to human health.

On average, the world has warmed by 1.33°F over the last century, with most of that increase occurring in the last 30 years (IPCC 2007). In many urban areas, however, the rate and intensity of warming have increased much faster. Over the 20th century, average annual temperatures in the arid subtropical Phoenix region (33°26'N, 112°W) have increased 3.1°F (Brazel et al. 2000). However, mean annual temperatures in the urban portions of our region have increased 7.6°F.

The 0.86°F per decade warming rate for Phoenix is not an isolated experience. For example, Los Angeles's rate was 0.80°F per decade; San Francisco, 0.20°F; Tucson, 0.60°F; Baltimore, 0.20°F; Washington, 0.50°F; Shanghai, 0.20°F; and Tokyo, 0.60°F (Hansen et al. 1999).

FACTOR #4 – A Vulnerable Electrical System

In the US, parts of our electrical delivery capability are at increasing risk of failure. The same land-cover and urbanization trends are almost certain to cause an increased demand for electricity due to increased mean global and urban temperatures and more prolonged heat waves.

The primary means of "adaptation" to climate warming is through the use of mechanical cooling (air conditioning). As described earlier, observations and models of climate change indicate that these elevated temperatures are being sustained longer into the evening that greatly augments "peak" electricity demand. The greater the demand, the more fragile the electric system becomes as older units fail due to mechanical breakdowns and as heavily laden power lines stretch and sag from heat. Beyond the human health impacts, there are significant financial implications. Researchers estimate annual service interruptions cost our country between $80 and $120 billion (Eckles, 2006; LBNL, 2004; Freeman, 2006).

Each of these four factors I have described must be examined and understood as a "system" that has many influences and many feedbacks. As one example, consider that CO_2 emissions from the US electric-power sector have grown by 27% since 1990, and CO_2 from electric power represented 39% of energy-related CO2 emissions in 2004. In cities with populations >100,000, peak-utility loads increase 1.5–2% for every 1°F (0.6°C) increase in summertime temperature. By 2025, US electricity consumption is projected to grow by 50% over 2003 levels. To meet this rising demand while retiring inefficient older plants, 281,000 MW of new power-generation capacity will be needed by 2025—equivalent to almost 950 new power plants of 300 MW each[ii] (EIA 2005).

A new generation of technologies and innovations, "SMART Innovations" (Sustainable Material and Renewable Technologies) are going to be needed if we are to meet this increased demand for electricity and protect our population while minimizing emissions of carbon dioxide that contribute to climate change.

THE FEDERAL GOVERNMENT – LOCAL GOVERNMENT NEXUS

Through my experiences with the cities of Chicago, Tucson, Phoenix, Philadelphia, New York, London, Seattle, Dallas, and Washington DC, I have gained insight into how the federal government can provide more needed support for cities and counties—large and small, urban and rural.

These governments and their officials are on the front lines in preventing, responding to and seeking ways to mitigate the impacts of climate change on their citizenry. Examples include the 1995 heat wave in Chicago that resulted in 739 deaths and the August 2003 heat wave in Europe that killed an astonishingly 35,000 people. These are certainly dramatic events, yet they are not isolated. The US experiences significant and multiple heat-related events each year such as:

Missouri: During a July 1980 heat wave, deaths increased by 64%. One in every 1,000 residents of St. Louis and Kansas City was hospitalized for or died of heat-related illness. Individuals of lower economic means were at 6 times greater risk of getting heat stroke (Jones et al. 1982). The hazards continue, as a recent study shows that residential customers of Kansas City Power and Light r used 42% more electricity in 2007 that in 1986 (Missouri 2007). In July 2006, Kansas City Power and Light broke energy records in the midst of a heat wave.

Wisconsin: During July 12-15, 1995 the Milwaukee County Medical Examiner's Office received reports of 197 deaths. Of these almost 50% were heat related. (US CDC 2001).

Michigan: Regional government is investigating how the state's two largest utilities, Detroit Edison and Consumers Energy responded when 720,000 customers were left without electricity, some for up to a week, just last month.

California: A 15-day heat wave in July 2006 caused power interruptions and a reported 136 deaths. Just a few weeks ago (June 21, 2008), workers from the LA Department of Water and Power accidentally broke a line that led to widespread power outages that cut power to LAX airport and the UCLA Medical Center and necessitated that several oil refineries burn off gas to relieve pressure, triggering an air quality/human-health warning.

Connecticut: Over 60,000 customers of Connecticut Light and Power and Con Edison were without power May 26, 2008 due to high winds with a subsequent event in June that left another several thousand without power.

Tennessee: Last August, Memphis maximum temperatures "dropped" to 94°F which was the first time in 10 days they did not top 100°F.

Although human-health impacts are felt more in urban areas, the urban heat island and increased and sustained heat waves also concern rural regions. Much of the electricity supplied to urban areas is generated in rural regions. Decreased air and water quality, water quantity, and waste byproducts affect the quality of life in rural areas as well as the health of ecosystems.

Lastly, at a time of increased food costs, sustained and increased temperatures also hurt crop yields and dairy production.

INITIAL PROGRESS

My testimony today and the facts I have presented are not meant to give the impression to this committee that little is being done at the federal level. Quite to the contrary, it has been my experience that some of our federal agencies deserve a great deal of credit for their current efforts. In particular:

The Environmental Protection Agency through its Office of Atmospheric Programs – Climate Change Division has been working to support local, regional, and state governments to better prepare for climate change and extreme heat events. In 2006, the EPA took the lead on developing an Excessive Heat Events Guidebook in partnership with NOAA/National Weather Service, the Centers for Disease Control and Prevention, and FEMA. This widely distributed guidebook is providing an initial platform for local governments to predict, assess, notify, treat, and mitigate Extreme Heat Events

The Climate Protection Partnership Division of EPA has also been managing a small but well-respected group called the "Heat Island Reduction Initiative" that has been successful in issuing best-practice guidance to local, state, and regional governments.

The National Center for Environmental Health at the US Centers for Disease Control and Prevention has been stepping up efforts to tackle the issues of climate change and human health. They have developed the modeling capabilities related to health system function, public health

economics and ecosystem changes relevant to health. As this program is able to expand, it will provide a much-needed national resource.

Additionally, the National Weather Service has developed and continues to expand its Heat Advisory, Excessive Heat Warning, and Excessive Heat Watch program, a key tool for preparing emergency responders and health-care providers to respond to extreme heat events.

Finally, over the last year I have worked with these agencies engaging state, regional and local officials around the country to develop the tools, research, products, and other support they need to address extreme weather, urban heat island, and electricity reliability.

The feedback has been loud and clear. Much more needs to be done to better prepare our local governments to address this highly complex problem so that we can reduce the vulnerability of human populations and protect our national security. As a starting point, the National Center of Excellence is about to launch a cyber-enabled virtual organization at www.Heat-Waves.org

This site will serve as a national platform where the research community, regulatory community, industry and local practitioners can come together to share the latest scientific findings, models, remote-sensing products, as well guidance documents and regional programs, policies, and initiatives.

RECOMMENDATIONS

All this shared information however, is just a starting point. Given the growing risk to our country and the increasing needs of our local and regional government, greater support and resources must be provided to our leading federal agencies. I therefore put forward to you Mr. Chairman and members of the Committee the following personal recommendations:

Action #1: Develop a Stronger and More Integrated Urban Research Focus

Cities are increasingly recognized as key focal points for both government policy and research, because they are where the most people live today (both nationally and globally) and where most future population growth will occur. They account for a large aprt of carbon and other toxic emissions, and their citizens are responsible for major consumption of energy, water, materials, and food. Cities are also hubs of innovation. Perhaps most importantly, cities today are taking proactive stands related to sustainability issues. Addressing sustainability problems like water supply, air quality, urban heat, public health, and energy security within the context of cities offers economies of scale that might lead to real solutions that can benefit millions of people relatively quickly. On the other hand, cities can be major sources of environmental stress and inertia.

Given the importance of cities for economic, social, and environmental policy, both in the US and abroad, it's remarkable how little in the way of federal funds are targeted at understanding and solving urban problems. Because no one mission agency has responsibility for all the components of a city, no government body is funding research that looks at how all the parts fit together. Instead, the EPA looks at urban water, solid waste, and air-quality, Department of Transportation looks at highway infrastructure and traffic, NOAA looks at urban climate, the Forests Service considers urban forests, and NASA develops new remote-sensing platforms. Who will synthesize all this information into a model that incorporates as much data as possible? Fundamentally, Congress should direct agencies and the NRC to look for ways to create synergistic urban research programs.

Action #2: Dedicated Urban Satellite

This action closely aligns with Action Item #1. Remote sensing from space can play a vital role in protecting human health and the environment from climate change, urban heat islands, and failures of electrical-power systems. Scientists continue to develop and refine complex predictive models to gain a greater understanding of land-use/land-cover changes, environmental indicators, and, increasingly, the role of urban temperature on microclimates, electricity reliability, and human health.

Changes in land surfaces, land use, and ecosystems all have great significance in our ability to understand and more effectively predict:

1. Expanded danger from storms and other meteorological phenomena
2. Adverse global and localized climate impacts
3. Dangerous urban environmental impacts
4. Human health vulnerability from urban heat island effects, heat waves and blackouts.
5. Dangers associated with nuclear, biological and chemical dispersion and associated human health/environmental vulnerability
6. Energy and peak electricity demand planning and vulnerability
7. Air quality and surface-water quality compliance and impacts
8. Surface transportation infrastructure degradation
9. Water consumption and resource management

During this time of increasing threats due to urban and global climate change the need for dedicated satellite systems that provide the basis for our ability to prevent harmful impacts is in jeopardy of phase-out and abandonment and/or failure. Only two Landsat spacecraft are in orbit; data acquired from Landsat 7 is of reduced quality due to a scan-line corrector failure, and Landsat 5 is operating well beyond its design lifetime. The ASTER sensor (onboard the Terra spacecraft launched in 1999) is also now operating in an extended mission mode. Even when these systems have been fully operational, their use in urban monitoring has been limited due to the competing demands for operational time, their orbits and repeat times, and the specific instruments they contain.

As costs continue to lower and technologic sophistication increases, the possibility of designing a cost-effective urban satellite system with greater capabilities and resolution is becoming a reality. Our nation needs its governmental agencies, industries, and universities to collaboratively design, construct, launch, and direct operations of an Urban Satellite System. With this tool, we can provide local and regional governments with detailed analysis and tracking of cities that will aid in planning, infrastructure management, emergency-response preparation, and mitigation strategies. Climate models being developed for urban regions are only as good as the data that is being entered. The time for significant improvement in data sourcing is upon us, but not without the realization of an American Urban Satellite System.

Action #3: Streamline and Enhance Electricity Interruption Reporting Requirements

We lack an effective and consistent national-level program that examines interactions of the built environment, climate, and safe-electricity delivery for cities, let alone an effective way to track outages. At best, our nation’s current system can be considered confusing and less than adequate.

The Energy Information Agency defines eight criteria by which utilities have to report major disturbances (service interruptions) within one hour and four criteria by which utilities have to report major disturbances within six hours.

The North American Electric Reliability Corporation (NERC) has been given the name of "Electric Reliability Organization" by the Federal Energy Regulatory Commission which, in essence, declares NERC's role as the independent entity with authority to develop and enforce mandatory standards for the reliability of the bulk power system.

NERC works with the *Eight Regional Entities*:

- Florida Reliability Coordinating Council (FRCC)
- Midwest Reliability Organization (MRO)
- Northeast Power Coordinating Council (NPCC)
- Reliability First Corporation (RFC)
- SERC Reliability Corporation (SERC)
- Southwest Power Pool (SRP RE)
- Texas Regional Entity (TRE)
- Western Electricity Coordinating Council (WECC)

Disturbance Reporting, as defined in standard 1-EOP-004 (Effective 1/1/2007), requires a preliminary written report to be filed with NERC and with the regional reliability entity. Each regional reliability entity has to establish reporting procedures to facilitate the preliminary reporting in its region.

Further complicating the issue is that the states have very different reporting requirements if, in fact, they even have reporting requirements. And none of the many reporting requirements were established with considerations of understanding human health and national security vulnerability from climate change.

At a time of anticipated increased heat waves, growing urban heat islands and increased demand for electricity, we need to increase our understanding of electricity outages of different scales. To examine the economic, environmental, and social impacts of our climate-electricity system and make appropriate recommendations to reduce our collective and individual vulnerability, researchers and agencies need access to highly accurate and refined data. In short, we need a new comprehensive and rational national power-outage reporting system.

Action #4: Create a Multi-Agency Working Group to Recommend Actions to Reduce Human Health and Environmental Vulnerability from Extreme Heat Events

Finally, there is a larger group of experts representing government, industry, and universities that need to be brought together to expand this preliminary list of actions.

I strongly urge this committee and Congress to support the development of "A Report to All Appropriate Committees of Congress" on the issues of heat waves, urban heat islands, and human health vulnerability.

This proactive effort will provide Congress greater insights and multi-stakeholder recommendations on three primary topics:

1. Identify existing and emerging needs of local and regional governments to prepare and respond to human heat-health vulnerability resulting from heat waves, urban heat island effect, climate change, and electricity outages.
2. Examine the roles and capabilities of federal agencies to support local and regional governments and suggest programs to improve these capabilities.
3. Provide recommendations for future research initiatives that can reduce vulnerability and improve our national security.

Because of their mission to protect human health and the environment as well as their efforts to date, the US Environmental Protection Agency would seem to me to be the logical agency to lead such an effort.

I strongly caution that the timing of such an effort must be immediate. By waiting and not addressing these issues in the present day, we risk our populace and our national security today and into the future.

About Arizona State University (ASU)

ASU has a vision to be a New American University, promoting excellence in its research and among its students and faculty, increasing access to its educational resources and working with communities to positively impact social and economic development.

Further, ASU is a public institution where sustainability is a fundamental precept underlying its teaching, learning, research, and business missions; and that seeks to produce knowledge and discover solutions to global problems of sustainability.

- ASU's Tempe campus has one of the nation's largest enrollments on a single campus at 51,481 students. ASU has a total of 64,394 at its four campuses.
- ASU is ranked as one of the top 100 universities in the world by the Institute of Higher Education.
- Economics professor Ed Prescott became the university's first Nobel laureate, earning the Nobel Prize for Economics in 2004.
- ASU's 2007 freshman class included 148 National Merit Scholars, more than any public university in the Pac-10 conference.
- ASU has the most undergraduates (11) named to USA Today's Academic First Team of any public university in the nation. Only Harvard (21), and Duke (12) have had more. The USA Today Academic Team rankings began in 1990.

About ASU's Global Institute of Sustainability

The Global Institute of Sustainability is the hub of ASU's sustainability initiatives. The Institute advances research, education, and business practices for an urbanizing world.
http://sustainability.asu.edu.

About ASU's School of Sustainability

Established in 2007, the School of Sustainability, the first of its kind in the world, offers transdisciplinary degree programs that advance practical solutions to environmental, economic, and social challenges—especially as they relate to urban areas.
http:schoolofsustainability.asu.edu.

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[i] Urban - All territory, population and housing units in urban areas, which include urbanized areas and urban clusters. An urban area generally consists of a large central place and adjacent densely settled census blocks that together have a total population of at least 2,500 for urban clusters, or at least 50,000 for urbanized areas. Urban classification cuts across other hierarchies and can be in metropolitan or non-metropolitan areas. A metro area contains a core urban area of 50,000 or more population, and a micro area contains an urban core of at least 10,000 (but less than 50,000) population. Each metro or micro area consists of one or more counties and includes the counties containing the core urban area, as well as any adjacent counties that have a high degree of social and economic integration (as measured by commuting to work) with the urban core.

[ii] A typical smaller and newer power plant has a capacity of 500MW, would run ~5,000 hours/year = 2.5 billion kWh/2.5TWh 10^{12} Older plants are more likely to be 1,000MW / 1GW Average US household uses 11,000kWh Arizona household uses ~12,500kWh per year Air Conditioning is the largest consumer of residential electricity in the US.