THE CONTRIBUTION OF THE SOCIAL SCIENCES TO THE ENERGY CHALLENGE

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

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THE CONTRIBUTION OF THE SOCIAL SCIENCES TO THE ENERGY CHALLENGE

TUESDAY, SEPTEMBER 25, 2007

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Subcommittee met, pursuant to call, at 10:04 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Brian Baird [Chairman of the Subcommittee] presiding.

BART GORDON, TENNESSEE
CHAIRMAN

RALPH M. HALL, TEXAS
RANKING MEMBER

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The Committee on Science and Technology
Subcommittee on Research and Science Education

Hearing on:

The Contribution of the Social Sciences to the Energy Challenge

2318 Rayburn House Office Building
Washington D.C.

September 25, 2007
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESS LIST

Dr. Robert Cialdini
Regents' Professor of Psychology and Marketing
Arizona State University

Dr. Duane Wegener
Professor of Psychological Sciences
Purdue University

Mr. John "Skip" Laitner
Visiting Fellow and Senior Economist
American Council for an Energy Efficient Economy

Dr. Jerry Ellig
Senior Research Fellow
Mercatus Center at George Mason University

Dr. Robert Bordley
Technical Fellow
Vehicle Development Research Laboratory
General Motors Corporation

HEARING CHARTER

SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

The Contribution of the Social Sciences to the Energy Challenge

TUESDAY, SEPTEMBER 25, 2007
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Tuesday, September 25, 2007, the Subcommittee on Research and Science Education of the House Committee on Science and Technology will hold a hearing to examine how research in the social sciences, including the behavioral and economic sciences, contributes to the design, implementation and evaluation of effective policies for energy conservation and efficiency.

2. Witnesses

Dr. Robert Bordley, Technical Fellow, Vehicle Development Research Laboratory, General Motors Corporation

Dr. Robert Cialdini, Regents' Professor of Psychology and Marketing, Arizona State University

Dr. Jerry Ellig, Senior Research Fellow, Mercatus Center, George Mason University

Mr. John "Skip" Laitner, Visiting Fellow and Senior Economist, American Council for an Energy Efficient Economy

Dr. Duane Wegener, Professor of Psychological Sciences, Purdue University

3. Overarching Questions

- What contribution do the social sciences make to our ability to predict or evaluate the effectiveness of public policies in changing individual and collective behavior related to energy use?
- What new and continuing areas of basic research in the social sciences could significantly improve our ability to design effective policies? What new technologies and methodologies are enabling advances in the research? Are there promising research opportunities that are not being adequately addressed?
- To what extent are policies (both private and government) to influence energy consumption patterns actually being shaped by what has been learned from the social sciences?

4. Federal Spending on Social, Behavioral and Economic Sciences

Basic and applied research in the social, behavioral and economic (SBE) sciences is funded out of a number of federal agencies, including the National Science Foundation (NSF), the National Institutes of Health (NIH) as well as other agencies within the Departments of Health and Human Services, Agriculture, Commerce, Defense, Education, Homeland Security, Housing and Urban Development, Interior, Justice, Labor, State and Transportation. The National Endowment for the Humanities and the Smithsonian Institution also provide some funding in these areas. Notably, given the topic of this hearing, the Department of Energy does not have a program of social science research applied to the energy challenge.

According to research funding statistics compiled by NSF[1], a total of just over $1 billion was obligated to basic and applied research in all social sciences for fiscal year 2004 (FY04), including $200 million for economics. Psychology was counted separately, and was funded at a total of $1.85 billion in FY04, of which $1.7 billion was funded by NIH and over $90 million was funded by DOD and Veterans Affairs. The primary interest of those three agencies is the medical aspect of psychology.

The main support for basic research in the social sciences comes from the SBE Directorate at NSF. Overall, NSF accounts for 61 percent of federal support for basic research in anthropology, social psychology and the social sciences at U.S. colleges and universities. In some fields, including archaeology, political science, linguistics, and non-medical aspects of anthropology, psychology, and sociology, NSF is the predominant or exclusive source of federal basic research support. The NSF SBE budget request for fiscal year 2008 (FY08) is $220 million, an increase of 3.9 percent over FY07. In addition to funding basic research in the social, behavioral and economic sciences, NSF's SBE Directorate funds the collection and analysis of data on science and engineering research, education and workforce trends (including the data presented here), resulting in the biannual "S&E Indicators." This activity accounts for $31 million in FY08, or approximately 15 percent of the SBE Directorate budget.

5. Social, Behavioral and Economic Sciences and the Energy Challenge

A key part of the solution to our energy challenge is the development of more efficient, cleaner energy technologies. This is a primary mission of the Department of Energy. However, while it may be impossible to quantify, individual and collective behavior also plays an important role, not just through direct use of energy, but also by creating or failing to create market demand for more energy efficient technologies. Individuals across the United States make decisions every day about what vehicle or appliance to purchase, whether to drive or take public transportation, what light bulbs to install, whether to shut down their computers at night. Each one of these decisions, from turning off the computer to buying a 35 mpg sedan versus a 15 mpg SUV, has an impact on the supply and demand curve that drives both energy prices and energy technology development, has some environmental footprint, and in the case of oil and natural gas, may have an impact on national security.

These impacts are generally quantified in the aggregate, based on data collected by the Energy Information Administration. In 2005, U.S. households consumed 21 quadrillion BTU (quad) of primary energy, accounting for 21 percent of total U.S. energy consumption. To put this in perspective, people in the United States consume 2.4 times as much energy at home as those in Western Europe, in large part because our homes are twice as large and not designed for energy efficiency, despite the availability of affordable technologies to make them so. Household vehicles account for an additional 14 quad or 14 percent of primary energy, resulting in an overall household total of more than one-third of annual U.S. energy consumption.

In 2005, the National Academy of Sciences (NAS) produced a report on "Decision-Making for the Environment: Social and Behavioral Science Research Priorities." Much of the research called for in the report is of an applied nature—for example, quantifying the environmental or economic impact of every minute action, such as running the clothes dryer during peak hours instead of off-peak hours. Information such as this might help policy-makers prioritize efforts and could even stimulate technological innovation, but it isn't clear that such information would actually influence consumer behavior. In the chapter on *Environmentally Significant Individual Behavior,* the NAS panel states that, "A basic understanding of how information, incentives, and various kinds of constraints and opportunities, in combination with individuals' values, beliefs, and social contexts, shape consumer choice in complex real-world contexts would provide an essential knowledge base for understanding, anticipating, and developing policies for affecting environmentally significant consumer behavior."

Energy-related behavior is significant not just to the environment, but to the consumer's own monthly expenses, to the economy as a whole, and to national security. The National Science Foundation is not responsible for generating the needed data on environmental and economic impact called for in the NAS report, or for sharing it with the public. However, NSF does fund the basic research in the social, behavioral and economic sciences that can help inform policy-makers at all levels in the development, implementation and evaluation of information campaigns, incentives

[1] Data are based on self-reporting by agencies. In many cases, especially where there is interdisciplinary work, it is hard to tally exact dollars spent on one field or another, so these values are at best an estimate.

programs, regulations and other public policies to change how we use energy in this country.

A similar story can be seen in the recent history of smoking in the United States. Changing societal norms resulted in a society that is now hostile to smokers and as such have greatly reduced the number of smokers, resulting in reduced health risks for individuals and a reduced burden on our collective health system. But linking smoking to lung and other cancers was not sufficient to bring about this decrease. Nor was the knowledge that second-hand smoke was harmful to others. Advertising by tobacco companies still made smoking look "sexy" just as car company advertisements make large SUV's look very appealing to the typical consumer. In addition to laws restricting advertising, and the near elimination of smoking from movies and television (the characters who light up in today's movies are typically the "bad guys"), public officials and non-profit organizations launched major information campaigns targeted at different populations. Many of those information campaigns failed to influence smoking behavior, in particular among youth. Social and behavioral researchers eventually helped to determine what kinds of advertisements and other anti-smoking campaigns work for which target populations.

There are many parallels to behavior and persuasion in the energy challenge. A 2003 survey commissioned by the Alliance to Save Energy found that an overwhelming majority of consumers (92 percent) agree that business, government, and consumers have an equal responsibility to reduce energy use. But attitudes have not translated into action. Social science researchers can help create and provide information in an understandable manner, a particularly challenging task in the case of energy; determine how information interacts with all of the other factors listed by the NAS panel to affect consumer behavior; understand variation in these interactions across subsets of the population; and work with policy-makers to help shape targeted information campaigns and policies.

The Department of Energy launched an "Energy Hog" energy efficiency campaign in 2004. The Energy Hog website provides useful information to consumers about how to save energy without spending a lot of money. Such information, however, is primarily reaching those self-selecting consumers who actively seek it. The majority of Americans, despite concern for both the environment and rising energy prices, simply don't consider energy in their own behavior or in that of their neighbors. The purpose of this hearing is to explore the basic research that could help policy-makers understand why attitudes about energy don't currently translate into action.

6. Questions for Witnesses

Dr. Robert Bordley

- Please describe the type of market research you do for GM and how your background and experience as a social scientist influences your work.
- What has social science research revealed about factors that influence an individual's vehicle purchasing decisions? What questions remain unanswered? Have you looked specifically at the issue of fuel economy?
- How are recent breakthroughs in research incorporated into marketing or business strategies? What role might the National Science Foundation play in building bridges between academic social science researchers and government and industry policy-makers?

Dr. Robert Cialdini

- Please describe the work you have done recently on individual behavior and energy conservation. What have you learned about what influences the decisions individuals make with respect to energy use?
- How can this research be used more effectively to inform policy? Do you as a researcher reach out to policy-makers or others in a position to influence policy? If not, how would you propose that these connections be made? Can the National Science Foundation play a role?
- What basic social psychology research questions relevant to the energy challenge remain unanswered? Do social scientists have all of the tools they need to answer these questions and adequate resources to pursue promising research directions? Are there as of yet undeveloped or underdeveloped technologies or methodologies that would help advance this research?

Dr. Jerry Ellig

- How predictive is a purely economic approach to evaluating the impact of energy policy on individual and communal behavior? What factors other than

price signals need to be considered when developing and applying economic models to energy-related behaviors?

- To what extent are policies to influence individual and community energy use being shaped by what has been learned from research in the social sciences, including economics?
- What tools and methodologies are most appropriate for evaluating the effectiveness of policies to incentivize consumer behavior with respect to energy use? What kinds of basic research questions underlie the development of such tools and methodologies?

Mr. John "Skip" Laitner

- How predictive is a purely economic approach to evaluating the impact of energy policy on individual and communal behavior? What other factors need to be considered to match economic theory to empirical data? To what extent are such data even available? That is, to what extent are relevant energy policies being evaluated for effectiveness?
- To what extent are policies to influence individual and community energy use being shaped by what has been learned from research in the social sciences, including economics? Are you aware of particular sectors of industry or government that make more of an effort to incorporate the results of such research into the design and evaluation of policy?
- Please describe the purpose and scope of the first-ever Behavior, Energy and Climate Change Conference being organized by ACEEE. What do you hope to achieve through this conference? How much interest have you seen from industry, government officials, and others in a position to influence policy?

Dr. Duane Wegener

- Please describe your involvement in the Purdue Energy Center, and in particular the mission and goals of the Social, Economic, and Political Aspects of Energy Use and Policy team of the Center. How and to what degree does your team interact and collaborate with the technology teams at the Center?
- How much support do you and your colleagues in this area get from federal funding agencies? Have you sought any support from or partnerships with public or private utilities or other non-governmental entities?
- What has social science research revealed about factors that influence how Americans form attitudes relevant to energy use and policy? How can this research be used more effectively to inform policy?
- What basic social psychology research questions relevant to the energy challenge remain unanswered? Do social scientists have all of the tools they need to answer these questions and adequate resources to pursue promising research directions? Are there as of yet undeveloped or underdeveloped technologies or methodologies that would help advance this research?

Chairman BAIRD. We will now call this hearing to order, and I want to thank all our witnesses and guests here and my good friend and colleague, Dr. Ehlers, for being here. I want to also thank staff for their outstanding work in putting this hearing together.

I am especially excited about today's hearing because it sets the ground work for a number of hearings that I hope to hold in this committee looking at how the social sciences can help us address some of the most difficult challenges we face in our country today. Energy, in my opinion, ranks among the country's top three challenges, next to health and national security. Solving our nation's energy challenges will depend on a combination of technological innovations and behavior changes. This committee and this Congress have held countless hearings on the energy technologies of tomorrow. What we don't talk often enough about is behavior and how changes in behavior can start making a big dent in our energy challenge today. Whereas we talk about the technologies of tomorrow, behavior can help us make the changes today.

The panel sitting before us will give us insight into how we might achieve this goal. One witness will tell us how a simple change in a written message to hotel guests asking them to reuse their towels could save 39 barrels of oil and 72,000 gallons of water in an average—in one hotel in one year. If you multiply that by all the hotels in all the cities in this country, that adds up to real energy savings, and that is just one example of the kind of things we can learn from this hearing today.

Imagine if every American decided to turn off their lights when they left the room, shut down their computers at night, or look for Energy Star labels the next time they shop for a major appliance. The truth is U.S. households are responsible for more than one-third of annual U.S. energy consumption. Of that approximately 60 percent goes into powering our homes and the rest into fueling our cars and SUVs, though not my SUV. To put it in perspective, American homes consume 2.4 times as much energy as homes built in Western Europe, 2.4 times as much. A recent survey by the Alliance to Save Energy found that 92 percent of Americans agree that businesses, government, and consumers have an equal responsibility to reduce energy use. That seems fair, given that consumers use one-third of the energy. Unfortunately, this attitude is not always translated into action. The truth is that typical consumers don't have the information to factor energy use to purchases and behaviors, and the government and industry have fallen far short in providing or communicating the needed information to the public in a way that will result in behavior change, and I want to underscore the latter point. Merely giving information but without the cognizance of how the information will actually lead to behavior change just doesn't do the job.

A recent National Academy of Sciences Report stated that "a basic understanding of how information, incentives, and various kinds of constraints and opportunities in combination with values, beliefs, and social contexts shape consumer choice in complex, real-world context would provide an essential knowledge base for understanding and anticipating and developing policies for effecting environmentally significant consumer behavior." That again from the

NAS. While the focus of the particular NAS report was environmental policy, the statement works equally well for policies related to energy use which has not only an environmental impact but also economic and frankly national security ramifications.

Our witnesses are working on different aspects of this exact problem. Together they will tell a story beginning with research into what influences individuals' energy-related behavior and ending with the relevance of such research to the development and evaluation of effective energy policies.

When the topic of social science comes up, there are always vocal skeptics. We see them on the Floor of the House, sometimes in this committee, and recently in the Conference Report on the *America Competes Act*. Those who may acknowledge the intellectual merit of the research but have trouble making the connection to areas of national need and question why the Federal Government should be supporting social science research in the face of so many competing demands for those dollars I hope will pay attention to this hearing today.

Today we will learn how the knowledge generated by research in the social sciences is relevant to policy-making for energy. But it is no less relevant to every other major issue facing the country today including health care, education, national security, crime, competitiveness, foreign policy, and the environment. We won't have hearings on all of those topics, but I guarantee we will have hearings on a few others and see how behavioral and social sciences can help understand these issues.

I want to thank all our witnesses for being here today. I look forward very much to your testimony and our discussion, and I would now recognize the Ranking Member, Dr. Ehlers, for any comments he may wish to make.

[The prepared statement of Chairman Baird follows:]

PREPARED STATEMENT OF CHAIRMAN BRIAN BAIRD

I now call to order this hearing on the contribution of the social sciences to the energy challenge.

Energy, in my opinion, ranks among our country's top three challenges next to health and national security. Solving our nation's energy challenge will depend on a combination of technological innovation and behavior change. This committee and this Congress have held countless hearings on the energy technologies of tomorrow. What we don't talk about is behavior—and how changes in behavior can start making a big dent in our energy challenge today.

The panel sitting before us will give us insight into how we might achieve this goal. One witness will tell you how a simple change in a written message to hotel guests asking them to reuse their towels could save 39 barrels of oil and 72,000 gallons of water in a single average-size hotel in one year. If you multiply that by all of hotels in all the cities in this country, that adds up to real energy savings. And that's just because of a single, easy action on the part of hotel guests.

Imagine if every American decided to turn off their lights when they left a room, shut down their computers at night, or looked for an EnergyStar label the next time they shopped for a major appliance? The truth is that U.S. households are responsible for more than one-third of annual U.S. energy consumption. Of that, approximately 60 percent goes into powering our homes and the rest into fueling our cars and SUVs. To put it in perspective, American homes consume 2.4 times as much energy as homes built in Western Europe.

A recent survey by the Alliance to Save Energy found that ninety-two percent of Americans agree that business, government, and consumers have an equal responsibility to reduce energy use. That seems fair, given that consumers use one-third of the energy. But, unfortunately, this attitude has not translated into action.

I am not blaming the American consumer. The truth is that the typical consumer doesn't have the information he or she needs to factor energy use into purchases and behaviors, and the government and industry have fallen far short in providing the needed information to the public in a way that will result in behavior changes.

A recent National Academy of Sciences Report stated that "A basic understanding of how information, incentives, and various kinds of constraints and opportunities, in combination with individuals' values, beliefs, and social contexts, shape consumer choice in complex real-world contexts would provide an essential knowledge base for understanding, anticipating and developing policies for affecting environmentally significant consumer behavior."

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When the topic of social sciences comes up, there are always vocal skeptics—those who may acknowledge the intellectual merit of the research, but have trouble making the connection to areas of national need and question why the Federal Government should be supporting social science research in the face of so many competing demands for those dollars.

Today we will learn how the knowledge generated by research in the social sciences is relevant to policy-making for energy. But it is no less relevant to every other every major issue facing the country today—including health, education, national security, crime, competitiveness, foreign policy and the environment.

I thank all of our witnesses for being here today, and I look forward to your testimony.

I now recognize the Ranking Member for any comments he may wish to make.

Mr. EHLERS. I thank the Chairman, and I am pleased that today's hearing will explore how energy-related policies are being shaped by social science research, and also I might add, by the behavior of people which is what we will be studying.

I understand that it is very challenging to determine why people do what they do regarding energy given all the variables in their lives. If Congress creates what looks like good policy but which lacks an understanding of the primary drivers of decision-making, our policies will still fail. We must account for social factors when crafting energy policies, and I will give a few examples in a minute.

Much of the basic research funded by the National Science Foundation examines the fundamental mysteries behind brain cognition and human behavior. Among other things, NSF studies the causes and consequences of social and cultural norms. I know many of my colleagues share my personal interest in developing policies to draw more students into the science and mathematics teaching profession. In that context, I believe that it is integral that the social science research work, in tandem with educational research to evaluate not only how to best prepare teachers to teach but to understand what would draw them and keep them in teaching. Perhaps if we continue this series of hearings we could delve into what incentives work best to encourage people to enter teaching professions, as well as their willingness to stay in them. I might also add, Mr. Chairman, we might also learn better ways of attracting students to study these particular areas of science and mathematics if we understood exactly what they and their colleagues were thinking and also learn that this ensures their future better than most other choices that they might make.

Returning to the topic at hand today, I am particularly interested in what influences individuals to make energy-efficiency deci-

sions. We all assume that if people understood their return on investment from energy efficiency measure, say home improvements to save on winter heating bills, then they would quickly make those changes. But I think our witnesses will share that it is much more complicated. We are not always as rational as we would like to believe. Furthermore, being well-educated about energy efficiency does not necessarily translate into action. Consumers are a fickle bunch, especially in a society where individualism and personal freedoms are highly cherished, and certain unranked desires on the part of the consumer may guide the decision more than rational thought.

Mr. Chairman, I would just like to bring forward something that happened to me. When my wife and I first got married and first went into a house of our own instead of a furnished apartment, we had to get a refrigerator. Not being an expert in what refrigerators are good for, what features are nice and so forth, I told my wife, you decide which features you want and then we will go out together and decide on the best refrigerator. She went shopping and came back, and had found two refrigerators that met her needs which she liked very much. I looked at them. One cost exactly twice as much as the other. That would make it a simple choice. And this is in the days before energy labels. But I proceeded to calculate the energy consumption of the two refrigerators and discovered much to my amazement that if I bought the more expensive one I would have saved money within 10 years compared to buying the cheap one because the cheap one used considerably more energy.

So we bought the more expensive one contrary to all rational thought. It lasted 23 years, so we not only saved more than the differential cost, but we actually saved enough to pay for more than two refrigerators of the other type.

So those are the lessons that we should learn. We now have the labels, but again I don't think the labels really make the picture clearer. It would be much better if I could assign some sort of age to the refrigerator and have a notice on the front that says this one will cost you X amount over so many years, and compared to other refrigerators that will last a shorter time.

There are so many things that we can do about this that we should be doing, and you have probably all heard my I-wish-energy-were-purple story. You haven't? How did you escape? But basically that if energy were purple, people's behavior would change because they could see the results. In the winter they could see purple oozing through the walls of their house if they are not well-insulated or purple rivulets running down the windows and doors, and so they would seal those up more tightly. And driving down the highway, the Prius might be just a little purple haze around the car but an SUV comes by, it is just a purple cloud. If people could see energy, if it were purple, they would change their behavior very quickly. The question I think Mr. Chairman is how can we help them see the consequences of their decisions, even though we can't make energy purple? What way can we make this more obvious to them so that it registers?

Well, I thank you, Mr. Chairman, for investigating this important topic, and I look forward to hearing from our witnesses.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF REPRESENTATIVE VERNON J. EHLERS

I am pleased that today's hearing will explore how energy-related policies are being shaped by social science research. I understand that it is very challenging to determine why people do what they do regarding energy, given all the variables in their lives. If Congress creates what looks like good policy, but which lacks an understanding of the primary drivers of decision-making, our policies may still fail. We must account for social factors when crafting energy policies.

Much of the basic research funded by the National Science Foundation (NSF) examines the fundamental mysteries behind brain cognition and human behavior. Among other things, NSF studies the causes and consequences of social and cultural norms. I know many of my colleagues share my personal interest in developing policies to draw more students into the science and mathematics teaching profession. In that context, I believe that it is integral that the social science research work in tandem with educational research to evaluate not only how to best prepare teachers to teach, but to understand what would draw them and keep them in teaching. Perhaps if we continue this series of hearings we could delve into what incentives work best to encourage people to enter teaching professions as well as their willingness to stay in them.

Returning to the topic at hand today, I am particularly interested in what influences individuals to make energy efficiency decisions. We all assume that if people understood their return on investment from energy efficiency measures—say, home improvements to save on winter heating bills—then they would quickly make those changes. But I think our witnesses will share that it is much more complicated. We are not always as rational as we'd like to believe. Furthermore, being well-educated about energy efficiency does not necessarily translate into action. Consumers are a fickle bunch, especially in a society where individualism and personal freedoms are highly-cherished.

I thank the Chairman for investigating this important topic and I look forward to hearing from our witnesses.

Chairman BAIRD. Dr. Ehlers, thank you. One of the things that is most pleasant about serving in Congress is you can serve with people like Dr. Ehlers as your Ranking Member because the example he cited illustrates that he has applied this in his life; and how many other Americans have the technological know-how as a Ph.D. physicist to make those calculations? And that is the kind of thing we are going to be talking about today.

So without further ado, I just want to thank my good friend, Jerry McNerney for joining us today, also a Ph.D. engineer, mathematician, but applied it to wind and solar energy for many years. So he knows whereof he speaks as well.

If there are other Members who wish to submit additional opening statements, your statements will be added to the record at this point. At this point I will introduce our witnesses. Dr. Robert Cialdini is Regents' Professor of Psychology and Marketing and W.P. Carey Distinguished Professor of Marketing at Arizona State University. Dr. Duane Wegener is a Professor of Psychological Sciences at Purdue University and an Initiative Leader in the Social, Economic, and Policy Aspects of Energy Use and Policy Division of the Purdue Energy Center. Apparently the Purdue Energy gets the concept to have you as part of the faculty. Mr. John "Skip" Laitner is Visiting Fellow and Senior Economist for Technology Policy at the American Council for an Energy Efficient Economy. Dr. Jerry Ellig is a Senior Research Fellow at the Mercatus Center at George Mason University and an Adjunct Professor at the George Mason University School of Law. And Dr. Robert Bordley is a Technical Fellow in the Vehicle Development Research Laboratory at General Motors Corporation and an Adjunct Professor in

the Industrial and Operations Engineering Department at the University of Michigan no less, with a nod to my dear friend.

As our witnesses know, each testimony is limited to five minutes each after which the Members of the Committee will have five minutes to ask questions.

We will start with Professor Cialdini. Thank you all for being here.

STATEMENT OF DR. ROBERT B. CIALDINI, REGENTS' PROFESSOR OF PSYCHOLOGY AND MARKETING, ARIZONA STATE UNIVERSITY

Dr. CIALDINI. Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, it is my pleasure to be here today to testify on the contribution of the social sciences to the energy challenge. I believe that the social and behavioral sciences do indeed hold tremendous potential to influence individual and collective behaviors affecting energy conservation providing that we understand how to craft the message. Here is why. It is standard practice when advocating for action among policy members, such as yourselves, to emphasize the breadth of a problem; and that makes sense because policy-makers are able to provide additional resources or to enact regulations to address those abuses that they seem to see as most prevalent.

However, a different and even opposite logic applies when communicating to the public about a problem. To understand that logic, consider the following incident. Not long ago, a graduate student of mine visited the Petrified Forest National Park in Arizona with his fiancée, a woman he described as the single most honest person he had ever met. They quickly encountered a park sign warning visitors against stealing petrified wood. It said, our heritage is being vandalized by the theft of 14 tons of wood every year. While still reading the sign, he was shocked to hear his fiancée whisper, we better get ours now.

What could have spurred this otherwise wholly law-abiding young woman to want to become a thief and to deplete a national treasure in the process? I believe it has to do with the mistake that Park Service officials made in creating that sign. They tried to alert visitors to the park of its theft problem by telling them how many other visitors were thieves. In so doing, they stimulated the behavior they had hoped to suppress by making it appear commonplace, when in fact, less than three percent of the park's millions of visitors have ever stolen a piece of wood.

Although their claims may be both true and well-intentioned, the creators of this and many other types of public service campaigns have overlooked something basic about the communication process. Within the lament, look at all the people doing this undesirable thing, lurks the powerful and undercutting message, look at all the people who are doing this undesirable thing. And one of the fundamental lessons of human psychology is that people follow the crowd. I am concerned that this point is being missed in our attempts to communicate the importance of environmental protection and energy conservation within our communities.

Therefore, in our messaging, we need to be diligent in making clear to the public that many unwelcomed actions with regard to

the environment are performed by only a small minority of the population.

My colleagues and I at Arizona State University have done research indicating that such an approach works. At the Petrified Forest, for example, we erected a pair of signs in different areas. The first urged visitors not to take wood and depicted a scene showing three thieves in action. After passing that sign, visitors became more than twice as likely to steal. Our other sign also urged visitors not to take wood, but it depicted a lone thief marginalizing that behavior instead of normalizing it. Those individuals took only half as many pieces of wood as before.

I believe that this lesson applies to other forms of environmental offenses such as energy wastage. The secret is to avoid validating the deviant actions of a small minority of wrongdoers by making them appear the rule rather than the exception. Otherwise we assure that a few rotten apples will spoil the barrel.

The truth is, we are not a nation of polluters or despoilers or energy pigs. We are not. Consequently, public service messages should raise the profile of the majority that does act pro-environmentally because as social science research tells us, that spurs others to follow.

To test this idea, we examined resorts' conservation choices made in upscale hotel rooms where guests often encounter a sign asking them to reuse their towels. This is the one at the hotel I stayed in a few blocks from here last night. As anyone who travels frequently knows, this card may urge action in various ways. Sometimes it requests compliance for the sake of the environment. Sometimes it does so for the sake of future generations, and sometimes it exhorts guests to cooperate with the hotel in order to save resources. What the card never says but is entitled to say because it is true is that the majority of guests do recycle their towels when given the opportunity. We suspected that this omission was costing the hotels and the environment plenty. Indeed, when as part of our research program we placed such a sign in certain guest rooms in an upscale Phoenix hotel, it increased towel reuse by 34 percent over the traditionally employed messages.

I am going to close by raising two things that I think are noteworthy about the results of our towel study. First, the message that generated the most participation in the hotel's program was the one that no hotel to our knowledge has ever employed. Apparently, this highly effective appeal didn't emerge from a history of trial and error as a hotel best practice. Instead, it emerged from scientifically based understanding of human psychology. This points out the need for us to call on social scientific research in a systematic fashion to help advance sound environmental policy. For instance, in the case of hotel conservation, an average 150-room hotel would save 72,000 gallons of water a year.

The second notable aspect of the hotel study was that the significant increase in program participation was nearly costless to the hotel, something that government needs to recognize as well. We don't need to institute highly, costly fixes, technological fixes, or tax incentives or regulations. We can do it with the messaging process costlessly.

Thank you for the opportunity to provide the results of my team's efforts to date. I will look forward to your questions and comments.

[The prepared statement of Dr. Cialdini follows:]

PREPARED STATEMENT OF ROBERT B. CIALDINI

Abstract

Social norms, which refer to what most people do (descriptive social norms) and what most people approve (injunctive social norms), are remarkably powerful in directing human action. Social science research has uncovered the most successful ways to incorporate norms into messages designed to produce socially desirable conduct.

Studies in several environmental contexts (e.g., home energy conservation, household recycling, hotel conservation efforts) show that (1) energy users severely underestimate the role of social norms in guiding their energy usage, (2) communications that employ social norm-based appeals for pro-environmental behavior are superior to those that employ traditional persuasive appeals, and (3) even though these highly effective social norm-based appeals are nearly costless—requiring no large technological fixes, tax incentives, or regulatory changes—they are rarely (and sometimes mistakenly) delivered.

Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, it is my pleasure to be here today to testify on *The Contribution of the Social Sciences to the Energy Challenge.* I believe that the social and behavioral sciences do indeed hold tremendous potential to influence individual and collective behaviors effecting energy conservation, providing that we understand how to craft the message.

Here's why. It is standard practice when advocating for action among policy-makers (e.g., legislative or other governmental officials) to emphasize the breadth of a problem. And, that makes sense because policy-makers can be expected to provide additional resources or regulations to address those abuses that appear to them most widespread. However, a different—and even opposite—logic may apply when communicating with the *public* about a problem. To understand that logic, consider the following incident.

Not long ago, a graduate student of mine visited the Petrified Forest National Park in Arizona with his fiancée—a woman he described as the most honest person he'd ever known, someone who had never taken a paper clip or rubber band without returning it. They quickly encountered a park sign warning visitors against stealing petrified wood, "OUR HERITAGE IS BEING VANDALIZED BY THE THEFT OF 14 TONS OF WOOD EVERY YEAR." While still reading the sign, he was shocked to hear his fiancée whisper, "We'd better get ours now."

What could have spurred this wholly law-abiding young woman to want to become a thief and to deplete a national treasure in the process? I believe it has to do with a mistake that park officials made when creating that sign. They tried to alert visitors to the park's theft problem by telling them that many other visitors were thieves. In so doing, they stimulated the behavior they had hoped to suppress by making it appear commonplace—when, in fact, less than three percent of the park's millions of visitors have ever taken a piece of wood.

Park officials are far from alone in this kind of error. Those responsible for developing and enforcing public policy blunder into it all the time. Teenage suicide prevention programs inform students of the alarming number of adolescent suicides and, research shows, cause participants to become *more* likely to see suicide as a possible solution to their problems. When publicizing cases of school violence, news outlets assemble accounts of incident after incident and, in the process, spawn the next one. During prominently announced crack-downs on the problem, government officials decry the frequency of tax evasion and, as demonstrated by one follow-up study, increase tax cheating the next year (Kahan, 1997). Although their claims may be both true and well-intentioned, the creators of these information campaigns have overlooked something basic about the communication process: Within the lament "Look at all the people who are doing this *undesirable* thing" lurks the powerful and undercutting message "Look at all the people who *are* doing it." And, one of the fundamental lessons of human psychology is that people follow the crowd. I am concerned that this point is being missed in our attempts to communicate the importance of environmental protection and energy conservation within our communities.

I think there is a better way to proceed. We need be diligent in making clear to the public that many unwelcome actions are performed by a small minority of the population. For instance, let's consider the case of littering. Few citizens litter with

any frequency; most take care to preserve the environment. The key to an enlightened public policy approach to litter is to deliver the message that *even one* abandoned newspaper can spread to despoil a pristine park or beach, that *even one* cigarette butt flipped from a car can ignite a devastating fire, that *even one* carelessly discarded plastic container can endanger wildlife, and, most important, that *even one* piece of litter can begin an accumulation that creates the mistaken—but contagious—impression that we all litter. It's not even remotely true that we are a nation of despoilers, and we shouldn't be misled into believing that it is. Instead, armed with the knowledge that, as a citizenry, we do care about our environment, we should focus on marginalizing the few who don't care.

Would such an approach work in other environmental arenas? My colleagues and I at Arizona State University have done research indicating that it well might. At the Petrified Forest, we erected a pair of signs in different areas. The first urged visitors not to take wood and depicted a scene showing three thieves in action. After passing that sign, visitors became over twice as likely to steal than before! Our other sign also urged visitors not to take wood, but it depicted a lone thief. Visitors who passed it became nearly half as likely to steal than before (Cialdini, 2003). I believe that this lesson applies to other forms of environmental offenses such as energy wastage. The secret is to avoid validating the deviant actions of a small minority of wrongdoers by making them appear the rule rather than the exception. Otherwise, we assure that a few rotten apples will spoil the barrel.

In addition, we should be sure to raise the profile of the majority that does act pro-environmentally, because that spurs others to follow suit. For instance, with our students, my fellow environmental researcher, Wes Schultz of California State University–San Marcos, and I obtained support from the William and Flora Hewlett Foundation to study how descriptive social norms (the perception of what most people do in a situation) can influence energy conservation decisions. Our survey of nearly 2,500 Californians showed that those who thought their neighbors were conserving were more likely to conserve themselves. But, at the same time, almost all of the survey respondents underestimated the conservation efforts of their neighbors. In a follow-up study, we placed door hangers on the doors of San Diego-area residents once a week for a month. The door hangers carried one of four messages, informing residents that (1) they could save money by conserving energy, or (2) they could save the Earth's resources by conserving energy, or (3) they could be socially responsible citizens by conserving energy, or (4) the majority of their neighbors tried regularly to conserve energy—information we had learned from a prior survey. We also include a control group of residents in the study whose door hanger simply encouraged energy conservation but provided no rationale. Even though our prior survey indicated that residents felt that they would be least influenced by information regarding their neighbors' energy usage, this was the only type of door hanger information that led to significantly decreased energy consumption, almost two kWh/day (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2007). This suggests a clear way to increase conservation activity—by trumpeting the true levels of conservation that are going unrecognized.

To investigate this idea, we examined resource conservation choices in upscale hotel rooms, where guests often encounter a card asking them to reuse their towels. As anyone who travels frequently knows, this card may urge the action in various ways. Sometimes it requests compliance for the sake of the environment; sometimes it does so for the sake of future generations; and sometimes it exhorts guests to cooperate with the hotel in order to save resources. What the card *never* says, however, is that (according to data from the Project Planet Corporation that manufactures the cards) the majority of guests do reuse their towels when given the opportunity. We suspected that this omission was costing the hotels—and the environment—plenty.

Here's how we tested our suspicion. With the collaboration of the management of an upscale hotel in the Phoenix area, we put one of four different cards in its guest rooms. One of the cards stated "HELP SAVE THE ENVIRONMENT," which was followed by information stressing respect for nature. A different card stated "HELP SAVE RESOURCES FOR FUTURE GENERATIONS," which was followed by information stressing the importance of saving energy for the future. A third type of card stated "PARTNER WITH US TO HELP SAVE THE ENVIRONMENT," which was followed by information urging guests to cooperate with the hotel in preserving the environment. A final type of card stated "JOIN YOUR FELLOW CITIZENS IN HELPING TO SAVE THE ENVIRONMENT," which was followed by information that the majority of hotel guests do reuse their towels when asked. The outcome? Compared to the first three messages, the final (social norm) message increased towel reuse by an average of 34 percent (Goldstein, Cialdini, & Griskevicius, 2007).

Two things are noteworthy about the results of the hotel study. First, the message that generated the most participation in the hotel's towel recycling program was the one that no hotel (to our knowledge) has ever used. Apparently, this simple but effective appeal didn't emerge from a history of trial and error to become a hotel "best practice." Instead, it emerged from a scientifically-based understanding of human psychology. This points out the need to call on social scientific research in a systematic fashion to help advance sound environmental policy. For instance, in case of hotel conservation programs, the average 150-room hotel would save 72,000 gallons of water, 39 barrels of oil, and would obviate the release 480 gallons of detergent into the environment in the course of a year if guests complied with the requests.

The second notable aspect of the hotel study was that the significant increase in program participation was nearly costless. In most cases, for an organization to boost effectiveness by 34 percent, some expensive steps have to be taken; typically, organizational structure, focus, or personnel must be changed. In this instance, however, none of that was necessary. Rather, what was required was a presentation of the facts about the preferred behavior of the majority.

Conclusion

In sum, when communicating with the public, it is important to avoid trying to reduce the incidence of a damaging problem by describing it as regrettably frequent. Such an approach, while understandable, runs counter to the findings of social science regarding the contagiousness of social behavior, even socially harmful behavior. Moreover, often, the problem under consideration is not widespread at all. It only comes to seem that way by virtue of a vivid and impassioned presentation of its dangers. Instead, it would be better to honestly inform our audience of the environmental peril resulting from even a small amount of the undesirable conduct. Furthermore, when most people are behaving responsibly toward the environment, we'd be less than responsible ourselves if we failed to publicize that fact, as the social science evidence is plain that the information will serve both to validate and stimulate the desired action.

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BIOGRAPHY OF ROBERT B. CIALDINI

Robert B. Cialdini is Regents' Professor of Psychology and Marketing at Arizona State University, where he has also been named W. P. Carey Distinguished Professor of Marketing. He has taught at Stanford University and Harvard's Kennedy School of Government. He has been elected President of the Society of Personality and Social Psychology. He is the recipient of the Distinguished Scientific Achievement Award of the Society for Consumer Psychology, the Donald T. Campbell Award for Distinguished Contributions to Social Psychology, and the (inaugural) Peitho Award for Distinguished Contributions to the Science of Social Influence.

Professor Cialdini's book Influence: *Science and Practice,* which was the result of a three-year program of study into the reasons that people comply with requests in everyday settings, has sold over a million copies while appearing in numerous editions and twenty-two languages.

Chairman BAIRD. My guess is that card doesn't use your effective message, right?

Dr. CIALDINI. It doesn't. It says please do this for the sake of the environment, and then it adds insult to injury by saying, don't forget to recycle every year. Americans waste four trillion documents, enough to paper the Grand Canyon 300 times. So they do the opposite of what our research suggests.

Chairman BAIRD. Dr. Wegener.

STATEMENT OF DR. DUANE T. WEGENER, PROFESSOR OF PSYCHOLOGICAL SCIENCES; INITIATIVE LEADER FOR SOCIAL, ECONOMIC, AND POLITICAL ASPECTS OF ENERGY USE AND POLICY, ENERGY CENTER AT DISCOVERY PARK, PURDUE UNIVERSITY

Dr. WEGENER. Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, thank you for the opportunity to testify.

I am here today in part because of the necessary transition from fossil fuels to new, sustainable energy sources will rely on more than development of new energy technologies. A successful transition to new energy sources will be determined to a large extent by changing in the energy use behaviors of energy consumers.

In my home discipline of social psychology, factors such as social norms, values, and attitudes have been identified as important determinants of behavior. However, these social factors are not always equally important. My research focuses on attitudes, persuasion, and the consequences of the resulting attitudes in terms of the persistence of the attitude over time, its ability to resist future attempts at change, and its ability to influence future thinking and behavior.

As the Charter for this hearing noted, there are indications that people hold favorable attitudes toward energy-relevant actions such as conservation. Yet, in too many circumstances, these attitudes do not seem to be having the desired effects on behavior. Why is it that these attitudes are not getting the job done and what do we know about attitudes and persuasion in help making these attitudes more influential?

The social psychology literature on attitudes has identified a number of determinants of when attitudes influence behavior and when they do not. Let me focus on one area of this research, the work on attitude strength. The concept of attitude strength came from the acknowledgment that not all attitudes are equally capable of influencing behavior. Many specific properties of the attitudes have been identified that make them relatively strong. In the persuasion experiments conducted in my lab, we focus on the factors that influence how much people think about the persuasive message. In some circumstances, people engage the message and think carefully about what it has to say. In others, they either lack the motivation or the ability to think carefully about the information in the message. In both types of situations, people can be persuaded but the changes in attitudes created by thinking carefully about the message creates attitudes that have this property of strength.

As one example, in a recent set of studies a colleague of mine, Kevin Blankenship, and I took topics that people were not naturally motivated to think carefully about, including the topic of building nuclear power plants in Canada. And we asked them to think about whether that message related to values that we had previously identified as either quite important or relatively unimportant to our participants. When considering whether the message was related to these important values, message recipients thought much more thoroughly about the information using a number of different measures of amount of thinking. And just as importantly,

the attitudes formed through thinking were then more capable of resisting a later message that opposed people's attitudes. In the nuclear power study, the later message opposed the building of nuclear power plants where the initial message had supported the building of those plants.

These thoughtful attitudes have also been shown in other research to be more likely than to guide later behaviors, even when the non-thoughtful attitudes were in fact just as favorable as those thoughtful attitudes.

So if people are favorable toward energy conservation, for example, but their opinions are not well-thought out, then these attitudes are unlikely to translate into energy conservation behaviors.

Theory and research and attitudes has also identified additional factors that make attitudes stronger. For example, attitudes are stronger when people hold them with confidence, and the attitude is also strong if the person views the proposal like the building of nuclear power plants as mostly good or mostly bad, rather than as having a more equal mixture of good and bad features which we refer to as ambivalence.

In each of these cases, the attitudes with these properties are more likely to have the consequences that I mentioned earlier, persistence, resistance, and impact on behavior. There is certainly much more to learn about persuasion and about attitude strength including, for example, which of the strength-related features is necessary or sufficient to produce the particular consequences, especially here to produce the desired attitude-consistent behaviors.

Although I spent most of my time this morning speaking as a researcher who conducts experiments on attitude change, I also work within a multi-disciplinary group of energy researchers in the Energy Center at Purdue University. The model in that Center is to build connections among social scientists from different disciplines, psychology, economics, political science, consumer behavior, science education, and others, and also to connect those researchers with the technological development teams and bioenergy hydrogen, et cetera. This integration of social scientists, natural scientists, and engineers is valuable in moving the issues of economic viability and technology adoption to the forefront of technology development. We believe that addressing the social obstacles that a new technology is likely to face will help to build new technologies that find viable markets more quickly and are therefore more successful. Both the basic research in social science and the integration of this science with technology development will be important in smoothing the behavioral pathways to a new energy economy. Unfortunately, both basic science and social psychology and policy and behavioral research on energy per se remains under-funded at the federal level.

To conclude, the best new technology will not help us to address the energy challenge unless the public adopts them. Therefore, the coming energy transition from fossil fuels to new sustainable sources of energy will consist in large part of behavioral changes will benefit from greater research to understand these behavioral changes and to integrate this work with technology development.

Thank you very much.

[The prepared statement of Dr. Wegener follows:]

PREPARED STATEMENT OF DUANE T. WEGENER

Abstract

The energy challenge is characterized by (a) a great need for development of new technology, and (b) a need for unprecedented changes in energy-related behavior. These behavior changes must occur at many levels, including investors, energy producers (including those in the supply chain), and individual consumers. At Purdue University, I address behavior change through basic research on attitudes, persuasion, and behavior. I also help to lead an initiative in the Purdue Energy Center that focuses on social, economic, and political/policy factors that will influence the behavioral pathways to a new energy economy. By interacting directly with technology development teams, my colleagues and I seek to identify and influence the barriers that new energy technologies will face. By integrating social science with technology development, we believe that new technologies can come on-line faster and more smoothly. The challenge for completing this work is that current federal funding provides strong support for technology pathways but provides insufficient support for research addressing the behavioral pathways. In the various sections of my written testimony, I describe my activities in the Purdue Energy Center, the available funding for our research, the existing research on attitude formation and change (including examples of recent research from my lab on attitudes toward nuclear power), and examples of relevant research questions that remain unanswered.

Chairman Baird, Ranking Member Ehlers, and Members of the Subcommittee, thank you for the opportunity to testify on the Contribution of the Social Sciences to the Energy Challenge. I believe that the social sciences will play a crucial role in understanding and facilitating the behavioral pathways to a new, sustainable energy economy.

I was asked to address four sets of questions. They are listed, along with my written testimony, in the following sections. In order to facilitate the identification of responses to specific questions, I have included headings to correspond with each question in the question set.

1. Please describe your involvement in the Purdue Energy Center, and in particular the mission and goals of the Social, Economic, and Political Aspects of Energy Use and Policy team of the Center. How and to what degree does your team interact and collaborate with the technology teams at the Center?

Involvement in the Center

I serve as one of three Initiative Leaders for the area of Social, Economic, and Political Aspects of Energy Use and Policy (SEPAE). The other two initiative leaders are Wallace Tyner (a Professor of Agricultural Economics) and Glenn Parker (a Distinguished Professor of Political Science). Included in the initiative leader role, we each also serve as a member of the Executive Board of the Energy Center (a decision-making body that meets quarterly). Our work as initiative leaders is multi-faceted. Because a primary goal for the Energy Center in general is to build new transdisciplinary research teams, we have been working to inform one another about the research we do in each of our respective disciplines. We have also been working to build connections to the various technology-development initiatives within the Center. Finally, as initiative leaders, we work to organize responses to calls for research proposals. Much of the early effort has been aimed at federal research dollars, but we have also attempted to make connections with State government, utilities that operate in the state, and, to a lesser degree, with private foundations (more on this in response to Question #2 from the Committee).

The Mission of the SEPAE Group within the Energy Center

The mission of the SEPAE group is directly related to the topic of today's hearing. We seek to extend research and theory from the social sciences to the topics of energy technology, energy use, and policy. In other words, SEPAE faculty work to address drivers and obstacles faced by new energy technologies (especially those studied within the other Energy Center research initiatives). The purpose of the SEPAE research is to increase the ultimate effectiveness of technology development by performing simultaneous analyses of economics, policy alternatives, public/political technology acceptance, and energy-related decision-making. Each of these factors should feed into energy-related behaviors, including investment by companies or individuals, use of new energy-related products, and support for policy-makers who champion particular energy policies.

We believe that these efforts are crucial in managing the necessary transition away from previous technologies that are ultimately unsustainable (and, in many forms, polluting) and to the use of new, sustainable energy technologies. The reality is that any new energy technology is likely to start with a variety of competitive disadvantages. Potential long-term sources of clean energy, such as the promised hydrogen economy, will require new infrastructure for storage, transportation, and fuel delivery. Even energy sources that potentially piggyback on existing infrastructure (such as generation of liquid fuels via clean coal technologies or biomass) require new processing facilities and pose new logistical challenges as they seek to compete economically with currently dominant energy sources (i.e., fossil fuels).

Every step in the process will depend on a combination of social, economic, and political forces. Uninformed (and perhaps even informed) citizens may continue to favor cheap and familiar sources of energy. Suppliers of that energy may also attempt to forestall widespread adoption of alternative energy sources. Yet, citizens concerned about issues such as security, environmental preservation, and support for local economic development may be willing to pay the premium necessary to fully develop new energy sources that can ultimately compete with fossil fuels. For many new energy technologies, new regulatory statutes and bodies will be necessary, and policies governing the economic risks for investors will have direct effects on whether private investment occurs and to what extent. As the next generation of energy sources comes online, customer acceptance may also determine the extent to which policy-makers and industry support the widespread development, and ultimately the economic feasibility, of the new technologies.

Unfortunately, in many cases, simply waiting for the development of a commercially viable product may be too late. For example, some promising technologies are being developed for use of plants that are genetically modified to increase their efficiency (and environmental friendliness) in production of biofuels. However, no regulatory system exists for the commercial use of those plants for production of biofuel. If the technology progresses to the point of becoming economically viable, but no regulatory process is put in place, it could create years worth of delays before the new plants can be productively used in the marketplace. Of course, this anticipated delay and the associated uncertainty could deter private investment in the technology. And the building of a regulatory system is likely to depend on both public and political perceptions of the new technology (e.g., in terms of its impact on the surrounding community and on the environment more generally).

Research addressing the social, economic, and political factors that influence development and adoption of new technologies will help the technology researcher to create technologies that face fewer obstacles. For example, public or political opposition to use of a genetically-modified plant in biofuel production might be based primarily in the concern that the modified gene will spread to native species (see Goy & Duesing, 1996; Meilan, 2004). If so, then creation of sterile versions of the plant might face less public and political opposition. In this type of situation, therefore, attention to social and political factors might identify issues that can be addressed in advance by technology developers, and the new technology can avoid an obstacle that would threaten the economic viability of the technology.

In other settings, identification of obstacles or drivers for adoption might identify effective means of educating or persuading the public or policy-makers about the benefits of the new technology. This could ease the creation of regulatory systems friendly to the new technology or could ease the zoning and approval of new plants using the technology. Therefore, in a variety of situations, the economic viability of the new technology might be enhanced by early attention to social, economic, and political/policy matters.

Interaction with Technology Teams

The integration of SEPAE topics with the technology development teams differentiates Purdue University's Energy Center from many others across the country. Ideally, the SEPAE topics will eventually be pursued across each of the other research areas within the center (including initiatives in Clean Coal, Solar, Bio-, Wind, Electrochemical, Power Electronics, Hydrogen, and Nuclear areas of energy technology).

These integrative efforts have yielded a number of successes in the brief time since the Energy Center's inception. For example, a team of researchers investigating production of biofuels from trees recently received a $1.4 million grant from the Feedstock Genomics program at the Department of Energy (DOE Grant # DE–FG02–06ER64301; through the Office of Science, Office of Biological and Environmental Research). In the grant proposal, the Principal Investigators noted the connections between SEPAE research in the Center and their research on biofuel production, and these connections were noted as a strong feature of the proposal in

panel reviews of the biofuel grant. The SEPAE activities were not funded in the DOE grant, but other recent efforts are beginning to produce funding for the SEPAE activities.

Recently, a team of SEPAE researchers submitted a grant application to the National Science Foundation program on Human Social Dynamics, and this grant has been recommended for funding (for $750,000 over three years, beginning in January 2008). The grant addresses social, economic, and political aspects of U.S. Ethanol Policy. In particular, the research supported by the grant will examine (a) the economics of the seven most likely ethanol policy options, (b) public and political perceptions of the ethanol policies (including comparisons between public perceptions and those of policy-makers in states that ban use of genetically-modified plants for biofuel production or not), and (c) the influences of attitudes and values on individuals' energy-related decision-making.

I am the Principal Investigator for that grant, along with Wallace Tyner (in Agricultural Economics) and Leigh Raymond (in Political Science) as Co-Investigators. In addition, however, the research team includes consultants in Psychological Sciences (Professor Janice Kelly), Biochemistry (Distinguished Professor Clinton Chapple), Forestry and Natural Resources (Associate Professor Richard Meilan), and Economics (Professor Timothy Cason). Therefore, the research team for this project includes researchers from across the areas of SEPAE, as well as Principal Investigators (Chapple and Meilan) from the DOE grant on biofuel production mentioned earlier.

As these two grants would imply, our interactions thus far have been closest between SEPAE and the BioEnergy initiative. We have also made some initial connections with the Hydrogen and Clean Coal initiatives, though not to the same extent. Other than these three areas, most of the interaction among areas of the Center has taken place in the Executive Board meetings, where each initiative leader describes the current efforts for their initiative. It is clear from our initial efforts that the creation of transdiciplinary teams involves a good deal of "start up" costs. It takes time and effort, not only in developing potential research questions of common interest, but then also attempting to find sources of funding that would be interested in supporting research on those questions.

Researchers in the energy technology areas are naturally focused on the work required to develop those technologies, and only some express interest in integration of SEPAE topics with technology development. In some cases, the researchers believe that public acceptance of the new technology must simply consist of making them aware of the benefits of the technology (whether the benefits be related to cost, environmental preservation, or security). However, as many of the committee members may routinely experience in their role as policy-makers, public acceptance is often influenced by a variety of factors that may, on the face of it, appear less than rational. In the energy domain, many new technologies that appear to have advantages over older technologies (e.g., in decreased pollution), are nonetheless opposed by nearby residents (the prevalent "not-in-my-back-yard" problem). This is certainly true for nuclear energy (Rankin, Nealy, & Melber, 1984; Rosa & Dunlap, 1994). A local example in Southern Indiana provided a similar situation when community members opposed a new coal-based power plant using updated technology capable of cutting pollution to a small fraction of that emitted by the coal-based plant to be replaced (despite the fact that the new plant would create more than ten times the amount of energy of the old plant).

Therefore, it seems crucial to understand the human aspects of energy-related behavior and to take those aspects into account in the technology development process. In order to do this, it may require directed investment on the part of funding agencies or energy centers to build and maintain these transdisciplinary collaborations.

2. How much support do you and your colleagues in this area get from federal funding agencies? Have you sought any support from or partnerships with public or private utilities or other non-governmental entities?

Support from Federal Funding Agencies

A number of SEPAE faculty have been successful in recent competitions for federal research support. However, this success comes despite a relative lack of available funds for SEPAE research.

There are at least a couple of standpoints from which to answer this question. One is from the point of view of energy researchers per se.

For Energy Research

As noted earlier, the SEPAE group has been successful of late in obtaining funding from the Human Social Dynamics (HSD) program of the National Science Foun-

dation (NSF). However, this program is, by no means, focused on problems related to energy per se. Therefore, it is not a surprise that relatively little of the funding through this program supports energy-related research. Over the four years of the HSD program, a number of the awards support projects focused on influences of climate change, but very few deal directly with energy or new energy technologies.

In addition to the NSF funding, SEPAE member Wallace Tyner was also successful in a recent Department of Energy (DOE) competition for research proposals in Ethical, Legal, and Societal Implications (ELSI) of Research on Alternative Bioenergy Technologies, Synthetic Genomics, or Nonotechnologies. This grant, set to receive $660,000 over three years, seeks to "develop realistic assessments of the economic and environmental impacts of regional and global policies designed to stimulate bioenergy production and use." Professor Tyner, who led the proposal, was joined by Tom Hertel, Distinguished Professor of Agricultural Economics, and Quinlai Zhuang, Professor of Earth and Atmospheric Sciences and Agronomy. This was a new program for the DOE, and it funded proposals for a total of $1 million during fiscal year 2007 (approximately five total grants of the size of the Tyner, Hertel, & Zhuang proposal). Therefore, unless this program or something like it is expanded quite a lot, the federal funding aimed specifically at social, economic, and political aspects of energy use or policy seems quite limited.

It is also true that none of the current National Energy Laboratories involve the study of social, economic, or political/policy dimensions of energy technology. Thus, if Congress sees potential benefits in specifically funding energy-related research addressing social, economic, and political/policy factors, this may require changes in the structure or priorities of federal funding sources. One model would be to set up a national center (a national lab) for the social-scientific study of energy. If benefits are seen in the direct integration of this research with technology development, it would be important for this center to be closely associated with either a technology-oriented national lab or energy center. Yet another model would be to provide finding for competitions within existing funding structures (e.g., through the DOE or even NSF) that focus on the social-scientific influences on energy use, policy, and technology. Again, if benefits are seen in integration of this research with technology development, specific calls could be made for transdisciplinary work on the topic (within either the current DOE focus on technology development or NSF interdisciplinary programs).

For Basic Science

A second standpoint for answering this question comes from my work as a basic (laboratory-based) researcher on processes involved in attitude formation and change. As discussed in more detail in response to Question #3, basic research on attitudes and attitude change seeks to identify psychological processes that generalize across many specific content domains (including, but by no means limited to energy-related topics). Because attitudes have potent influences on behavior, attitude change provides one of the best mechanisms for influencing energy-use behavior (and behaviors in a variety of other domains, such as health, civic engagement, environmental preservation, etc.).

In energy and other domains, it would make little sense to fund research on applications (such as chemical processes involved in making liquid fuels from coal) without continuing to fund basic research (such as the actions of a catalyst on reactions that occur with controlled concentrations of certain chemicals). Yet, whether intended or not, this is what has happened at the National Institutes of Health (NIH) for research on attitudes and attitude change (and for Social Psychology generally—the discipline in which most psychological research on attitudes occurs).

Indeed, over the years, the National Institute of Mental Health (NIMH) has been the single largest funding source for basic research in social psychology (and attitude change). This continued to be true until a few years ago. Since that time, NIMH funding for social psychological research has virtually dried up, because NIMH has decided that basic research in all areas of social psychology (not only attitudes and attitude change) is not sufficiently related to severe mental illnesses. Although NIH continues to fund applied research into specific conditions or diseases (e.g., cancer, drug abuse), there is concern from the scientific community that funding for basic (cross-content) research on the relevant behavioral processes is insufficient. This has occurred despite the fact that Congress has repeatedly requested that NIH increase its support for basic behavioral research.

The reader might wonder how this decrease in funding is related to research on energy per se. When basic research is not funded, this reduces advances in theory and research relevant to many applied domains. For example, as I describe in more detail later, my colleagues and I recently conducted research on implications of attitudinal ambivalence for attitude change. In that research, we found the same pat-

tern of results for a health-related topic (proposed taxing of junk food) and an energy-related topic (proposed building of nuclear power plants). Thus, decreases in funding for basic research decreases knowledge that can benefit many (seemingly unrelated) areas of applied interest.

It is true that NSF continues to fund basic research in social psychology generally (and attitude change in particular). Unfortunately, because the NSF budget has not increased, overall support for basic research on attitudes and attitude change (and for research on social and cognitive processes in general) has markedly decreased and remains severely under-funded.

Support from Non-Governmental Entities

In the first two years of the Energy Center, SEPAE efforts at seeking funding for our research have focused on federal funding sources (though, as discussed earlier, relatively few federal dollars are specifically aimed at the types of research we conduct). One reason for this is undoubtedly that most of the researchers gathering as members of SEPAE have had their previous research supported primarily by federal dollars.

We have made some attempts, and are continuing to do so, in other areas, however. Our few contacts with energy utilities thus far have been channeled back to regulatory decisions pending with the Indiana Utility Regulatory Commission. One regulatory settlement occurred recently in the area of natural gas to support analysis of a demand-side (energy conservation) program. Unfortunately, the structure and funding included in that settlement would not support the kinds of research that we conduct in the SEPAE group. Although we are certainly open to direct work with utilities, we have not identified other opportunities for funding our research in this way.

In other areas of the Center, there are close ties with Indiana State Government (especially in supporting research for how to use Indiana coal in environmentally responsible ways). However, we have not yet identified a State government funding mechanism for SEPAE research.

Just in the past couple of weeks, we have also had SEPAE members (Tyner and Wegener) meeting with a broad group of Purdue University researchers to discuss a proposal to a private foundation. This foundation is consulting with various Universities on possible projects that address agriculture and the environment (a Purdue proposal would likely address the environmental impact of biofuels, with a heavy emphasis on changing land use behaviors). These foundation connections are new for us and may take some time to cultivate. The exploration of new funding sources is certainly one type of "start up" cost involved in the building of transdisciplinary research teams to address important societal problems.

3. What has social science research revealed about factors that influence how Americans form attitudes relevant to energy use and policy? How can this research be used more effectively to inform policy?

Influencing Attitudes

I have to answer this question from the standpoint of a social psychologist, without claiming to be an expert in all areas of social science relevant to attitude formation and change. One interesting aspect of the social psychological literature on attitudes and persuasion is that it is designed to be basic science, identifying general psychological properties that are applicable to attitudes about different people, objects, or policies. Therefore, in most social psychological research on attitude change, the same effects and processes are shown to occur for two or more topics. In many cases, these topics are not directly energy-related, but there is little reason to expect that the processes identified would not also occur when the attitudes are about energy use or energy policy.

Research on attitudes and attitude change has been a core part of social psychology since the 1930s. G. W. Allport (1935) first called *attitude* social psychology's most indispensable construct, but this is arguably still true today. This is because attitudes (one's overall evaluations of people, objects, or issues) are pervasive and functional (see Maio & Olson, 2000b; Pratkanis, Breckler, & Greenwald, 1989). For example, attitudes predict behavior when controlling for other psychological constructs, such as values (Homer & Kahle, 1988) and subjective norms (Ajzen & Fishbein, 1970, 2005). Indeed, it is partly because attitudes are capable of influencing behaviors that researchers became interested in techniques used to change attitudes.

It is beyond the scope of the current testimony to provide a comprehensive review of the last 80 years of research and theory in this area. Therefore, I will provide only a brief summary to provide examples of common variables and processes that

have been studied. The reader can see Petty and Cacioppo (1981/1996) for an accessible (undergraduate level) overview of attitudes and persuasion. Petty and Wegener (1998) and Wegener and Carlston (2005) provide more recent reviews.

I divide my current summary into sections on classes of variables studied, common processes in message-based persuasion, and examples of research from my lab that has addressed attitudes toward nuclear power.

Classes of Variables that Influence Attitudes

Factors involved in message-based attitude change (of the type involved in mass communications, such as advertising) have included characteristics of the source of the message, characteristics of the message itself, characteristics of the recipient of the message, and characteristics of the context in which people receive the message (see Petty & Wegener, 1998). Prevalent source characteristics include the credibility (expertise and trustworthiness), attractiveness (likability), and power of the source. Prevalent message characteristics include the position of the message (i.e., relatively agreeable or disagreeable to the message recipient) and the quality and quantity of arguments used in the message. Other message features include framing of the message (e.g., stating the message in positive terms, such as "if you stop smoking, you'll live longer," or negative terms, such as "if you smoke, you will die sooner") or the order in which opposing messages are encountered. Recipient characteristics include characteristics of the attitudes message recipients already hold, demographic characteristics, and personality of the person receiving the message. Finally, context variables include the level of distraction created by competing activities, the modality (e.g., written, audio) through which the message is received, and the uplifting or depressing setting surrounding the persuasive message (which could also be considered as creating differences in the mood state of message recipients).

Persuasion Processes

In addition to the many individual variables that have been studied, a variety of psychological processes have been identified to determine when and how the variables influence attitudes. Many of the persuasion processes can be organized using the Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986b; Petty & Wegener, 1999). The ELM organizes persuasion processes according to how much people are thinking about (elaborating on) the available information about the person, object, or topic of interest.

High-elaboration (thoughtful) processes. The message recipient is likely to think more about available information when highly motivated (e.g., because the message topic is important or personally relevant to the recipient) and able to do so (e.g., because environmental distractions are minimal; see Petty & Wegener, 1998). When elaboration (thinking) is high, message recipients are likely to generate many evaluative thoughts about the information, and these thoughts are responsible for influences of the available information on attitudes (see Wegener, Downing, Krosnick, & Petty, 1995). In these types of situations, argument quality is likely to be an important determinant of attitude change. If arguments are compelling, attitudes become more favorable, but if arguments are weak, then little attitude change occurs. In contrast, if motivation or ability to think is lacking, argument quality has little effect on attitudes (e.g., Petty, Cacioppo, & Goldman, 1981).

When thinking carefully about available information, message recipients are also likely to actively assess the evaluative implications of available information by "calculating" the likelihood and desirability of presented information. For example, a statement in a message might say that a particular political candidate favors higher subsidies for producers of ethanol that use cellulosic feedstocks (e.g., grasses or trees) than for producers that use corn. When thinking carefully about the information, message recipients assess the likelihood that the candidate strongly favors the policy and their own perceived desirability of the policy (and attitudes are calculated by multiplying likelihood perceptions and desirability perceptions; Fishbein & Ajzen, 1975). Thus, differences in the quality of arguments can be created by changing the likelihood or desirability components of the statements (Petty & Wegener, 1991).

Low-elaboration (non-thoughtful) processes. As noted earlier, effortful elaboration (thinking) is less likely when motivation or ability to think is lacking (e.g., because the attitude issue is not likely to affect the message recipient or the message is encountered when the person must also pay attention to competing activities). When this occurs, attitudes can still be formed or can change, but by using "short cut" (heuristic) strategies that take less cognitive effort.

For example, attitudes can be influenced by classical conditioning, in which positive or negative stimuli are simply associated with the attitude object. In fact, many advertisements use this type of strategy by associating pleasant music or scenery with a product, even when the music or scenery is utterly irrelevant to the qualities

of the product. On a related note, people might also use a "How do I feel about it?" heuristic, in which they mistake feelings created by an unrelated activity (such as the weather outside or watching a happy or sad movie) as being reactions to the attitude object or issue (see Clore & Schnall, 2005).

Other relatively simple processes include familiarity-based liking of objects that one has seen often (even if seen so briefly that one cannot report whether one has previously seen the object or not; Kunst-Wilson & Zajonc, 1980). One reason for this *mere exposure* effect may be that ease in perceiving the object (because it has been seen before) is experienced positively (Winkielman & Cacioppo, 2001).

When *heuristics* are used to quickly and easily determine what one's attitude should be, source characteristics ("I should agree with people I like") that are irrelevant to the primary features of the object may, nonetheless, influence people's attitudes (see Petty & Wegener, 1998). The impact of these *peripheral* aspects of the communication is likely to be different, however, when thinking a lot about available information. In such circumstances (when people are paying close attention to the qualities of information about the object), the influence of peripheral aspects of the persuasive attempt should be minimized (Petty & Cacioppo, 1986b; Petty & Wegener, 1999).

General ELM principles. Therefore, the ELM framework explains when communicators would expect peripheral aspects of a communication to influence attitudes (when motivation or ability to think is low) and when they should not (when motivation and ability are high). This would explain why some relatively peripheral features, like the physical attractiveness of the message source, influences attitudes in some situations (low motivation or ability), but not in others (high motivation and ability; Puckett, Petty, Cacioppo, & Fisher, 1983). In contrast, when motivation and ability to think are high, the quality of arguments provided in the message should have strong effects on recipient thoughts and attitudes. But when motivation or ability is lacking, the quality of arguments should have little effect (Petty & Cacioppo, 1986b).

Persuasion is not so simple as to say that any one variable can only influence persuasion when people are thinking a lot or a little, however. For example, consider a communication given by an expert source (e.g., a Princeton Professor of Education advocating a new educational policy; Petty et al., 1981). The expertise of the source can be used as a relatively simple "peripheral cue" when thinking is minimal ("I should agree with experts"). However, source expertise can also influence attitudes when people are thinking carefully, if the right conditions exist. For example, if the available information is somewhat ambiguous (open to interpretation), then, as people think carefully about the information, it may be interpreted more positively if provided by an expert rather than a non-expert (Chaiken & Maheswaran, 1994). The idea that the same persuasion variable can influence attitudes for different reasons as the level of elaboration (thinking) increases from low to high levels is referred to as the variable serving "multiple roles" in persuasion (see Petty & Wegener, 1998, 1999).

Perhaps the key reason that researchers pay close attention to the level of thinking by research participants is that the level of thinking determines how consequential the resulting attitude will be. When attitudes are formed or changed in more thoughtful ways, they last longer over time, they better resist future attempts at change, and they serve as stronger guides for future thoughts and behaviors (Petty, Haugtvedt, & Smith, 1995; Wegener, Petty, Smoak, & Fabrigar, 2004). Of course, when seeking to influence the use of energy by consumers or the purchase of energy-efficient products, it would be important not only to create attitudes favorable toward those behaviors, but to create attitudes strong enough to influence those behaviors.

Examples of Attitudes toward Nuclear Power

Consistent with my basic science orientation, over the years, I and my colleagues have used a variety of message topics in studying attitude change. In a number of cases, however, we have used messages that propose the building of new nuclear power plants. Let me given some examples of specific research questions that have guided portions of this work.

Values and information processing. For many years, attitudes researchers have associated "strong" attitudes (i.e., those that resist change and influence behavior) with attitudes that express or connect directly to one's cherished values (e.g., Sherif & Cantril, 1947; Maio & Olson, 2000a). For example, in one early program of research, Ostrom and Brock (1969) asked message recipients to consider a message in relation to values the recipients viewed as personally important or unimportant. After measuring attitudes, Ostrom and Brock presented an opposing message attempting to change the newly formed attitudes and found that attitudes initially

formed while considering important values were more resistant to change than attitudes formed while considering unimportant values. This result was viewed as consistent with "value expressive" or "value linked" attitudes being stronger if the values are important to people.

However, this "structural" view of value effects on attitude strength is not the only possibility. As mentioned earlier, from an ELM point of view, increases in thinking about the issue can also result in strong attitudes (Wegener et al., 2004). Therefore, it seemed plausible that thinking about important rather than unimportant values might make the issue seem more important or interesting, and this increased thinking might be responsible for the creation of stronger attitudes. Indeed, in a series of studies, consideration of important values led to higher levels of information processing than consideration of unimportant values, and this amount of thinking was responsible for the strength (resistance to change) of the resulting attitudes (Blankenship & Wegener, in press). Measures designed to tap "value expression" showed that the increases in thinking per se did not create attitudes that "expressed" the values, as assumed by Ostrom and Brock (1969) and Sherif and Cantril (1947).

One important feature of the values and processing work is that consideration of important values increases processing of information about topics viewed as utterly irrelevant to message recipients. For example, a number of the studies addressed proposed admission of an Eastern-European country into the European Union (a topic participants viewed as quite irrelevant to them), and one of the studies proposed the building of nuclear power plants in Canada (another topic of relatively little relevance to our message recipients).

As described in the ELM sections earlier, topics of low personal relevance typically receive little thinking, and attitudes produced (by mostly peripheral means) are not very consequential. However, in many domains (such as health, where people often view consequences of negative health behaviors as unlikely to occur for them), practitioners would want people to think about and form consequential attitudes on those topics. Asking people to consider important values (or even briefly presenting the values prior to message presentation, Blankenship, 2006) may be one easy way to get people to think about topics they would otherwise ignore (often to their own peril).

Another applied implication is that persuasive messages about non-threatening, personally irrelevant topics might be useful in creating attitudes that impact perceptions and behavior on more relevant topics. For example, people start out as less favorable toward the building of a nuclear power plant in their community than they are toward nuclear power in general (Rankin, Nealy, & Melber, 1984; Rosa & Dunlap, 1994). But messages about nuclear power in general or in distant places (where less inherent resistance exists) may be viewed by message recipients as irrelevant to them and unworthy of their attention. A technique such as consideration of important values might prove helpful. It can use the low-relevance topic, where initial resistance to the message is relatively low, but because the technique can produce high levels of processing, the attitudes produced are then harder to change and more likely to guide later decisions and behavior. It may be, therefore, that thoughtful persuasion of the benefits of nuclear power in Canada could be useful in lessening the public resistance to widespread development of nuclear power closer to home.

Message order effects. The ordering of different messages has also been of interest for many years (e.g., Lund, 1925; Hovland & Mandell, 1957), but results have been mixed. Sometimes the first message encountered is more persuasive (a primacy effect, e.g., Lund, 1925), and sometimes the second/last message received is more persuasive (a recency effect, e.g., Hovland & Mandell, 1957). Summarizing the work to date, Hovland (1957) speculated that primacy might be most likely when presenting information on an unfamiliar/novel topic. Although research on message order flourished in the early 1960s, results continued to be mixed, with a number of results inconsistent with Hovland's (1957) contentions (see Lana, 1961; Rosnow & Robinson, 1967). As recently as 1993, a prominent attitudes text (Eagly & Chaiken, 1993) expressed pessimism that consistent message order effects would be discovered anytime soon.

However, consistent predictions could be made using the ELM notion that higher levels of information processing should lead to stronger attitudes that are more resistant to change. In a pair of studies reported by Haugtvedt and Wegener (1994), we showed that high levels of personal relevance consistently lead to primacy effects (greater impact of the first message), and low levels of personal relevance lead to recency effects (greater impact of the second/last message). Consistent with the ELM theorizing, greater processing of the first message should create stronger attitudes prior to receiving the second message. With stronger attitudes (when proc-

essing of the first message is high rather than low), the message recipient is able to resist the second message, resulting in primacy. In contrast, when attitudes following the first message are weak, the second message is able to exert more persuasive impact (for additional discussion, see Haugtvedt & Wegener, 1994).

These effects were found when the two messages favored and opposed the building of nuclear power plants (when high relevance conditions suggested that the plants be built in the message recipients' own and nearby states, and low relevance conditions suggested that the plants be built in distant states). Consistent with the basic science approach of generalizing the effects across different types of topics, the same effects were also found using a proposal for an educational policy (i.e., institution of senior comprehensive exams for graduating seniors, Petty & Cacioppo, 1986a).

Ambivalence and processing. Finally, a recent set of research studies has examined the effects of attitude ambivalence on information processing. Ambivalence occurs when people realize that there are both positive and negative aspects of an attitude object or policy. For example, people might believe that nuclear power is good because of the lack of greenhouse gas emissions, but is bad because of the radioactive waste.

Research on persuasion has shown that people tend to think carefully about information on topics about which they are ambivalent (Maio, Bell, & Esses, 1996). One way to understand this effect would be to say that people are unsure as to what their attitudes should be when they are ambivalent, and they actively process available information in an attempt to determine what their attitude should be (see Chaiken, Liberman, & Eagly, 1989).

However, another prominent feature of ambivalence is that it is uncomfortable for people to be ambivalent. Because of this, they may be motivated to use information processing to reduce the ambivalence. Note, however, that not all information should be equally capable of reducing ambivalence. Consider a person who is moderately favorable toward nuclear power, for example, because s/he sees more positive than negative features. This person would be more likely to overcome the ambivalence by learning about additional positive features (because the larger number of positive features will "dwarf" the negative features and reduce the feeling of conflict). If the person learns about new negative features of nuclear power, this would only increase the ambivalence (because there would be more negative perceptions to counter the positive, and the feeling of conflict would increase).

This suggests that effects of attitude ambivalence should not be a general increase in information processing (as suggested by past research). Instead, ambivalent people should want to process information that adds new information supporting their existing position (because it could help to decrease the ambivalence). In contrast, people experiencing ambivalence should want to avoid processing of information that opposes their existing attitude (because the information threatens to increase their ambivalence).

Clark, Wegener, and Fabrigar (under review) reported evidence consistent with the proposal in a series of three studies (one addressing attitudes toward nuclear power, and two addressing attitudes toward the taxing of junk food). When people were relatively ambivalent before they received the persuasive message, they processed the message to a greater extent when the message was relatively agreeable (i.e., focusing on features of the proposal that further supported the message recipients' views before they received the message). When the message disagreed with the ambivalent person's pre-message assessments, message recipients did not think carefully about the information. In addition, ambivalent participants perceived the agreeable messages as more likely than the disagreeable messages to reduce ambivalence, and these perceptions of potential for ambivalence reduction led to the processing differences across messages that were relatively agreeable or disagreeable.

However, when participants were relatively unambivalent, they showed a very different pattern of message processing. Unambivalent people processed messages more when the messages were disagreeable rather than agreeable. These results were consistent with past research that did not address ambivalence, but likely examined situations where ambivalence was relatively low. In that past research, disagreeable messages were thought to receive more scrutiny because they threaten the person's attitude or self confidence (e.g., Cacioppo & Petty, 1979; Edwards & Smith, 1996). Although this may be for people experiencing low levels of ambivalence, it appears that motives to reduce ambivalence overpower any attitude-threat effects and entirely reverse the traditional effects of message position on amount of message processing.

When one reorganizes these studies to examine effects of ambivalence on message processing, the Maio et al. (1996) effects are limited to the processing of relatively agreeable messages. When the person already agrees with the point of view in the message, s/he is more likely to process the message when feeling high rather than

low levels of ambivalence. In contrast, with disagreeable messages, people experiencing high levels of ambivalence are less likely to think carefully about that message than people experiencing little or no ambivalence.

Therefore, if applied researchers had assumed (as previous research had suggested) that ambivalence would generally lead to careful thinking (and careful thinking would lead to strong attitudes, as discussed in the ELM), these researchers would have been sorely mistaken. In fact, if using a disagreeable message (which is the typical kind of message when changes in attitudes are sought), the ambivalent people are significantly less likely to process information carefully (and, therefore, their attitudes would remain weak and unlikely to guide future behavior).

Using the Research to Inform Policy

I am not sure if informing policy is the primary role of research on attitudes and attitude change. It is true that the need for policies like government subsidies (e.g., to make environmentally friendly forms of energy more affordable) might be more necessary when consumers do not strongly favor use of those new technologies. It may also be true that government policies influence how much public support a new energy source receives. For example, it may be that support for use of ethanol may stem, in part, from people wanting to support farmers and rural communities (which also implies support for subsidies that go to support farmers or ethanol producers).

It seems to me, however, that research on attitudes and attitude change may be more useful in helping to support and implement government policies pertaining to energy use. For example, it may be deemed as useful or even necessary for our country to transition away from use of fossil fuels (which are polluting and come largely from beyond our borders, producing a security premium for obtaining a steady supply of these fuels). But, as noted earlier, an effective transition from cheap fossil fuels to more costly (and perhaps less convenient) new technologies will take more than technology development alone.

Public attitudes, values, and norms supporting the transition will go a long way toward paving the way for new technologies to take hold and become commonplace. For example, our local municipality recently implemented a city ordinance restricting smoking in public places. Both before and after this policy decision was made, there was a flurry of advertising supporting this decision prior to implementation of the ordinance. These efforts were clearly not intended to influence the members of the City Council, who had already decided how they were going to vote. The advertising was there to prepare the public for the change and to persuade them that it makes good health sense for employees and patrons. If successful, such efforts increase the likelihood that the ordinance will receive little opposition in the future, and the restrictions will become an accepted norm.

If Federal, State, or local government views particular energy sources or technologies as economically or politically desirable, these entities (or policy-makers within them) may want to persuade the public that these energy sources or technologies are desirable. Indeed, such persuasion may be necessary for the public to accept use of the new technologies in their communities. The relevance of these ideas becomes apparent when considering that, in many places around the country, our energy-producing infrastructure is aging and new power plants will be necessary. Yet, the process of building a new plant is often held up, in part, by company officials trying (unsuccessfully) to convince local residents that the plant will not create negative consequences for their community.

Part of this likely stems from incomplete understanding of the principles studied in attitudes and persuasion. For example, utility officials presenting information about the environmental impact of their proposed plants are not likely to be viewed as credible communicators. They have a clear self-interest, and might often be viewed as untrustworthy. In many of these instances, a better grasp of persuasion principles might suggest use of an independent third-party communicator who can provide information without being perceived as having ulterior motives. Assuming that strong (persuasive) arguments are available (e.g., new power plants can often produce many times the power of old plants with far less pollution than the old, smaller plants), this information may be processed in a more objective manner if presented by a trusted and expert source.

It is also true that initial concerns may not be the same as long-term concerns. For example, although people oppose the building of a nuclear power plant more when it is proposed to be near rather than far away from them, the same is not true for opposition of plants that are already built. That is, people are not more negative toward nuclear power (or oil development) when they live near to it rather than far away (Smith, 2002). Similarly, people who live near a nuclear power plant tend to become more favorable toward it over time—a long-term adaptation effect

(van der Pligt, Eiser, & Spears, 1986, 1987). Therefore, for energy sources that promise long-term benefits (and that operate in safe, and environmentally friendly ways), it may be that the primary public perception obstacles are incurred early in the process—when obtaining zoning and permits to build the plant.

Stepping outside my own area of attitudes and persuasion research, I should also mention that other work in the SEPAE area of the Purdue Energy Center is very explicitly aimed at assessing policy alternatives per se. For example, Dr. Tyner's economic analyses specifically address the influences of policy alternatives on whether the technology is likely to draw private investment or not. Perhaps other panel members will also address the links between other social science areas and policy.

4. What basic social psychology research questions relevant to the energy challenge remain unanswered? Do social scientists have all of the tools they need to answer these questions and adequate resources to pursue promising research directions? Are there of yet undeveloped or underdeveloped technologies or methodologies that would help advance this research?

Unanswered Questions

In over 80 years of empirical social psychology research, much has been learned about how people form and change their attitudes. But for virtually every variable in the persuasion setting, and for each process that has been identified, there exists additional questions that have not yet been examined. Let me provide examples of three types of research questions that seem worth pursuing—one dealing with specific predictors of attitude strength, a second dealing with weak attitudes influencing later information processing in ways that make them stronger over time, and a third addressing the specific cognitive mechanisms that connect attitudes and other psychological variables to behavior. By focusing on attitude strength and behavior, I do not mean to imply that we know everything about attitude change. We certainly do not. However, because the ultimate goal of most attempts at attitude change is to change behavior, a focus on behavior in future research seems as likely as any other focus. I want to be clear, however, that I write this section with the caveat in mind that every year seems to produce new questions that simply were not in the collective consciousness of researchers, sometimes even months before.

Necessary and Sufficient Strength-Related Features of Attitudes

I have mentioned at various points in this testimony that the goal of persuasion is not simply to produce positive attitudes toward one's desired product or policy. The goal is to produce a favorable attitude that is also strong enough to last over time, to resist future attempts at change, and to guide future thinking and behavior (Petty & Krosnick, 1995). This basic idea has been in the literature for some time, but which properties of the attitude are sufficient or necessary for the attitude to produce these desired consequences? Many properties have been studied (e.g., accessibility, ambivalence, certainty, direct experience, knowledge, elaboration; Wegener et al., 1995). However, these properties of attitudes have often been studied in isolation, so the relative contribution of each attitudinal property remains unclear. Also, many of the attitudinal properties are only weakly or moderately correlated with each other, so there is not a single unified "strength" property of attitudes (Krosnick, Boninger, Chuang, Berent, & Carnot, 1993).

This leaves open the real possibility that the contribution of different strength-related attitudinal properties might differ across the types of attitude consequences of interest. For example, consider a context in which the attitude object is relatively novel (as many new energy technologies would be) and the primary question is whether one's attitude will persist long enough to guide future behavior. In this situation, it may be that relatively "passive" attitude properties such as accessibility in memory or certainty might be especially important (it turns out that accessibility and certainty are empirically linked, in that both can be increased by simple repeated expression of one's attitude; Holland, Verplanken, & van Knippenberg, 2003).

On the other hand, when the attitude is controversial and the person is likely to encounter many diverging opinions, the ability of the attitude to resist change may be the key. In such settings, the most important strength-related properties of attitudes may be more "active" qualities that give the person greater ability to counterargue "attacking" messages. If so, then attitudes based on large amounts of knowledge or on high levels of elaboration might be the attitudes best able to hold fast in the face of the diverging opinions. These questions have simply not been addressed in existing attitude strength research.

Initially Weak Attitudes Becoming Stronger Over Time

Another interesting set of research questions may address the possible impact of initially weak attitudes. In existing attitude strength research, the weak attitudes are simply treated as relatively non-consequential (i.e., unlikely to last over time, influence behaviors, etc.). However, there may be at least some "weak" qualities of attitudes that create the potential for the attitudes to "snowball" into becoming strong. For example, as described earlier, recent research in our lab shows that ambivalence and message position combine to influence information processing (Clark et al., under review). That is, ambivalent people think carefully about information that agrees with their pre-message attitudes but avoid thinking about information that disagrees with their pre-message attitudes.

In our initial studies, participants were given the persuasive message rather than choosing to view it on their own. However, these results from our initial research would also have direct implications for what ambivalent and unambivalent people would choose to receive if given the choice. A result parallel to our information processing studies would be for people experiencing ambivalence to be more likely to expose themselves to agreeable rather than disagreeable information. People experiencing little ambivalence may be more balanced in their choices or might even expose themselves to more disagreeable rather than agreeable information.

But notice what the effects of this exposure are likely to be. When ambivalent people expose themselves to agreeable information, this should make them less ambivalent and should, therefore, make their attitude stronger. In contrast, exposure to balanced or more disagreeable information would make people's attitudes more ambivalent and, therefore, weaker. One interesting aspect of this possible pattern of results is that exposure to attitude-consistent information is one of the results that has been discussed in past research as indicative of attitude strength (i.e., as "impact on thoughts and behavior"). Because of this, past researchers have expected (and some have recently found; Brannon, Tagler, & Eagly, 2007) that people with stronger attitudes are more likely to seek attitude-consistent rather than attitude-inconsistent attitudes. These effects are rather small in magnitude, however, and we suspect (but have not yet tested) that this overall pattern masks the effects of some specific types of weak attitudes (especially those that are ambivalent).

More generally, it would change the attitude strength literature in important ways if specific forms of "weak" attitudes actually create stronger preferences for attitude-consistent information or create stronger influences on other types of thinking and behavior.

More Specific Mechanisms to Connect Attitudes and Behavior

In many respects, the study of attitude change is predicated on the ability of attitudes to influence future behavior. Indeed, much research over the years has studied when attitudes predict future behavior and when they do not (and other psychological constructs, such as norms, influence behavior instead; see Ajzen & Fishbein, 2005). This emphasis seems justified, both for the study of attitudes in general, and for studies of attitudes in relation to energy.

There are a number of respects in which we can increase our understanding of exactly how attitudes or other psychological constructs influence behaviors, however. For instance, much research on attitude-behavior consistency speaks of "prediction" of behavior, but there is an important distinction to be made between prediction of behavior and influence on behavior (Fabrigar, MacDonald, & Wegener, 2005). For example, consider a person who forms a positive attitude toward hybrid automobiles after riding in a friend's hybrid automobile. Suppose that this person goes to buy a new car a few months later, but the person does not buy a hybrid car.

This could happen for many reasons, but consider two distinct explanations for this lack of attitude-behavior consistency that have not been systematically differentiated in the attitudes literature to date. One possibility is that the person's positive attitude toward hybrid cars persisted unchanged right up until the purchase decision, but the attitude did not prove strong enough to guide the behavior when the purchase was made. However, there is another possibility—one that produces the same lack of attitude-behavior consistency (at least when using the initial positive attitude to predict the later behavior). That is, the person may use his or her current attitude when deciding to purchase a new automobile, but the attitude may have changed in the months since the original positive attitude was formed. This latter situation is not really a case of attitude-behavior inconsistency at all, but the change in attitude means that the earlier positive attitude did not carry through to guide the purchase behavior.

In fact, the social psychology program at Purdue University will be holding a conference during May of 2008 with the explicit theme of motivating work to develop more complete theory connecting psychological antecedents with behavior.

We Cannot Forget about Applied Energy Research

The question posed to me by the Committee was framed in terms of basic social psychology research, and I am entirely comfortable with that, because I am first and foremost a basic scientist. I should also note, however, that technology-focused researchers do not always appreciate the fact that we are working to identify generalizable persuasion principles that operate across topic domains. Quite naturally, practitioners focusing on a particular topic will view our research as more relevant and informative to them if it deals specifically with their domain of interest (be it a specific form of energy, a particular health condition, or some other specific topic).

Because of this, there may be benefits of applied research that addresses psychological processes that have been identified in unrelated domains but would have clear relevance to influencing attitudes related to energy. At a minimum, if it is important to direct attention in the energy domain toward the psychological principles we discover, it may be helpful to fund some portion of the basic research (e.g., that funded through NSF) in ways that explicitly incorporate energy-related topics. Doing so would ensure that energy researchers and practitioners identify the persuasion (and other social psychology) principles discovered as relevant to the energy domain.

Even in areas where the basic research has not used energy-related topics, telephone surveys and other tools for attitude measurement can be used to determine the current attitudes, beliefs, and knowledge that people hold about energy topics. When the characteristics of current attitudes are documented, for example, this would tell energy researchers which basic persuasion principles are relevant to attitudes in that energy domain. For example, if surveys show high levels of ambivalence for people's attitudes toward clean coal technologies, this would suggest that the research on attitude ambivalence described earlier (e.g., Clark et al., under review) is quite relevant.

Tools and Resources

One of the benefits of social science research in general, and social psychological research in particular, is that it is very efficient from a cost standpoint. With some sub-disciplines excepted (such as social, affective, or cognitive neuroscience, which use Functional Magnetic Resonance Imaging, fMRI, techniques), most research laboratories can be constructed with $100,000 or less. Once a lab is established, the primary costs are those of personnel (i.e., faculty time, graduate students, post-doctoral fellows, research assistants) and research participants (especially if recruiting research participants from the surrounding community).

Because of this efficiency, it seems likely that one might often gain more "bang for the buck" from research on behavior change than on higher-cost funding of new (as yet untried, and often economically unfeasible) energy-production technologies. This is not an argument to reduce funding to develop new technologies. But the research on basic persuasion principles will be relevant across many such technologies, and the transition away from fossil fuels will absolutely require changes in behavior that involve energy conservation (using current technologies) as well as adoption of new energy sources, policies, and products. More generally, this transition will require policies to encourage investment, persuasion of potential consumers, changing norms to encourage adoption, and other social, economic, or governmental interventions to facilitate shifts in energy use.

Unfortunately, despite the relative efficiency of social science research, there is much less federal funding available to fund this research (at least within social psychology) than there used to be. As I described earlier, this is largely a function of the shift in funding priorities for the National Institute of Mental Health. This shift may have made sense for that institute if its primary mission is, indeed, severe mental illness. However, this shift in priorities has left a sizable gap in funding for basic science whose results and theory cut across many basic and applied disciplines. It is extremely important to find a new home for federal funding of basic research in social psychology in general and of research in attitude change in particular.

New Technologies or Methods

Most social psychological research uses existing computer technology in creative and useful ways. Therefore, many of the new research methods come from the creativity of researchers, rather than the development of new research technology per se. This is not true of all social psychology research, however. As I mentioned earlier, my colleagues in social, cognitive, or affective neuroscience use a variety of techniques that I do not (including fMRI and other versions of brain imaging or scanning).

There are also a variety of new "implicit" measures of attitudes that have been developed recently to tap into attitudes and perceptions that people are reluctant to share or of which people might not even be aware. These typically use existing computer technology, but they represent some very interesting methods that are just beginning to pay big theoretical dividends. For example, implicit measures of attitudes have been shown to improve prediction of behavior in some contexts and for some behaviors, even when traditional direct measures of attitudes are also used (see Ajzen & Fishbein, 2005; Fazio & Olson, 2003). There are many unexplored questions using these techniques.

The long-term impact of these methods for theories of attitudes and attitude change are still unclear. It is also important to note, however, that there is still much to learn using more "conventional" methods to ask people about their attitudes and thereby examine how factors in a persuasive message or in the environment influence the attitude.

Finally, it is also important to note that social psychologists' focus on cognitive and motivational processes requires sophisticated statistical techniques and research methods (see Reis & Judd, 2000; Sansone, Morf, & Panter, 2004). These developments help to build stronger evidence in tests of psychological theories, and parallel analyses then receive use in related academic and applied disciplines (for a recent example advance in this area, see Muller, Judd, & Yzerbyt, 2005).

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BIOGRAPHY FOR DUANE T. WEGENER

Dr. Wegener received his Ph.D. in Social Psychology from Ohio State University in 1994. After serving as an Assistant Professor of Psychology at Yale University for three years, he joined Purdue University in 1997 as an Associate Professor and was promoted to Professor in 2003. Dr. Wegener serves as one of three Initiative Leaders for the Social, Economic, and Political Aspects of Energy Use and Policy, a research initiative within the Energy Center at Discovery Park—an interdisciplinary research hub at Purdue University.

Dr. Wegener's research focuses on attitudes and persuasion, especially influences on the amount and nature of information processing and the consequences of the resulting attitudes for later thinking and behavior. Dr. Wegener has been PI or Co-PI on grants in social psychology (National Science Foundation), health (focusing on processing of health communications; Canadian Institute for Health Research), and energy (focusing on energy-related attitudes and decision-making; National Science Foundation—Human Social Dynamics Program).

In 2001, he received the American Psychological Association (APA) Early Career Award for distinguished contributions to the science of social psychology. Dr. Wegener's research has resulted in over 50 publications in journal articles and book chapters. He is currently a Section Co-Editor for the *Social and Personality Psychology Compass,* and he served as Associate Editor for *Basic and Applied Social Psychology* and the *Personality and Social Psychology Bulletin.* He has also served as an editorial board member for the *Journal of Personality and Social Psychology,* the *Journal of Experimental Social Psychology,* and *Personality and Social Psychology Bulletin,* and as an ad hoc reviewer for over 30 academic journals.

Chairman BAIRD. Thank you, Dr. Wegener.

Dr. Laitner.

STATEMENT OF MR. JOHN "SKIP" LAITNER, VISITING FELLOW AND SENIOR ECONOMIST, AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY

Mr. LAITNER. Good morning, Chairman Baird, Ranking Member Ehlers, Members and staff of the Subcommittee. I recently joined the American Council for an Energy Efficient Economy as their Senior Economist for Technology Policy. However, I am now celebrating 37 years in the energy policy arena, and in those nearly 4 decades of effort, there have certainly been some disappointments along the way. At the same time, however, I have never been more confident in telling this subcommittee that the United States has never been better positioned to move onto a path of sustainable energy production and consumption, one that promotes both productivity and economic prosperity if we choose to do it. But it is not really just about technology or economics, rather it is about the human element, the innovative spirit, and with apologies to my colleagues from the south, about our vaunted Yankee ingenuity. In that sense, a productive and prosperous energy policy equally depends on a better understanding of the human dimension. What is it that might be done to motivate that ingenuity and what might be done to translate it into productive action.

Let me give you a very concrete example. Some years ago a colleague of mine had a really good idea for a new technology but in fact it wasn't really a new technology, it was seeing a different blend of technologies, a new design, a rearrangement of existing ones, a new configuration that if implemented would save manufacturers a good bit of money. Suffice it to say that if my estimates are correct, by 2025, the annual savings from this new energy efficient technology would rival the anticipated output from the Alaska National Wildlife Refuge. It is potentially very big.

So here is where the social science comes in. First, what is it that really motivated him to develop a prototype of this technology? Second, what gave him the inspiration to see a new way of doing things? Third, critically, why can't he get it to the market? He seems to hold onto it, always wanted to make just one more refinement. He doesn't seem to know how to really close the deal, and given the Chairman's background, I think he might have some interesting insights into that kind of behavior. But fourth, how many more are out there just like him? I suspect a lot. And how many more could there be if we encouraged a greater entrepreneurial enthusiasm? Again, I suspect a lot. Fifth and finally, what can we do to motivate a greater level of innovating seeing entrepreneurial action? This is all from the production side. There are similar questions from the perspective of the consumer. What is it that encourages early and then accelerated adoption of new technologies? We have heard a bit of that already. What does this tell us about the energy policy signal beyond the price signal?

Mr. Chairman, I submit the energy problem is not purely a technology problem. While there is already a good bit of science involved to be sure and there is clearly a need for more research and disciplines like material science and advanced electronics, more generally in biology, chemistry, and physics, fundamentally I believe it is equally a problem with the human dimension. Yes, we

are seriously under-funding our R&D efforts and especially for energy efficiency but it is even worse for the social sciences.

Members of the Subcommittee may be interested in at least one set of energy-related statistics to help frame these last thoughts. Based on the 2007 edition of British Petroleum's Energy Statistical Review, it appears the U.S. enjoys what is referred to as proven fossil fuel reserves of around 130 billions of oil equivalent. That is good. At our current rate of consumption, that is roughly a 52-year resource. The bad news is about 90 percent of that resource is coal. But the good news is in the spirit of Leonardo daVinci's motto, sapere vedere, Tuscan dog Latin meaning to know how to see, we may also see something more on the order of 900 billion tons of energy-efficiency reserves over the next century. As it turns out, we may use about two-thirds of this large efficiency resource in our normal pattern of growth. However, that would still mean an energy consumption of about three and one-half times greater than we are using today by the end of the century. That is huge. Depending on how much of that energy comes from renewables or other clean energy resources, that may not be good enough. So the question then becomes, how do we unlock that remaining one-third of the efficiency resource so that we might keep our total energy use to say less than 50 percent growth compared to today's use of energy and still maintain a robust economy? How exactly do we get at it? At a minimum, the answer is at least one part accelerated R&D and one part new insights from the social sciences, an expanded investment in our understanding of the human dimension.

In answering this question at least in part, let me finally turn to an analogy drawn from baseball. Pitcher Nolan Ryan was something of a hero of mine. He won I think 324 games over his career which included a stint with President Bush's own former team, the Texas Rangers. But how many games would Nolan Ryan, the so-called Ryan Express, how many would he have won had he taken the field without his catcher or without his infield? In a very similar way, if we are to design and implement an energy policy that sustains our economy in a highly prosperous way, we should be funding and fielding a complete team effort. Yes, we need improved energy efficiency standards and smarter incentives. Yes, we need more research and development, but yes, we also need to support more research and more funding for that research in the field of social sciences.

I thank you for this opportunity to speak. I would be happy to take questions.

[The prepared statement of Mr. Laitner follows:]

PREPARED STATEMENT OF JOHN A. "SKIP" LAITNER

Summary

This testimony responds to an invitation from the Subcommittee on Research and Science Education to help members explore the relevance of the social, behavioral and economic sciences in shaping a more productive pattern of energy use and a more balanced set of energy policies. Any useful policy assessment clearly must include some form of economic analysis. Prices and incomes do matter in the evaluation of public policy, but they are not all that matter. Technological innovation and market dynamics are among those things that influence our demand for energy-related goods and services. Social norms and structures also play a role. These all, in turn, are shaped by culture, beliefs, values, preferences, habits, and the availability of alternatives.

For the most part, current economic policy models fail to adequately capture the ways in which individual energy consumption patterns change in response to both economic and noneconomic policies and programs. Therefore, policies based on these models have consistently overlooked the energy savings that can be achieved through the accelerated adoption of energy-efficient technologies, changing social preferences, and more energy-aware behaviors. As such, these models have tended to underestimate the energy savings that can be achieved while generally overestimating the costs of achieving increased levels of energy efficiency. The inaccuracy of these models has large and important implications for both energy policy and climate change mitigation policy. There is good news in all of this but, as we shall see, there is work ahead.

Given this circumstance, and based on the available evidence, the American Council for an Energy-Efficient Economy (ACEEE) believes three distinct recommendations are in order. First, and after further review, the Subcommittee should issue a set of findings that confirms our testimony. We think it will send a positive signal to the economics and social science communities that there is clear room for improvement. Second, support the development and funding of a National Energy Efficiency Data Center (NEEDC), which would be a national nonprofit organization whose purpose will be to collect, organize, disseminate and archive energy efficiency and social science statistics, particularly those related to public policies and programs. Finally, more research and greater research funding will provide the means to expand our knowledge and understanding of how human behavior and choice can increase energy efficiency, reduce our energy dependency, and reduce our impact on the global climate while still maintaining a robust economy.

Introduction

My name is John A. "Skip" Laitner and I am the Senior Economist for Technology Policy for the American Council for an Energy-Efficient Economy (ACEEE), a nonprofit organization dedicated to increasing energy efficiency as a means of promoting both economic prosperity and environmental protection. I am here today at the invitation of this subcommittee to explore the relevance of the social, behavioral and economic sciences to energy use and policy. I thank you for the opportunity to testify today. Working with me in the preparation of this testimony and also here today is my ACEEE colleague, Karen Ehrhardt-Martinez. She holds a professional degree in sociology and works with me on a variety of economic and technology issues.

Any useful policy assessment must include some form of economic analysis. Prices and incomes do matter in the evaluation of public policy, but they are not all that matter. Indeed, the great English economist Joan Robinson wrote in 1947 that "economics science has not solved its first problem—namely what determines the price of a commodity?"[1] That remains true today, now 60 years later. But I might add, neither has economics determined exactly what magnitude of income is sufficient to satisfy either individual or household demands.

Among those things that influence our demand for goods, services, and amenities, and that also impact things like technological innovation, market dynamics, and personal choice are social norms and structures. These, in turn, are shaped by culture, beliefs, values, habits, alternatives, and basic human and social needs. In short, there is compelling evidence that an accurate economic analysis (of either energy use or the environmental impacts associated with the production and consumption of energy) requires a broader understanding of human behavior and choices. It also requires an understanding of the ways in which they are shaped by the institutional and social frameworks of our society. Recent studies of climate change policy have also stressed the importance of human choice and human behavior for the development of effective policies that reduce emissions and mitigate climate change.[2] However, current economic models fail to adequately capture the ways in which individual energy consumption changes in response to economic and noneconomic policies and programs.[3] Therefore, policies based on these models have consistently

[1] Robinson, Joan. 1947. *An Essay on Marxian Economics.* London, England: MacMillan, page 79.

[2] Brewer, Garry D. and Paul C. Stern, Eds. 2005. *Decision-Making for the Environment: Social and Behavior Science Research Priorities.* Committee on the Human Dimensions of Global Change, National Research Council, Washington, DC: National Academies Press; and also see, Stern, Paul C., Oran R. Young; and Daniel Druckman, Eds. 1991. *Global Environmental Change: Understanding the Human Dimensions.* Committee on the Human Dimensions of Global Change, National Research Council, Washington, DC: National Academies Press.

[3] Laitner, John A. "Skip", Stephen J. DeCanio, and Irene Peters. 2000. "Incorporating Behavioral, Social, and Organizational Phenomena in the Assessment of Climate Change Mitigation Options." in E. Jochem, J. Sathaye and D. Bouille, *Society, Behavior, and Climate Change Miti-*

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overlooked the energy savings that can be achieved through changing social preferences and the accelerated adoption of energy-efficient technologies and more energy-aware behaviors. As such, these models have tended to underestimate the energy savings that can be achieved while generally overestimating the costs of achieving increased levels of energy efficiency. The inaccuracy of these models has large and important implications for both energy policy and climate change mitigation policy. In my testimony here today, I will expand on these notions a bit more as I try to answer three questions that this subcommittee has posed for me:

1. How predictive is a purely economic approach to evaluating the impact of energy policy on individual and communal behavior? What other factors need to be considered to match economic theory to empirical data? To what extent are such data even available? That is, to what extent are relevant energy policies being evaluated for effectiveness?
2. To what extent are policies to influence individual and community energy use being shaped by what has been learned from research in the social sciences, including economics? Are you aware of particular sectors of industry or government that make more of an effort to incorporate the results of such research into the design and evaluation of policy?
3. Please describe the purpose and scope of the first-ever Behavior, Energy and Climate Change Conference being organized by ACEEE. What do you hope to achieve through this conference? How much interest have you seen from industry, government officials, and others in a position to influence policy?

In responding as fully as I can to each of questions, let me divide up my testimony into five parts. The first section following this introduction provides an energy and economic context that I hope will be helpful in responding to the Subcommittee's request. The next three sections will deal specifically with each of the questions posed. The last section will provide recommendations and conclusions.

Energy Consumption in Context

As one of the richest and more technologically advanced regions of the world, the United States has expanded its economic output by three-fold since 1970. Per capita incomes are also twice as large today compared to incomes in 1970. Notably, however, the demand for energy and power resources grew by less than 50 percent during the same period.[4] This decoupling of economic growth and energy consumption is a function of increased energy productivity: in effect, the ability to do more with less consumption. In today's testimony I would like to accomplish three specific tasks as I try to answer your questions. First, I would like to note how this decoupling has been achieved; second, reaffirm the compelling evidence that suggests greater energy productivity gains can be achieved—that there is, indeed, significant room for improvement; and third, suggest that social science research can provide policy-makers with a more satisfying set of insights that can help our nation to capture those greater energy productivities while maintaining our economic prosperity and enhancing overall environmental quality. There is good news in all of this but, as we shall see, there is work ahead.

The Success of Energy Efficiency to Date

The Members of this subcommittee may be surprised to learn how big of a role that energy efficiency has already played supporting the growth of our economy over time. Figure 1, below, provides the historical context of efficiency gains estimated through 2007 as they might compare to the development of new energy supplies since 1970. In effect, Figure 1 compares the projected level of energy consumption in 2007 to that which might have been necessary had the economy continued to rely on 1970 technologies and market structure.[5]

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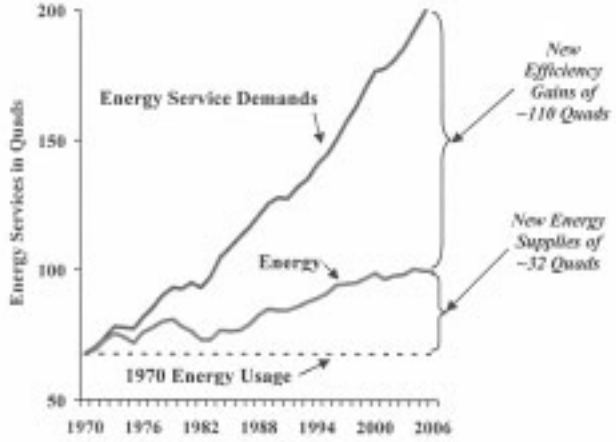
gation. Dordrecht, The Netherlands: Kluwer Academic Press, pages 1–64. See also Laitner, John A. "Skip", Stephen J. DeCanio, Jonathan G. Koomey, and Alan H. Sanstad, "Room for Improvement: Increasing the Value of Energy Modeling for Policy Analysis." *Utilities Policy,* 2003, 11, 87–94. Finally, see also, Worrell, Ernst, Stephan Ramesohl, and Gale Boyd. 2003. "Towards Increased Policy Relevance in Energy Modeling," *ACEEE 2003 Summer Study on Energy Efficiency in Industry.* Washington, DC: American Council for an Energy-Efficient Economy.

[4] These and other specific energy-related data cited in the testimony are the author's calculations as they are drawn from the Energy Information Administration's *Annual Energy Review 2006,* Report No. DOE/EIA–0384(2006), Washington, DC: U.S. Department of Energy, June 2007; and Energy Information Administration's *Short-Term Energy Outlook—August 2007,* Washington, DC: U.S. Department of Energy.

[5] Strictly speaking, the term energy efficiency as used here today can be more broadly defined as a reduction in energy intensity; that is, a reduction in the number of Btus needed to support a dollar of economic activity. This change results from two key drivers. This first is a change

Figure 1. U.S. Energy Service Demands, Energy Efficiency Gains, and Energy Supplies



Source: Author calculations based on EIA data referenced in footnote 4.

In 1970 Americans consumed an estimated 68 quadrillion Btus (quads) for all uses of energy—whether heating and cooling our homes, schools, and businesses; powering our many industrial processes; or transporting both people and freight to the various places they needed to go. If we converted all forms of energy consumed in 1970 to an equivalent gallon of gasoline per capita, it turns out that the U.S. economy required about 2,670 gallons of gasoline equivalent for each man, woman, and child living in the U.S. at that time. Had the United States continued to rely on 1970 market structure and technologies to maintain its economic growth we would today be consuming an estimated 210 quads of energy. That would have been about 5,550 gallons of gasoline per person equivalent. But in fact, the consumption estimated for 2007 appears to be only slightly more than 100 quads of energy (in rounded numbers). Again on a per capita equivalent, this means that the United States economy requires about 2,660 gallons of gasoline per resident.

In examining these numbers more closely, several insights might pop into mind. First, energy efficiency has allowed us to decrease the per capita energy use, at least somewhat, compared to what we used in 1970 while still enjoying an expanded set of goods and services. Second, instead of doubling our energy use with the expanded economy, in effect, the gains in energy efficiency have allowed us to reduce total energy use by the equivalent of 110 quadrillion Btus in 2007. As such, energy efficiency has "fueled" roughly 77 percent of the new growth demands in the United States since 1970. The new energy resources, on the other hand, have provided less than one-third of the demands (or about 32 Quads as shown in the figure).

Technology Drivers Behind Our Energy Efficiency Gains

Among the reasons for the increased energy productivity during the past 35–40 years has been the emergence and widespread adoption of advanced technologies, including substantial improvements in standard consumer products, new high-tech electronics, improvements in fuel economy, and the emergence of a variety of information and communication technologies (ICT). A refrigerator in 1970, for example, would have consumed on average 1,600 to 1,800 kilowatt-hours (kWh) of electricity

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in market structure as we move away from energy intensive industries as a source of income to higher value-added services. The second is what we typically think of as energy efficiency—more efficient lighting and consumer products, greater fuel economy in our vehicles, and more efficient power plants and industrial processes. The United States has benefited from both economic drivers; and both were made possible by a combination of behaviors, innovations, and choices of technology. From a macroeconomic perspective the evidence suggests that anything we can do that positively reduces energy use while maintaining incomes and economic prosperity can be termed "energy efficiency." It is in that larger sense that I use the term here today.

per year. Today, new refrigerators might require only 450 to 600 kWh—even as their volume has doubled in size. In 1970 cogeneration units that might have achieved efficiencies on the order of 50 to 60 percent. This was still more favorable than the 32 percent system efficiencies of our electricity grid back then, a level of inefficiency that persists still today.[6] Yet, cogeneration was seldom part of a company's long-term energy plans. Their more productive cousins—what today we call combined heat and power (CHP) plants that can achieve overall efficiencies of 90 percent and beyond—are becoming a critical resource in the strategic plans of many energy-intensive industries. In 1970 I was driving a used 1957 Chevy that may have gotten all of 20–21 miles per gallon—if that. Today I own a Toyota Prius that perhaps averages 45 miles per gallon. And today I do more online banking and shopping, and businesses now conduct more of their transactions electronically—especially in the last two decades. These and many other advanced technologies have added up to a significant increase in overall energy productivity.

The Social Drivers Behind Our Energy Efficiency Gains

The impressive gains in energy efficiency since 1970 are the result of numerous innovations and choices made by both businesses and consumers. But what are the drivers behind these innovations in efficiency? What spurs people to choose energy-efficient technologies and behaviors? And how much variation is there in the decision-making process?

Among the drivers of innovation and efficiency is the increasing level of concern about rising energy prices. However, while energy prices comprise an important motivating factor, innovation and efficiency have also been driven by concerns about environmental degradation, global climate change, international energy security, and even the lack of adequate energy and water supplies within developing countries.

In other words, it is a varied backdrop of concerns that has motivated action by individuals, households and companies that are interested in solving problems. In addition to their concerns over energy and the environment, individuals and groups also regularly contend with concerns over earning a decent income, as well as developing a highly profitable enterprise. But the complexity of the process doesn't end there. A thorough understanding of motivating factors is further complicated by the diversity of interests, backgrounds, skills, and personalities held by would-be agents of change. In fact, these individuals and organizations bring with them both shared and divergent sets of interests, backgrounds and skills, creating a kaleidoscope of shifting concerns and behavioral outcomes. In other words, there is a wide range of corporate, group, and individual characteristics that shape one's propensity toward energy-saving or energy-efficient behaviors and those characteristics often change over time; yet none of these attributes or concerns are adequately captured in the energy prices signals and changes in incomes that economic models typically rely on to evaluate the impacts of energy programs or policies. Moreover, by relying on energy prices as the primary driver of behavioral change, economic models fail to measure and incorporate the impact of other important elements such as consumer information pertaining to the availability of more energy-efficient products on the market, the variety of ways of shipping a product while generating net energy savings, or traveling to new places for work or leisure in ways that use less energy. In short, energy choices are not simply a function of energy prices but involve a more complex mix of motivating factors that vary across individuals and organizations and that shape their propensity to act.

The good news is that studies by ACEEE and others have repeatedly shown that the United States can cost-effectively reduce energy use 25 percent or more over the next 15–20 years in ways that *increase* overall productivity.[7] Moreover, given the right choices and investments in the many cost-effective but underutilized energy-efficient technologies, these gains in energy productivity could provide much needed

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[6] Perhaps also of interest to the Subcommittee: what we waste just in the production of electricity is more energy than Japan uses to power its entire economy. We already have the technology to substantially reduce that level of waste, however. It appears that the real problem may lie more in understanding how to encourage the adoption of technologies like combined heat and power or other waste-to-energy technologies. Hence, the problem may lie more in the dimension of social sciences than in improving our technology.

[7] Nadel, Steven. R. Neal Elliott, and Therese Langer. 2005. *A Choice of Two Paths: Energy Savings from Pending Federal Energy Legislation.* Washington, DC: American Council for an Energy-Efficiency Economy. See also, McKinsey Global Institute, 2007, *Curbing the Global Energy Demand Growth: The Energy Productivity Opportunity,* San Francisco, CA, McKinsey & Company. Finally, see also, "Closing the Efficiency Gap: Strategic Plan for Energy Efficiency Improvement in the G8 Countries," 2007, Washington, DC, United Nations Foundation.

slack in the now overly stressed energy supply markets.[8] This, in turn, could lessen energy price volatilities, and minimize greenhouse gas emissions—all in ways that save additional money for businesses and consumers. While this information is readily available, it has not been included in most of the economic models used to evaluate energy policies. As a result, policies based on these models have consistently overlooked the cost-effective energy savings that can be achieved through changing social preferences and the accelerated adoption of energy-efficient technologies and behaviors.

Economic Models, Social Preferences and Energy Policy

The Subcommittee has asked: how predictive is a purely economic approach to evaluating the impact of energy policy? To answer this question it might be helpful to first put this into context. For that purpose, let me take you back to 2003 when both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy's Energy Information Administration (EIA) received a Congressional request to evaluate a proposed climate policy that would reduce energy-related carbon dioxide emissions by about one-third compared to levels forecasted for the year 2025. The resulting EIA modeling analysis, using its National Energy Modeling System (NEMS), suggested that if the policy were adopted there would be a negative impact on investment and household consumption, and that energy prices would rise significantly compared to the reference case.[9] Conversely, the EPA relied on the Argonne National Laboratory's AMIGA Modeling System and found the impacts to be somewhat more positive; indeed, the analysis (which unfortunately was never publicly released) showed that there could be small but positive increases to both investment and consumption over time.[10]

Three key differences perhaps explain this sharp contrast in modeling results. First, the AMIGA modeling system tends to use a more dynamic characterization of technology cost and performance over time. This means that as price signals increase (for example, through a cap and trade mechanism) and as non-price policies are implemented (by expanding voluntary initiatives such as the ENERGY STAR programs, for example, or by increasing performance-based standards such as the Energy Efficiency Resource Standard and appropriating additional funds for energy-related R&D efforts), the AMIGA modeling system tends to show a greater improvement in technology performance that reduces the costs and generates a higher energy bill savings. Second, the model tracks the substitution of productive capital as it displaces less energy-efficient technologies over time. It then translates this into a more appropriate GDP accounting framework than the NEMS model is able to do.[11] Finally, AMIGA allows consumer and business preferences to shift over time in response to various programs. For example, consumers today might purchase a new appliance only if it pays for itself in three years. However, an expanded set of voluntary programs might encourage the adoption of technologies that might pay for themselves in, say, four or five years. That greater willingness to adopt technologies would mean a greater level of net energy savings for the economy.[12]

There are two critical points to be made in answering the Subcommittee's question in this regard. First, since the EIA report was the only analysis that was publicly released, the persistent storyline of negative economic impacts tended to erode public and Congressional support for any meaningful action on either energy or climate policy in the United States. Therefore, the most direct effect of poorly devel-

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[8] Elliott, R. Neal. 2006. *America's Energy Straightjacket.* Washington, DC: American Council for an Energy-Efficient Economy.

[9] Energy Information Administration, 2003, *Analysis of S. 139, the Climate Stewardship Act of 2003,* Washington, DC, U.S. Department of Energy.

[10] U.S. Environmental Protection Agency, 2003, "Preliminary Analysis of the Climate Stewardship Act," Unpublished results, May 23. The witness has direct knowledge of this modeling result as he was the EPA project officer that undertook this analysis in cooperation with the Argonne National Laboratory's AMIGA modeler, Donald A. Hanson.

[11] In fact, AMIGA generally follows the accounting framework of the Bureau of Economic Analysis (BEA) as it estimates quarterly GDP for the United States. As BEA tracks changes in GDP for any given period of time, it accounts for total household consumption, total investment, overall government spending, and total net imports. AMIGA follows this same accounting procedure. Hence, if there are programs and policies that stimulate increases in more productive investment in the economy that saves money for households and businesses, and reduces imports of oil and natural gas, AMIGA would show those programs and policies to provide net benefits to the U.S. economy.

[12] Perhaps of interest to the Subcommittee, there is more information on this topic as a result of a November 2006 national workshop that ACEEE convened to explore a number of these critical insights. The workshop title was "Energy and Economic Policy Models: A Re-examination of Some Fundamental Issues." For a full list of participants and access to the papers presented there, see: *http://www.aceee.org/conf/06modeling/*.

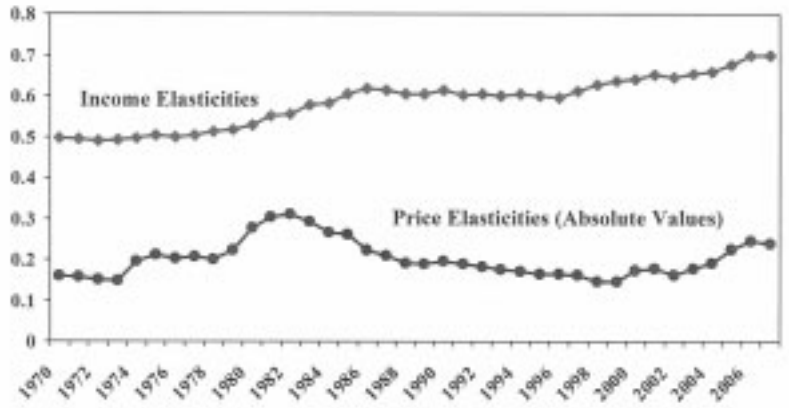
oped economic modeling exercises on behavior has been to limit the range of perceived opportunities for action and therefore to limit action itself. In other words, the publication of a set of modeling runs that relied on an inappropriate characterization of energy productivity benefits has limited the public sense of opportunity to act. Second, the exclusion of appropriate social variables and technology characterizations from these models also tends to make these options invisible during debates of possible remedies and solutions. In other words, poorly specified models have also tended to limit policy options to a narrow set of potential solutions predominantly focused on increasing energy supply as opposed to policies that could increase efficiency using social and behavioral science and existing technologies. Integrating these important social and technological measures into economic models can provide us with a more satisfying and thorough review of energy and climate policy options, thereby significantly broadening the options from which to choose.

Currently, the primary method for integrating behavior into economic models is through what economist call "elasticities." When derived from time series data for prices and incomes as they compare to changes in energy use over time, these values provide economists with a measure of how energy use responds to changes in prices and incomes. As an example, economists may determine that a 10 percent increase in price has in the past resulted in a one percent decrease in the demand for energy. In that case we say that the energy price elasticity is -10 percent (sometimes expressed as -0.1). On the other hand, if we determine that a 10 percent increase in income has in the past resulted in a three percent increase in the demand for energy, here we would say that the energy income elasticity is +30 percent (or expressed as +0.3).

These and other forms of elasticities are used directly or indirectly in economic models to estimate future energy consumption based on different policy scenarios that inevitably result in increased energy prices whether induced by fuel taxes, cap and trade systems, or otherwise. In short, the elasticity is a constant that is used by economists to estimate the level of energy consumption at a variety of different energy prices or to estimate the cost of inducing specified amounts of energy/carbon savings. Unfortunately, this method fails to account for non-economic programs and policies and changing preferences among consumers and the important impact that they can have on elasticities and consumption patterns. In other words, elasticities and preferences are not fixed. They change over time. Figure 2 on the following page highlights this point.

The data in Figure 2 provide annual estimates for what economists call long-run elasticities over the period 1970 through preliminary estimates for 2007. As opposed to monthly or quarterly changes, the so-called long-run in this case covers the year to year changes in total U.S. energy consumption given changing prices and per capita incomes. The intent is not to suggest that these are actual estimates to be used in economic policy models; the data are much too aggregate in hat regard. But they are highly useful for our purposes here today. The intent behind Figure 2 is to highlight the point that these values change over time; they are not at all constant as most economic models assume them to be.

Figure 2. Annual Changes in Energy-Related Income and Price Elasticities



Source: Author calculations based on EIA data referenced in footnote 4

Using one approach a modeler might determine that the income elasticity over this period of time might be 0.60. But, in fact, the value changes annually. In 1970 the income elasticity appears to be on the order of 0.50, generally rising over time. By 2007 it approaches a value of 0.70. On the other hand, the price elasticity (in absolute terms meaning that we've dropped the negative sign) might be estimated as 0.20 over the period of analysis shown in Figure 2. However, there is a significantly different pattern of annual changes in price elasticities than is shown for income elasticities. First the pattern is much more volatile. It starts at about 0.16 (again as an absolute value). It then bumps up and dips before reaching a peak of about 0.31 in 1982. It then slides back down to 0.17 in the year 2000. The pattern finally closes at a significantly higher 0.24 by the end of the period.

Given the set of data highlighted in Figure 2, three points quickly emerge. First, we've clearly confirmed that elasticities are not at all constant. Any analysis that makes that assumption may generate biased results. Second, the data show policy-makers that, yes, these changes are occurring but they provide little insight into what drives these changes; more critically, they provide little insight as to what mix of programs and policies might provide a more reasoned or balanced response to concerns about energy and climate change issues. Finally, most economic models start with the presumption that prices are the critical determinant of behavior. But the data in Figure 2 suggest that, for the United States over this time horizon, income levels are a greater determinant of energy use than are energy prices. This seems to suggest that policy-makers may want to explore income-based policy initiatives as a complement to the price signal. In other words they might want to evaluate the extent to which incentives may induce a more appropriate public response, or they might want to explore policies that encourage innovations that increase energy productivity and generate savings for the economy.[13]

The social sciences can and should contribute in at least three ways:

1. Recognizing and Understanding Changes in Elasticities
2. Documenting and Modeling Socially-Induced Changes in Energy Consumption
3. Documenting and Modeling the Variation in Energy Consumption Patterns across Social Groups/ Segments

1. Recognizing and Understanding Changes in Elasticities

[13] In fact, one recent journal article provided evidence that a combination of programs and policies that complemented a mild price signal actually generated a more cost-effective result than a policy that depended on price signals alone to drive changes in total energy consumption. Hanson, Donald A. and John A. "Skip" Laitner. 2004. "An Integrated Analysis of Policies That Increase Investments in Advanced Energy-Efficient/Low-Carbon Technologies." *Energy Economics,* 26(4), 739–55. See especially the discussion surrounding price and non-pricing policies as highlighted by the results in Table 4 of that article.

As we've just highlighted, most economic models now portray elasticities as fixed. However, both Figure 2 and other research on elasticities shows that these values change significantly over time. The available evidence suggests that such changes are the result of changing social structures, preferences, values, social norms, feedback, commitment, etc. Moreover, complex systems and patterns typically arise out of a multiplicity of relatively simple interactions that cannot be explained by the use of constant elasticities. But the time series data necessary to support these kinds of assessments are generally not available to draw precise conclusions.

2. Documenting and Modeling Socially-Induced Changes in Energy Consumption

People respond to more than just energy prices. There is a large body of research and literature that shows that people may reduce their energy consumption by as much as one-third in response to non-financial incentives, disincentives, and other programs. Two examples highlight this point. First, in a recent study of hotel guest behaviors, Robert Cialdini (also a witness at this hearing) sought to increase the number of guests that were willing to reuse their towels instead of having them laundered on a daily basis. The study left cards in each hotel room asking guests to reuse their towels and noted that 75 percent of people staying in the hotel had, at some point in their stay, reused their towels. By emphasizing the behavior as normative, Cialdini was able to lift reuse rates from 35 percent to 58 percent, saving both water and energy.[14]

In another study, Schultz and his colleagues used a social norms approach to help homeowners to conserve energy. The study involved delivering notices to household doorsteps, telling homeowners how their energy consumption compared to the neighborhood average. Homeowners who were consuming more electricity than their neighbors reduced their consumption.[15]

3. Documenting and Modeling the Variation in Energy Consumption Patterns across Social Groups/Segments

Understanding variations in energy consumption patterns across social groups and segments is critical to creating effective policies and understanding the effect of social dynamics on energy consumption and carbon emissions. For example, the use of price elasticities of demand that are based on the average consumer fail to take into account the effect of income inequality on demand and fail to capture the ways in which price elasticities vary across different segments of the population over time.

People are social animals. We act in accordance to the norms and values of the groups to which we belong. Therefore, understanding behavioral change requires an understanding of the ways in which membership in particular demographic groups shape and constrain individuals' conscious and subconscious decisions regarding energy consumption. A variety of demographic characteristics can offer important insights into energy consumption behavior, including those linked to age, education, income, household status, religion, gender, ethnicity, occupation, political affiliation, etc.

For example, recent studies on the relationship between gasoline prices and consumption levels indicate that elasticities associated with transportation fuel costs have been declining.[16] These studies create the perception that increasing gasoline prices have little impact on consumption.[17] However, a study of the same relationship across different income categories is likely to reveal a curvilinear relationship such that both lower and higher income groups experience low price elasticities, while middle income groups display higher price elasticities. Low income groups that have limited discretionary income have already reduced their consumption to the minimum and there-

[14] Cialdini, R.B. 2005. "Basic Social Influence Is Underestimated." *Psychological Inquiry* 16(4): 158–161.

[15] Schultz P.W., J.M. Nolan, R.B. Cialdini, N.J. Goldstein, and V. Griskevicius. 2007. "The Constructive, Destructive, and Reconstructive Power of Social Norms." *Psychological Science* (May).

[16] Hughes, Jonathan E., Christopher R. Knittel, and Daniel Sperling. 2006. *Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand,* Center for the Study of Energy Markets (CSEM) Working Paper 159. Berkeley, CA: California Energy Institute, University of California. September.

[17] For a thorough review of the literature on elasticities, see Dahl, Carol. 2006. *Survey of Econometric Energy Demand Elasticities Progress Report,* Golden, CO: Division of Economics and Business, Colorado School of Mines, August.

fore cannot respond to price signals by reducing their consumption further, while high income groups that have large amounts of discretionary spending are better able to absorb the price increases without changing consumption patterns. It is the middle income groups that are most likely to change their consumption in response to increasing prices of gasoline.

The Role of Social Science Research on Energy Policy

When applied correctly, both non-economic and economic social science research can provide critical insights into the most effective, viable, and sustainable energy policies. When correctly specified, economic models can provide policy-makers with a range of policy scenarios and likely outcomes. When used in conjunction with economic insights, non-economic social science research can help by: (1) ensuring the development of *appropriate* technologies, (2) increasing the adoption of existing technologies, (3) improving the effectiveness of economic policies and forecasts, and (4) identifying non-economic mechanisms for catalyzing the types of social change required to reduce carbon dioxide emissions and moderate climate change.

Since the 1980s, funding for non-economic social science research on energy consumption has declined dramatically. More funding is clearly needed in order to expand our understanding of the social dynamics of energy consumption, energy conservation, and energy efficiency. By expanding this knowledge base, we could significantly improve our capacity to reduce energy consumption via mechanisms that are currently less well understood.

Past research on non-economic mechanisms, performed primarily in the 1970's and 1980's, is being currently being applied in some programs. At the national level, the ENERGY STAR program is using research on information dissemination and labeling to improve its information campaigns. It is also using research on the effectiveness of social marketing strategies in its design of campaigns to increase the adoption of energy-efficient technologies. A variety of electric utilities have also used social science research to inform demand-side management programs to effectively reduce energy consumption and reduce peak load demand.

The Behavior, Energy and Climate Change Conference

Finally, the Subcommittee has asked about the upcoming Behavior, Energy and Climate Change (BECC) Conference—scheduled for November of this year in Sacramento, CA. We certainly invite your participation in some capacity. This event has been organized in response to the needs of policy-makers to better understand the energy behavior and energy-related choices made by consumers at all levels, whether residential, commercial, industrial, governmental, or nonprofit. The routine activities of these energy users are the key drivers of greenhouse gas emissions. Therefore, efforts to reduce climate impacts necessitate a clear understanding of the social and behavioral factors that shape choices to conserve energy or to purchase more efficient appliances, buildings and vehicles.

Conference planning began early in 2007, when the California Institute for Energy and Environment (CIEE), under the auspices of the University of California System's Office of the President, brought together a small planning group to begin to think about how to engage policy-makers and researchers in a dialogue about the importance of behavioral research in accelerating the pace and impacts of new climate policies in California (and California's partner states and provinces). Subsequent discussions led to a Behavior, Energy and Climate Change Summit meeting in Sacramento in May of this year. At the BECC summit, policy staff of state legislature, energy and environmental agencies, private and public utilities, academic researchers, and private sector representatives (50 in all) met to discuss common interests, concerns and information needs in this area. There was broad agreement regarding the importance of behavior and choice in understanding and affecting climate change, and a willingness to continue the conversation and to engage a larger group in finding ways to improve policy, enhance program impacts, and increase the quantity of scientific research needed to support these efforts.

An important outcome of the summit is the upcoming Behavior, Energy and Climate Change Conference to be held November 7–9, 2007 in Sacramento, California. CIEE has partnered with the American Council for an Energy-Efficient Economy (ACEEE) and Stanford University's Precourt Institute for Energy Efficiency (PIEE) in sponsoring this meeting, which has now gained national attention and participation from across the United States and Canada. (ACEEE has consistently provided a venue to report behavior research related to energy use for 25 years at its biennial

Summer Study on Energy Efficiency in Buildings.[18] PIEE is a newly funded institute. It has behavior research as one of six focal areas and is compiling a database of the literature.)

The BECC conference program includes more than 60 speakers and will cover a broad range of topics. But a common theme is linking knowledge—whether from scientific literatures, ongoing academic research, energy evaluation, or program experience—to policy development and implementation. The hoped-for results will include increased awareness, new collaborations between researchers and decision-makers in industry and government, a more effective mix of policies (voluntary and regulatory), greater support for behavior-focused research, and an acceleration of the rate and impacts of efforts to reduce climate change in California and elsewhere. More of the conference details, including the preliminary program agenda can be found on the ACEEE Web site at *http://www.aceee.org/conf/07becc/07beccindex.htm.* The final conference agenda, the full set of presentations, and a conference summary document will also be available on the web site following the conclusion of the conference.

In addition to the conference, the initial discussions also identified the need to compile the diverse and dispersed literature on behavior, energy and climate change to facilitate research and encourage collaborations among policy-makers, academic researchers and others. The Precourt Institute at Stanford is undertaking this project and has recently developed a searchable bibliographic database of relevant literature as well as lists of foundational readings and other resources. The initial set of references will be available on their Web site on September 25 at *http://piee-behavior.stanford.edu.* The database will expand over time as other researchers contribute additional literature and information, and professional profiles of researchers involved in the area will also be added.

Conclusions and Recommendations

Based on more than 25 years of research on the role of energy efficiency in our economy, ACEEE believes the evidence indicates a generally less-than-satisfying performance of economic models as they have been used to assess a variety of energy and climate-related energy policies. By definition, national energy policy decisions, based on erroneous or incomplete information, will lead to sub-optimal economic and environmental outcomes. The good news in all of this is that, despite the generally pessimistic outcomes published by many of the conventional models, there has been a resurgence of interest in how economics and the social sciences can inform policy, increase energy efficiency, and reduce energy consumption. One indication of this renewed interest is the planned *Behavior, Energy and Climate Change Conference* to be held November 7–9, 2007 in Sacramento, California.

On the other hand, renewed interest does not guarantee real results. Any real advancements in the capacity of the economics and social science communities to contribute to more meaningful policy insights will require targeted support from policy-makers to overcome the current lack of research funding as well as the paucity of existing data.

Given current circumstances, and based on the available evidence regarding the contribution of social sciences to energy policy, ACEEE believes three distinct recommendations are in order. First, and after further review by this subcommittee, we believe it appropriate for the Subcommittee to issue a set of findings that confirms our testimony. We think it will send a positive signal to the economics and social science communities—that there is clear room for improvement. Second, support the development and funding of National Energy Efficiency Data Center (NEEDC), a national nonprofit organization whose purpose will be to collect, organize, disseminate and archive energy efficiency and social science statistics, particularly those related to public policies and programs.[19]

Finally, and more critically, more research and greater research funding are needed in order to expand our knowledge and understanding of how human behavior and choice can increase energy efficiency, reduce our energy dependency, and reduce our impact on the global climate.

Energy consumption is an integral part of our daily lives. Individuals, households, businesses, industries, and organizations consume energy in work and in leisure, 24/

[18] For those interested in learning more about this highly regarded event, the 2008 Summer Study will be convened next August in Asilomar, CA. See, *http://www.aceee.org/conf/08ss/08ssindex.htm.*

[19] For more details on this proposal, see: Horowitz, Marvin J. 2006. "It's Time for a National Energy Efficiency Data Center," Arlington, VA: Demand Research; as presented to the ACEEE workshop, "Energy and Economic Policy Models: A Re-examination of Some Fundamental Issues, Washington, DC. The Horowitz paper and others from this workshop can be downloaded from *http://www.aceee.org/conf/06modeling/*.

7. Energy heats and cools our homes; harvests, processes and cooks our food; provides us with transportation; powers our computers; and powers our industrial machinery.

Energy consumption is rooted in human behavior. What is less widely recognized is that the solutions to energy shortfalls are also rooted in human behavior. Instead, the first and most common response is to look to *technology* to provide the answers. And, when available technologies aren't adopted, we look to the field of *economics* to explain why not. Unfortunately this approach is unable to adequately identify and address the behavioral roots of our energy problems that extend beyond the realm of economics. Effective solutions must draw on a broader understanding of social systems and human behavior.[20]

The need for a better understanding of human behavior and choice has been repeatedly noted by the National Research Council's Panel on Human Dimensions of Global Change, emphasizing the need for behavioral research for effective policies that reduce emissions and mitigate climate change.[21] Most recently, the National Academies reported that behavioral science has been significantly under-supported in the U.S. Climate Change Science Program.[22] In fact, most of the social science work in this area has either been undertaken by lone academic investigators or supported by progressive State government and utility companies, particularly in California, the Pacific Northwest, and parts of the upper Midwest and New England. The resulting academic social science literature is scattered across the disciplines of sociology, psychology, anthropology, and economics. It is not coherent or well-organized. And it is difficult for policy-makers and researchers to access—although there have been several efforts to bring these literatures together in comprehensive reviews.[23] The non-scientific literatures are mainly from energy program evaluations and market studies. They are of uneven quality. Although some of this work can be found in public databases,[24] much is a "gray literature" that is not known to policy-makers and, in fact, not readily accessible.

More research and greater research funding will provide the means to expand our knowledge and understanding of how human behavior and choice can increase energy efficiency, reduce our energy dependency, and reduce our impact on the global climate while still maintaining a robust economy.

This concludes my testimony. On behalf of my colleague, Karen Ehrhardt-Martinez, and my other associates at ACEEE, we thank you for the opportunity to present these views. I will be happy to respond to further questions and, of course, to provide any additional material the Subcommittee believes will be helpful in examining this critical topic.

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[20] In my own work these past several decades, and although I am an economist, I've come to see technology as something much different than what is characterized in the various energy and economic policy models. This difference in the characterization of technology may further illustrate the critical role of the social sciences in shaping a more robust energy policy. In short, technology is not simply an economic characterization of machines and devices, or some stylized production function that is coded within an economic model. Rather, I've come to view "technology" as the cumulative human knowledge embedded in our nation's artifacts, equipment, and structures as they are designed to deliver some useful or desired social outcome. A second part of that characterization is that technology is the set of norms, rules and criteria by which we choose to deploy that knowledge.

[21] Brewer, Garry D. and Paul C. Stern, Eds. 2005. *Decision-Making for the Environment: Social and Behavioral Science Research Priorities.* Committee on the Human Dimensions of Global Change, National Research Council. Washington DC: National Academies Press. See also, Stern, Paul C., Oran R. Young, and Daniel Druckman, Eds. 1991. *Global Environmental Change: Understanding the Human Dimensions.* Committee on the Human Dimensions of Global Change, National Research Council. Washington DC: National Academies Press. Finally, see Stern, Paul C. and Elliot Aronson, Eds. 1984. *Energy Use: The Human Dimension.* New York: Freeman.

[22] Committee on Strategic Advice on the U.S. Climate Change Science Program. 2007. *Evaluating Progress of the U.S. Climate Change Science Program: Methods and Preliminary Results.* Washington DC: National Academies Press.

[23] For example: Schipper, Lee, Sarita Bartlett, Dianne Hawk, and Ed Vine. 1989. "Linking Lifestyles to Energy Use: A Matter of Time?" *Annual Review of Energy.* 14, 273–318. See also, Lutzenhiser, Loren. 1993. "Social and Behavioral Aspects of Energy Use," *Annual Review of Energy and the Environment.* 18, 247–89. Finally, see Wilson, Charlie and Hadi Dowlatabadi. 2007. "Models of Decision Making and Residential Energy Use." *Annual Review of Environment and Resources.* 32, 2.1–2.35.

[24] California Measurement Advisory Council searchable database. *http://www.calmac.org/search.asp.* See also, Consortium for Energy Efficiency, Market Assessment and Program Evaluation Clearinghouse searchable database *http://www.cee1.org/search/search.php*

BIOGRAPHY FOR JOHN "SKIP" LAITNER

John "Skip" Laitner is the Senior Economist for Technology Policy for the American Council for an Energy-Efficient Economy (ACEEE). He previously served almost 10 years in a similar capacity for the U.S. Environmental Protection Agency (EPA), but chose to leave the federal service in June 2006 to focus his research on developing a more robust analytical characterization of energy efficiency resources and behavioral response within energy and climate policy analyses and within economic policy models. In 1998 Skip was awarded EPA's Gold Medal for his work with a team of other EPA economists to evaluate the impact of different strategies that might assist in the implementation of greenhouse gas emissions reduction policies. In 2004 his paper, "How Far Energy Efficiency?" catalyzed new research into the proper characterization of efficiency as a long-term resource. Author of more than 150 reports, journal articles, and book chapters, Skip has more than 35 years of involvement in the environmental and energy policy arenas. He's been invited to provide technical seminars in diverse places as Australia, Canada, China, France, Germany, Korea, South Africa, and Spain. He has a Master's degree in Resource Economics from Antioch University in Yellow Springs, Ohio.

Chairman BAIRD. Thank you, Mr. Laitner.

Dr. Ellig.

STATEMENT OF DR. JERRY ELLIG, SENIOR RESEARCH FELLOW, MERCATUS CENTER AT GEORGE MASON UNIVERSITY

Dr. ELLIG. Chairman Baird, Ranking Member Ehlers, Members of the Subcommittee, I would like to thank you for the opportunity to testify today.

The Subcommittee asked in its invitation, asked me to address three questions, and it is hard not to address those without first saying a little bit about what I think economics is, what it can do, what it can't do. Since I am an economist, that is what I was asked about.

On the Social Sciences Building at the University of Chicago is an inscription from Lord Kelvin that says if you cannot measure, your knowledge is meager and unsatisfactory. There is an oral tradition that the late, great economist Frank Knight passed down through some of his students that the late, great economist Frank Knight looked at that inscription and said something to the effect of, yes, and after you have expressed it in numbers your knowledge is also of a meager and unsatisfactory sort.

The point is I think that the most important thing that economics contributes is an understanding of principles that help explain human behavior, not numbers, not predictions, not even picking the stocks in the stock market, although those are some things that economists do, but rather understanding some fundamental principles, and that is, you know, the basis from which I am talking today.

The first question—I will paraphrase the questions to save time—essentially asked how predictive is a purely economic approach and what factors other than price signals do we need to look at to understand human behavior.

There is a syllogism that we use at the Mercatus Center when we are teaching Congressional staff how to analyze policy, when we are teaching students at GMU how to analyze policy. It goes like this. It is actually very similar to something that Mr. Baird quoted in his opening statement, that institutions in a society create incentives and knowledge flows but then guide human interactions that create outcomes. And we tell folks, if you understand that, you can understand the effects of policy. Now, it is a very broad state-

ment, and it should be obvious from that statement that just doing economics doesn't answer all the questions we need to answer in order to fully understand that. Institutions may be formal like laws and regulations or they may be informal and more evolved like culture and values and social norms. And there is an awful law that economists certainly don't understand about where institutions come from, how they evolve, how they change, which things are durable, which things are not durable. They create incentives and knowledge flows. Incentives may be financial or they may be anything else that motivates people to act. So I define incentives very broadly even though typically economists say incentives and people think, oh, they are assuming people only care about money. Incentive is really an understanding about human behavior, whatever it is that motivates folks to act. If you make it easier for folks to do something, they will probably do more of it. If you make it harder for folks to do something, they will probably do less of it. That is a more general paraphrase of the economist lesson about prices.

Knowledge flows. Knowledge is not necessarily information that can be chopped up into bits and transported. It is often tacit which means individuals need to be able to act on knowledge that only they have, and different institutions enable individuals to use knowledge differently. And finally, outcomes. Public policy, we want to influence outcomes. The problem is the main thing that public policy directly effects is institutions, so we have to track how the institutional change works through knowledge and incentive flows to create outcomes.

Now, why did I go on for a long time about this? Because it should be fairly obvious from that description that we need a lot more than economics to understand that. So, you know, do we need all social sciences? You get a big amen from me out of that.

Second question essentially asks about whether social science is having an effect on policy? I sure hope so, and I think we can probably all cite some very good examples, but I have to mention that in talking to folks in federal agencies, talking with Congressional staff and others in this town, I also frequently hear comments like I understand what you are saying about good public policy but you have to realize we do stuff for other reasons than what you are talking about. And if Congress were to more clearly signal that it is actually interested in knowing about the actual results of policies that are enacted, putting clauses in appropriations for example that say this is the outcome we are trying to accomplish and this is how much of it we expect for this appropriation, I think that would send a positive signal that would help motivate federal agencies to make greater use of research in both the social and the natural sciences.

Final question asked about what kind of tools and methods are most appropriate for understanding energy-related issues. My short answer, all of them. My concern, if I were overseeing federal research funding of social sciences or on a subcommittee that oversees the agency that oversees research funding, one of the most important questions I would ask is, is the way we do this encouraging disciplines to use and look at a variety of different methods or is it encouraging kind of a tunnel vision in which each discipline says one method is the only right way to do it? I know economists who

are very closed-minded who say that econometrics and statistics is the only way to get empirical knowledge. I have heard somebody who is an expert on program evaluation argue that only randomized field studies can generate useful, empirical knowledge. It seems to me we shouldn't be throwing out any information.

In conclusion, you would get a yes out of me if you ask, are social sciences important? The only reason I think that we care about energy is because of what energy allows people to do, and so if the focus really is people, then we need social sciences to understand how energy policy affects people.

[The prepared statement of Dr. Ellig follows:]

PREPARED STATEMENT OF JERRY ELLIG[1]

Mr. Chairman and Distinguished Members:

Thank you for the opportunity to appear here today and testify on *"The Contribution of the Social Sciences to the Energy Challenge."* I am a senior research fellow at the Mercatus Center, a research, education, and outreach organization affiliated with George Mason University and located a short Metro ride away on the Arlington, Virginia campus. The Mercatus Center's mission is to bridge academics and policy: we conduct interdisciplinary research in the social sciences that integrates practice and theory. Toward that end, we have a variety of policy-relevant research programs and also operate the largest economics-based professional development program for congressional staff, called Capitol Hill Campus.

My own research focuses primarily on the causes and consequences of regulation—primarily "economic" regulation, including economic regulation of energy. I am not a model-builder, but I'm a big consumer of others' theoretical and statistical models. There's a perception in this town that the main thing economists supply to the policy process is numbers. When two economists disagree on the numbers, that gives rise to jokes with punch lines like, "You could lay all the economists in the world end-to-end and never reach a conclusion." In my view, the most important thing economists can supply to decision-makers is not numbers, but understanding. Reasonable researchers may sometimes hold differing views about the size of the effects of various policies, but there's a lot more agreement among economists on basic underlying principles that help explain human behavior in a predictable way: people try to do the best they can with what they've got, consumers buy less of something if the price goes up, price controls imposed on competitive markets tend to create shortages, monopoly harms consumers, trade makes both parties better off, individual decisions can make society worse off if there are significant "externalities," and so forth.

I doubt you will get much disagreement from this panel on whether the social sciences have a role in energy policy. Energy enables people to do things they could not otherwise do, or could only do at very great cost and inconvenience. Energy allows us to maintain and improve our quality of life. In other words, energy should be the servant, not the master; energy is a means of enhancing human welfare, not an end in itself. Since the social sciences study how people interact, the social sciences are necessary if we want to understand the effects of energy, and energy policy, on people.

We should keep in mind both the contributions and the limits of the social sciences; they are necessary but not sufficient to make policy choices. Effective decision-making requires two things: knowledge of the consequences of alternative courses of action and value judgments that allow the decision-maker to determine which consequences are the most desirable. Like any of the sciences, the social sciences are tools for understanding causation—what *is* and what *would likely* happen as a result of various policy initiatives. To decide what *should be done,* decision-makers must combine the results of the analysis with value judgments that reflect their assessment of what is worth doing. No analytical model, no matter how complex, can automatically crank out the "right" policy decision.

But just as analysis is not a substitute for judgment, values are not a substitute for understanding reality. Values determine what outcomes decision-makers would want to pursue, but values alone do not provide the cause-and-effect analysis necessary to determine how those outcomes can be accomplished most effectively. At

[1] The views expressed in this testimony are solely my own and are not official positions of the Mercatus Center or of George Mason University.

least as important as how options can be accomplished most effectively is the analysis of unintended consequences. Without the firm grounding in reality provided by social science, decision-makers are flying blind. The social sciences, and science generally, are crucial to policy because reality isn't optional.

The Subcommittee's invitation to testify posed three questions; I'll take each in turn.

1. *How predictive is a purely economic approach to evaluating the impact of energy policy on individual and communal behavior? What factors other than price signals need to be considered when developing and applying economic models to energy-related behaviors?*

Let me start with the second question first. Real policy problems do not respect disciplinary boundaries. For this reason, it's most useful to think of different social sciences as complementary sets of tools for understanding reality, rather than different ways of understanding that are in opposition to each other. In other words, we don't need to decide whether an "economic" or "psychological" or "sociological" approach is the right one. Properly understood, each is a different piece of the puzzle. All of these examine these questions from a different perspective and provide valuable insight.

Let me put it another way, using a simple syllogism that we frequently employ when analyzing the effects of policy in the economic education programs the Mercatus Center runs for congressional staff: *Institutions* generate both *incentives* and *knowledge flows* that shape human interaction, and human interaction leads to *outcomes.* That's just one sentence, but it requires many social sciences to understand all the implications. Let me explain.

Institutions are the established ways of doing things. They may be formal and explicitly enforced, such as laws and regulations, or they may be informal, such as culture, ethics and social norms. Institutions define the "rules of the game"—what is considered permissible and impermissible behavior. They also shape the way people perceive and interpret what's going on around them.

Incentives are whatever motivate people to act. They may be monetary or nonmonetary. Cash, fame, a desire to "do the right thing," a desire to "go along with the crowd," or the prospect of a pleasant afterlife are all incentives.

Knowledge can be objective information that can be written down and transferred. But a great deal of knowledge is highly dispersed. Much relevant knowledge is tacit; as physical chemist and philosopher of science Michael Polanyi put it, "We know more than we can tell."[2] Public policy can have a significant effect on the extent to which people utilize and act on dispersed and tacit knowledge.

Outcomes are the things we actually observe people doing and the consequences of those actions. Outcomes can be the intended effects of a policy, or they may be unintended consequences. The policy-making process should identify desired outcomes, identify ways of measuring the policy's effect on those outcomes, and also identify and analyze potential unintended consequences. Indeed, in the *Government Performance and Results Act,* Congress required federal agencies to do this for their most important strategic goals. Agencies are supposed to articulate the major outcomes they are trying to achieve, measure whether they have achieved them, and match outcomes with information on resources and costs.

Returning to my one-sentence syllogism, we can start with the fact that, although public policy ultimately seeks to influence outcomes, it can only directly alter institutions. The fact that a policy is *intended* to achieve a particular outcome does not guarantee that the policy will achieve the outcome. Policy can only alter institutions—mostly the formal institutions, such as laws and regulations. The problem is, behavior does not necessarily change exactly as policy-makers intend; many other factors come into play. The behavior of people changes as the incentives and knowledge flows change. To understand the effects of a policy, decision-makers need to understand how the policy change alters knowledge flows and incentives, and how those in turn affect both producer and consumer behavior—all the subjects of social science research.

What's the role of economics in this big picture? Most contemporary economics textbooks define economics as the study of how people satisfy unlimited wants with limited resources. "Unlimited wants" are the things that people value, for whatever reason. "Limited resources" simply means that neither individuals nor our entire society have enough resources to get everything we can imagine we want. Whenever people try to do the best they can with what they've got, economics helps us understand the decisions they make.

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[2] Michael Polanyi, *The Tacit Dimension* (1974), p. 4.

Now let me turn to the first question: "How predictive is a purely economic approach to evaluating the impact of energy policy on individual and communal behavior? *Predicting* what decisions people will make requires that we know something about what specific wants people have, what their priorities are, what possibilities they perceive, and what resources they believe they have or can get. This is where other social sciences enter the picture. Psychology, sociology, anthropology, neuroscience, sociobiology, and numerous other social sciences help us understand what people want, why they have the wants they have, how and what opportunities they perceive, what wants and methods they regard as "proper" and "improper," how values and wants change, which opportunities for innovation will get noticed and acted upon, and numerous other questions that must be answered to predict how people will react to particular policies.

Here are a few of the many questions that economics either cannot answer or cannot answer by itself:

- How do particular formal and informal institutions emerge and change over time? This includes laws, culture, ethics, norms, and other social influences that guide behavior.
- Why do many individuals follow group norms, and why do some decline to do so?
- What factors count as incentives for individuals in particular situations?
- How does the way people receive and process information affect their behavior?
- How do institutions, incentives and knowledge flows alter the "mental models," heuristics, and "rules of thumb" that guide individual decisions?

I hope it's clear from this brief description that the relationship between economics and other social sciences should be one of complementarity, not conflict.

These comments on the role of economics and other social sciences are somewhat esoteric. A few concrete examples from energy policy might help make my meaning clearer.

One of the most basic insights of economics is that price controls tend to create shortages when the controlled price is below the price that would otherwise occur in the market. In the 1970s, the U.S. imposed an extensive system of price controls on oil and gasoline. Gas lines resulted, because there was no incentive to conserve, and no signal that people could use to figure out how much to conserve. We had a similar experience in the 1970s with natural gas price controls.[3]

In recent years, oil and gasoline prices have been relatively unregulated. When this is the case, prices send signals to consumers and producers about the true state of the world, and those prices change quickly with changing situations. Regulation of prices will always distort these signals although governments have tried this throughout history. Rent controls (held artificially low) have caused shortages in the supply of rental housing, and minimum prices on airline tickets increased consumer costs and caused people to take fewer flights than they would otherwise. Today, changes in crude oil prices caused by events anywhere in the world translate quickly into changes in retail gasoline prices. Nobody likes paying $2.50 or $3.00 per gallon for gasoline, but the rising price of gasoline in recent years has given consumers a message and an incentive: stay away from the pumps unless gasoline is worth at least this much to you. So we don't have gas lines, and nobody has to sleep in their cars to get a good place in line even when the price of oil hits $80 per barrel, as it did last week.

Oil and natural gas provide textbook examples of how economic principles can provide valuable insight on the fundamental causes of controversial policy problems. This isn't just a figure of speech; the examples really are used in textbooks to illustrate the effects of price controls.[4] Note that social science examines not just consumer behavior, but producer behavior as well. Prices send strong signals to motivate the appropriate behavior to match supply and demand.

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[3] In their classic study of natural gas price controls, Stephen Breyer and Paul MacAvoy concluded that natural gas regulation's "major objective—benefiting the household consumer—was not achieved. . .regulation denied consumers gas reserves for which they would have been willing to pay." The that regulation imposed on households outweighed any benefits households received as price controls redistributed wealth from gas producers to consumers. See Stephen Breyer and Paul MacAvoy, *Energy Regulation by the Federal Power Commission* (Brookings, 1974), pp. 86–87.

[4] See, e.g., W. Kip Viscusi, John M. Vernon, and Joseph E. Harrington, Jr., *Economics of Regulation and Antitrust* (Lexington, MA: D.C. Heath, 1992), Ch. 18.

I don't think any new discoveries in the analysis of human behavior have undermined this explanation of why we had gas lines in the 1970s but don't have them today, or why we had natural gas service curtailments in the 1970s but don't have them today. Price controls encouraged us to waste gasoline and imposed tremendous human costs in the 1970s; decontrolled prices penalize that kind of waste now. Ditto for natural gas. And I doubt that advances in research on human behavior would give us reason to think that the effects of price controls on consumer and producer behavior would be qualitatively different in the future.

Maybe the *size* of the effect would be different: if there's more of a conservation ethic now and we reinstituted price controls, maybe people wouldn't waste as much gasoline as they did in the 1970s. And if we had gas lines again, a better understanding of what drives individual decisions could also aid in crafting effective public-service messages to discourage people from going to the gas station just to top off their tanks. But I doubt any change in values or behavioral factors would lead people to consume *less* gasoline as a result of price controls that drove down the price.

I didn't mention price controls just because I wanted to discuss the 1970s; distortions due to price controls still exist in some energy markets today. Retail price regulation of electricity is a good contemporary example. Most American consumers pay the same price for electricity regardless of the time of day they choose to use it. This increases electricity demand at peak times, and it may increase overall demand as well. My own household is a good example of this. The previous owner installed a washing machine and dishwasher that can be programmed to start on a time delay, so they can run in the middle of the night. But the power company's pricing tells us it doesn't really matter when we run the appliances. The resulting increase in peak power demand artificially increases resource use, electricity prices, and environmental costs—if only because more peak-load power plants must be built. Dynamic pricing that promotes conservation or shifting of use to off-peak times would be a "win-win" for consumers and the environment. It would reduce the likelihood of peak-load price spikes in the bulk power market while making some new power plant construction unnecessary. Pilot programs demonstrate that consumers—even residential consumers—will respond to the price signals provided by dynamic pricing.[5]

Thus far, you probably think it sounds like I'm saying that economists already know what's important to know for energy policy, and we can't learn anything from other social sciences. Nothing could be further from the truth. I don't think other social sciences' research on human behavior overturns any fundamental economic laws if we really understand what economics has to offer. But I do think this research can supply critical information that can help us understand how established practices, habits, and routines change; how policy affects behavior in situations where many people are motivated by factors other than price; or how institutional and behavioral factors affect the size of individuals' response to policy changes.

Dynamic electricity pricing, for example, is not being adopted very rapidly. In her survey of dynamic pricing issues and pilot programs, Northwestern University economist Lynne Kiesling notes a variety of barriers. Some are formal institutions, such as the rate structures traditionally adopted by state regulators. But she also notes that inertia stems from what might be called cultural barriers:

> The most important, yet also the most intangible and difficult to change, obstacle to dynamic pricing and enabling technologies is the set of incentives for inertia. The primary stakeholders in the industry—utilities, regulators, and customers—all have status quo bias.. . . Customer inertia is deep because they have not had to think about their consumption of electricity and the price they pay for it. . ..[6]

The marketing of "green" electric power presents another interesting and informative example. Where they have the freedom to do so, many consumers choose to purchase green power even though it costs more. Clearly, something other than price is important to these consumers. If a goal of public policy is to induce people to buy more green power, then it's important to know what factors motivate people to buy it even though it's more expensive—and it's equally important to know how a *change* in any factor, including but not limited to price, would change the amount of green power people decide to purchase. Do people buy green power because they want to contribute to measurable improvements in environmental quality? Or be-

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[5] Lynne Kiesling, "Retail Electricity Deregulation: Prospects and Challenges for Dynamic Pricing and Enabling Technologies" (May 4, 2007), *http://www.law.northwestern.edu/searlecenter/papers/Kiesling_Annual_Rev_Final.pdf.*

[6] Kiesling, p. 37.

cause they want to reduce carbon emissions? Or because it's the "in" thing to do and they want to be with the crowd? Or because they want to make a statement about their own values regardless of what everyone else is doing? The answers to these questions probably imply very different public policy and marketing strategies, and behavioral science can help answer these questions.

People also make tradeoffs. If policy alters the desirability of green power along several different dimensions in opposite directions, then the amount purchased might go up or down. Knowing how important the different dimensions are would help us identify whether a particular set of policies would ultimately increase or decrease sales of green power. Market research informed by psychology can help us find out which other attributes of green power matter to consumers, and what kinds of tradeoffs consumers are willing to make.

In short, I don't think new research on human behavior allows us to discard what we know from economic analysis. The real contribution of this research is that it helps us understand behavior in situations where people's motivations, perceptions, and limitations were previously not very well understood.

2. To what extent are policies to influence individual and community energy use being shaped by what has been learned from research in the social sciences, including economics?

This is a huge question, to which there is no simple answer. I certainly hope we as a nation have learned something from the experiment with price controls in the 1970s. On a smaller scale, there are certainly examples of situations where research in economics or other social sciences is being used either to design policies or test their actual effects. One of the most ambitious pilot programs testing consumer acceptance of dynamic electricity pricing, for example, is the Olympic Peninsula GridWise Demonstration Project, led by the Pacific Northwest National Laboratory.[7] Federal policy seeks to encourages dynamic pricing and other forms of "demand response" that reduce electricity use at peak times.[8]

However, I've also seen cause for concern. When teaching in Mercatus Center programs for congressional staff, time and again I hear feedback to the effect of, "I understand what you're saying about what's good public policy, but you have to realize we do things for other reasons on the Hill." One of my favorite examples was legislation enacted in 2003 which gave the Federal Trade Commission a 180-day deadline to enact a regulation requiring optometrists to furnish patients with a copy of their contact lens prescriptions, but a 365-day deadline to perform a study that would help determine whether the regulation was necessary! (I mention his not because I think this was a bad regulation, but because the process just seems backward.)

When researchers at the Mercatus Center talk with federal agencies about the importance of measuring their outcomes and assessing how much of the outcome was caused by the policies they implement, we get the distinct impression that many career agency managers doubt whether Congress really wants to know about actual policy outcomes. In at least one case, an agency manager told me he does not believe Congress wants the agency to identify clear outcomes, because if specific outcomes were identified, that would erode support for the policy!

Thus, actual practice sometimes seems to contradict the congressional intent clearly stated in the *Government Performance and Results Act.*[9] Discovering why this happens would be an interesting project for an interdisciplinary team of social scientists.

It would be helpful if lawmakers signaled their willingness to make use of social science research—both prospectively when considering legislation and appropriations, and retrospectively when conducting oversight. If every piece of authorizing legislation contained a clause stating what *specific* outcome or outcomes Congress expects the legislation to achieve, that would send a clear message that retrospective policy evaluation really matters. Another clear message would be a clause in

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[7] Kiesling, p. 29.

[8] See, e.g., Federal Energy Regulatory Commission, *Assessment of Demand Response & Advanced Metering,* Staff Report (Sept. 2007), *http://www.ferc.gov/legal/staff-reports/09-07-demand-response.pdf.*

[9] Section 3 of GPRA requires agencies to produce strategic plans that state their missions, goals, and objectives, "including outcome-related goals and objectives," and identify program evaluations used to reevaluate goals and objectives. A program evaluation is defined as "an assessment, through objective measurement and systematic analysis, of the manner and extent to which federal programs achieve intended objectives. Section 4(b) requires agencies to produce annual performance plans identifying measures that will be used to assess "the relevant outputs, service levels, and outcomes of each program activity" and resources required to produce those results. Annual performance reports must compare actual program performance with the goals in the performance plan.

each appropriation indicating *how much* of the outcome Congress expects the agency to achieve with the appropriation. If some policies were explicitly enacted as experiments, perhaps with sunset clauses and with an authorization and appropriation for independent program evaluation, that would help as well. As it is, even when agencies want to do program evaluation, it's often regarded as a distraction, a burden, or something they just don't have the time and resources to do. Building program evaluation into legislation could help raise its priority.

3. What tools and methodologies are most appropriate for evaluating the effectiveness of policies to incentivize consumer behavior with respect to energy use? What kinds of basic research questions underlie the development of such tools and methodologies?

A variety of tools and methodologies have been developed to evaluate the effects of policy on behavior: econometrics and other statistical techniques, surveys, field interviews, randomized field trials, laboratory experiments, archival history, and others. One type of laboratory experiment that consumer researchers frequently use is one that is the social science equivalent of a clinical trial, where consumers are given "conditions" that would either contain a stimulus (something that you want to evaluate to see if it changes behavior) and a control, without the stimulus. By varying pairs of stimuli and controls, social scientists can uncover which policies are likely to cause consumers to change their behavior. Practitioners of each technique can always point to aspects that could use further development.

But it's important that research in each discipline avoid becoming wedded to a particular methodology as the only path to truth. I know of economists, for example, who feel that manipulation of large data sets is the only "scientific" way to do empirical research. I've heard experts in program evaluation argue that randomized field trials are the only accurate way to gauge the effects of policy. No doubt we could find some social scientists with similar tunnel-vision in regard to other research methodologies. Federal research grants can either promote or discourage this kind of tunnel-vision, depending on what kinds of criteria are used to select research for funding. I don't have a specific complaint or solution in this regard, but just raise this as an issue that should be considered.

Conclusion

Policy changes at best affect some of the knowledge flows and incentives people face. Social science research bridges the gap between policy and actual outcomes by examining how knowledge flows and incentives change human behavior. Without social science, achieving the desired outcome is really a shot in the dark. Good social science doesn't guarantee that a policy will succeed, but it greatly raises the odds.

BIOGRAPHY FOR JERRY ELLIG

Jerry Ellig is a senior research fellow at the Mercatus Center at George Mason University and an Adjunct Professor at the George Mason University School of Law. Between August 2001 and August 2003, he served as Deputy Director and Acting Director of the Office of Policy Planning at the Federal Trade Commission. Dr. Ellig has also served as a senior economist for the Joint Economic Committee of the U.S. Congress and as an Assistant Professor of Economics at George Mason University.

Dr. Ellig has published numerous articles on government regulation and business management in both scholarly and popular periodicals, including the *Journal of Regulatory Economics, Journal of Politics, Federal Communications Law Journal, Managerial and Decision Economics, Business & Politics, Antitrust Bulletin, Contemporary Policy Issues, Competitive Intelligence Review, Journal of Private Enterprise, Texas Review of Law & Politics, Wall Street Journal, New York Times, Barron's,* and the *Washington Post.* His co-authored/edited books include *Dynamic Competition and Public Policy* (Cambridge, 2001), *Economic Deregulation and Customer Choice* (Center for Market Processes, 1997, with Robert W. Crandall), *New Horizons in Natural Gas Deregulation* (Praeger, 1996, with Joseph Kalt) and *Municipal Entrepreneurship and Energy Policy* (Gordon & Breach, 1994, with Alison E. Woodward and Tom R. Burns). He is co-author of the Mercatus Center's annual *Performance Report Scorecard,* which evaluates the quality of annual performance reports produced by federal agencies.

Dr. Ellig received his Ph.D. and M.A. in economics from George Mason University in Fairfax, VA, and his B.A. in economics from Xavier University in Cincinnati, OH.

Chairman BAIRD. Dr. Bordley.

STATEMENT OF DR. ROBERT F. BORDLEY, TECHNICAL FELLOW, VEHICLE DEVELOPMENT RESEARCH LABORATORY, GENERAL MOTORS CORPORATION

Dr. BORDLEY. Chairman Baird, Dr. Ehlers, Dr. McNerney, and all the Members of this committee and staffers, I am truly honored to be able to present in this forum and also visit my parents in Maryland.

I was asked three questions. The first question is about describing the type of market research I have done at General Motors. The first question I have looked at is estimating the change in——

As you can see, I am not technologically fully equipped to handle the sophistication of this committee meeting, but bear with me.

The second area I was focused on is grouping products into segments. You know, there is an awful lot of products out there, small, mid-sized, large. The key question is, how do people perceive them? How do they group products together in their own minds? Do they group small products together, do they group mid-sized products together? Do they group environmentally efficient products together? How do they actually group products together? And we want to try to look at the way customers group them. So that is one issue. That involved a lot of psychological work on how individuals decide which items are similar.

We have also done a lot of—or I have also done a lot of work about grouping customers into segments. For example, lower-income people with large families, people who want some style but are price-sensitive, people who want a vehicle that convey status. You know, this draws mainly on the socioeconomic literature about the different social classes in America, their needs for a vehicle, if they have large families, if they need to tow, as well as whether they view the vehicle as merely a means of transportation, an expression of personality or status, or something they want to enjoy. People are different. They have different needs during their lifestyle depending upon where they live, and that is important to understand.

Modeling demand for products as a function of all the attributes of the product, performance, comfort, appearance, price. Now again, this draws mainly on the economic and statistical literature. Modeling the decision process by which customers first become aware of a product, like how much can advertising affect their awareness of a product? And this work draws heavily on psychology. If you are not aware of a product, then you can't consider buying it.

The second stage is how they come to seriously consider the product. Given the hundreds of products available, what are the simple criteria people use for winnowing down the set of choices down to a manageable set of choices? Do they screen out vehicles with a poor image for quality, a poor image for environmental-friendliness. How do they screen them down to their choice set? This draws on the psychological and sociological literature on how products acquire an image and reputation.

How do they come to shop for a vehicle? Do people visit a lot of car dealers or a few? How much does the increased availability of information on the internet affect the shopping process? This is an economic/psychological question.

How did they come to buy the product? What kind of products should a dealer have on their lot to maximize the chances of having what the customer needs? What kinds of financial offers are more attractive in sealing the deal? How should dealers determine how best to approach each customer since some customers are very detail-minded and others are more holistically oriented. Some of these questions draw on economics, others draw on areas of psychology that are still being researched.

Modeling the impact of advisor recommendations on the products customers seriously consider. Today, recommendations come from all sorts of places, from the internet, from Consumers Report, other magazines, auto magazines, word of mouth. This is still an area of considerable research by psychologists and market researchers. One of the big issues is what sources of information do people trust? What do they rely on in making their decision?

Understanding the differences between work practices in different dealerships and how those different work practices lead to better or worse dealer performance. In this kind of problem, the dealership is often treated as a special culture which is studied using methods adapted from cultural anthropology, and it is been very successful.

Second question, what has social science revealed about the factors that influence an individual's vehicle purchasing decisions? What questions remain unanswered? Although the developments in economic and psychological methodology on models predicting individual choice have been central to modeling customer demand. The economist, Douglas McFadden, was very influential. He was awarded a Nobel Prize because of his central role in creating many of these models. The mathematical psychologist, Duncan Luce, received the National Medal of Science for his role in creating the building block that led to these models. These models are fundamental to what GM and what other carmakers use in trying to understand the relative importance of different attributes of customers. We also employ direct assessment techniques for trying to assess customer willingness to pay for attributes as well as for specific features like OnStar. And we do clinics again based on the research in psychology and sociology about how to do clinics.

The whole question about how the internet has reshaped the purchasing process is currently a very active area of research for which no one has yet developed a definitive answer. It is profoundly changing the market. Does the internet shape customer preferences to focus on attributes that are more communicable on the internet, like cost and quality, versus less communicable attributes, like vehicle styling and the interior comfort?

I myself have not specifically looked at the issue of fuel economy.

How are recent breakthroughs in research incorporated into marketing or business? In what role might the NSF play? A lot of our previous models based on economics assumed individuals are rational. One of the real paradigm changes has been in research in economics and psychology. The Nobel Prize-winning work of Vernon Smith and psychologist, Daniel Kahneman as well as Herb Simon, have strongly undermined that perspective and suggest that individuals are systematically not rational. We know basically how they deviate from rationality, and that is led to a whole effort

of trying to rethink how we should understand customer behavior rigorously. And trying to operationalize that is still ongoing. We still don't understand that.

There are clearly some success stories in industry collaboration. I mentioned the Edelman Prize at the at the Institute's forum conference as an example showing successful applications. There are some non-successes. I think it is critical to say that NSF has been very pro-active in trying to build bridges between the universities and academia. When I worked at the NSF in the Decision Risk and Management Sciences Program, I basically was concerned with a program that explicitly kept matching grants between, you know, NSF and industry to fund academic research. I was also involved with administering some of NSF's small business initiation grants. There is a lot of important bridges that NSF has built. Obviously we can strengthen them and develop other kinds of things. For example, one of my thoughts is we might have a faculty in residence kind of program, you know, in different kinds of corporations because a lot of times the questions that, you know, industry people have aren't easy to formalize. If you have an acknowledge scholar there, oftentimes they can lend perspective because you really oftentimes can't communicate your problem via an email.

Chairman BAIRD. Dr. Bordley, I am going to ask you to wrap up a little early. We are going to have a vote in about 15 minutes, so in order to make sure everybody gets to ask some level of questions, then I am going to ask you to——

Mr. BORDLEY. All right. That actually finishes my testimony. A lot has been done. NSF deserves high praise for what has been done, but a lot more could be done. Thank you.

[The prepared statement of Dr. Bordley follows:]

PREPARED STATEMENT OF ROBERT F. BORDLEY

Mr. Chairman and Committee Members, thank you for the opportunity to testify today on behalf of General Motors. I am Bob Bordley, a GM Technical Fellow. I am working in GM R&D and Strategic Initiatives Group. The Committee asked me to respond to the following questions:

1. Please describe the type of market research you do for GM and how your background and experience as a social scientist influences your work.

I have been employed at GM since 1978. My marketing research work includes:

(1) **Estimating the change in product demand given changes in product prices.** *This work draws heavily on conventional economics.*

(2) **Grouping products into segments (e.g., small, mid-sized, etc.) based on which products customers consider comparable.** (This addresses questions like: do people first decide they want a vehicle made by a certain manufacturer and then shop among the available vehicles made by the manufacturer or do they first decide they want a mid-sized vehicle and then look across manufacturers in determining which mid-sized products they will consider? *It is based on psychological work on how individuals decide which items are similar.*

(3) **Grouping customers into segments** (e.g., lower income people with large families, people who want some style but are price-sensitive, people who are want a vehicle that conveys status, etc.) *This draws mainly on the socioeconomic literature about the different social classes in America, their needs for a vehicle (if they have large families or need towing capacity) as well as whether they view the vehicle as merely a means of transportation, an expression of personality or status, or something they want to enjoy.*

(4) **Modeling demand for products** as a function of all the major attributes of the product: performance, comfort, appearance, price, etc. *This draws mainly on the economic and statistical literature.*

(5) **Modeling the decision process by which customers**

(5.1) Become aware of a product: (How much can advertising affect awareness?) *This works draws heavily on psychology.*

(5.2) Come to seriously consider the product: (Given the hundreds of products available, what are the simple criteria people use for winnowing the set of choices down to a manageable set of choices? Do they screen out vehicles with a poor image for quality, a poor image for environmental-friendliness, etc.?) *This draws on the psychological and sociological literature on how products acquire an image and reputation.*

(5.3) Come to shop for a product (Do people visit a lot of dealers or a few? How much does the increased availability of information on the internet affect the shopping process?) *This is an economic/psychological question.*

(5.4) Come to buy the product. (What kinds of products should a dealer have on their lot to maximize the chances of having what the customer needs? What kinds of financial offers are more attractive in sealing the deal? How should dealers determine how best to approach each customer since some customers are very detail-oriented, others are more holistically oriented?) *Some of these questions draw on economics, others draw on areas of psychology that are still being researched.*

(6) **Modeling the impact of advisor recommendations** on the products customers seriously consider. (Recommendations come from the Internet, consumers report and other magazines, automotive magazines, word of mouth, etc.) *This is still an area of considerable research by psychologists and marketing researchers. What sources of information do people trust?*

(7) **Understanding the differences between work practices in different dealerships** and how those different work practices lead to better or worse dealer performance. In this kind of problem, the dealership is often treated as a special 'culture' which is studied using adaptations of methods in *cultural anthropology.*

2. What has social science research revealed about factors that influence an individual's vehicle purchasing decisions? What questions remain unanswered? Have you looked specifically at the issue of fuel economy?

(1) Developments in economic and psychological methodology on models predicting individual choices and how those models can be best estimated have been central to modeling customer demand. The economist, McFadden, was awarded a Nobel Prize because of his central role in creating many of these models. The mathematical psychologist, Duncan Luce, received the National Medal of Science for his role in creating the building block that led to McFadden's work. These models help GM understand, for example, the relative importance of quality, performance, roominess, fuel economy, and price in affecting a customer's chance of buying a vehicle. We also employ direct assessment techniques for trying to assess customer willingness to pay for these attributes (as well as for specific features like OnStar.) Conducting these clinics is based on methodologies developed in psychology. The company also conducts massive surveys and, once again, psychological theories about how questions should be asked in surveys have been very important.

(2) The whole question of how the Internet has reshaped the purchasing process is a very active area of current research—to which noone has yet developed a definitive answer. Does the Internet shape customer preferences to focus on attributes that are more communicable on the Internet (e.g., cost and quality ratings) versus less communicable attributes (like vehicle styling and the interior comfort of its seats)?

(3) I myself have not specifically looked at the issue of fuel economy.

3. How are recent breakthroughs in research incorporated into marketing or business strategies? What role might the National Science Foundation play in building bridges between academic social science researchers and government and industry policy-makers?

(1) The previous models assume that individuals are rational. Research in both economics and psychology (e.g., the Nobel-Prize winning work of economist, Vernon Smith, and psychologist, Daniel Kahneman as well as Herb Simon) has strongly undermined that perspective. This suggests that the entire paradigm may potentially have to be rethought on the basis of a psychologically sounder understanding of human behavior.

(2) There are clearly some success stories in industry/university collaboration as well as many more stories of non-success. The fact that a paper gets published

in a journal which cites industry support and funding for the project definitely provides no guarantee that the research was ever used (or even looked at) by the sponsoring company. However the Edelman competition of the Institute of Operations Research and Management Sciences provides many examples of clearcut successes where universities were often involved. We need to learn from these and other success stories.

It would be wrong to say that NSF has not already built some bridges between university and industry. The Decision Risk and Management Sciences Program of the National Science Foundation, when I was a program director there, had a program that was explicitly concerned with funding research with matching support from industry. NSF also has small business initiation grants that are explicitly focused on trying to encouraging technology. I administered some of those grant proposals and felt that this program was also very useful. (This is probably also true for other NSF programs with which I am not directly familiar.) We need to look at these existing programs, understand both what is successful about them and what is less successful about them, so that we can strengthen the bridges which NSF has already tried to build.

(3) Here is another thought: We might imagine moving to a model where a person with an endowed chair by a certain company would be committed to physically spending a certain number of days a week on-site in that company's location or on-site at the location of a consortium where industry practitioners would have direct access. Currently endowed chairs are mainly housed in universities where their occupants are more removed from the specific needs to industry. While it's important to have some time spent in isolation from the practical problem—in order to think about it—it's also important to have some time spent directly involved in the practical problem. A practical problem is frequently not something that can be communicated from an industry person to an academic with a short e-mail. And even when it is successfully communicated by e-mail, the academic solution to that problem often turns out to be too late and too complicated to address the real practical issue. The Center for Naval Analysis used to have a program (and might still have a program) where researchers were rotated between the research labs to work onboard a ship in order that they retain a real feel for the needs of industry.

So a lot has been done to build bridges and NSF deserves high praise for its accomplishments. But there is more that could be done.

BIOGRAPHY FOR ROBERT F. BORDLEY

CAREER SUMMARY

A Dominican Lay Scholar with extensive experience in developing, applying and managing statistical, decision analysis and operations management models.

WORK EXPERIENCE

2007–Present, GM Technical Fellow, Operations Research Group, Warren, MI

2006–2007, GM Technical Fellow, Vehicle Development Research Laboratory, Warren, MI. *Received Award for Best Decision Analysis Publication. Supply Chain Design:* Determined how GM's supply chain should react if GM had a sudden need to add production of a foreign vehicle at an existing plant (Part of Global Flex initiative). *Product Development:* Quantified Impacts of late engine changes using design structure matrix and workload model. Reanalyzed models relating vehicle attributes and customer attributes. Developed an alternative approach to robust design optimization based on decision analysis.

2003–2006, GM Technical Fellow, GM NA Product Development Center, Warren, MI. *Health Care Costs:* Worked with corporate strategy to model the drivers of GM's health care costs. Results led to reductions in brand drug coverage, initiatives on coordination of benefits and other efforts. *Product Development:* Modeled GM's new product development process to identify sources of cost and waste. Particularly targeted opportunities for reducing rework. Led to initiatives focused on reducing product content change.

GM Proving Grounds, Milford, MI. *GMNA Award for Creative & Incredible Performance in Engineering Design.* Updating GM problem remediation tools (e.g., control charts) and testing by applying to root causes various product problems (fuel caps, fuel pumps, rattling, ignition switches, blower motors). Using Statistical Analysis to Properly Target Welcome Call Initiative. Helped specify when calls would be made and the vehicles to be emphasized.

Received 2004 Chairman's Honors Award (savings>$360M/yr) and currently exceeding $1B.

GM Global Engineering Center, Pontiac, MI. Used influence diagrams to identify the key drivers of GM warranty costs.

- Modeled the drivers of GM's JD Power Score. Results led to more headcount focused on root cause analysis.
- Developed overall warranty cost driver model.
- *Led team receiving 2002 GM's People Make Quality Happen Award. (Realized savings: 250M/yr)*
- Developed battery warranty cost driver model. Potential Cost savings of $30M/yr identified. Company switched to more heat-resistant battery design, consistent with model recommendations. Developed models for ground warranty, brake warranty, powertrain control modules.

Enterprise Customer Network, Detroit, MI.

- Developed model of drivers of customer loyalty to assist in formation of GM's CRM strategy.

1998–2002, Technical Director, GM Corporate Strategy & Knowledge Development, Detroit, MI. Provide technical support in decision analysis and marketing to strategy formulation and operations improvement projects.

- Validated and implemented algorithm creating current product segmentation.
- Used statistical analysis to identify key drivers of dealer dissatisfaction, leading to development of best practices for improving VSSM dealer relations. Subsequent corporate focus on these drivers improved GM's dealer satisfaction from worst in the industry to average
- Developed marketing modules of enterprise model commissioned by Strategy Board, including modules to value the impact of changing the number of GM product entries and to project GM's long-run share given current policies.
- Conducted statistical analyses supporting the design of GM web tool, AUTOCHOICE.
- As part of a three-person team, guided the use of CART software for revising GM's needs segmentation.
- Developed a panel on social cycles as part of creation of New Product Concepts war room. Team received 1998 President's Council Award.
- Led successful Dialogue Decision Process projects in technology partnering, information technology and procurement.
- Used Enterprise Miner to prove that the current needs segmentation is more accurate than Claritas or demographic segmentations.
- Developed a 120-page overview of the approaches used by 60 major corporate strategists.

1993–1997, GM Vehicle Development & Technical Operations, Warren, MI. Manager, Portfolio Planning Department. Coordinated the review & documentation of GM's R&D projects.

- Led decision analysis on more than 50 R&D projects. Work stimulated dramatic changes in some projects. Team received GM Award of Excellence in 1994.
- Managed creation of a database to enable customers to access GM R&D projects more easily.
- Managed the implementation of new project budgeting system.

1991–1993, GM Research & Development, Warren, MI. Manager, Management & Marketing Sciences. Managed a team of 12 R&D professionals.

- Managed development of a model prioritizing product problems based on their impact on product repurchases.
- Developed the mathematical model that was the basis of Pricewar, a widely used GM product pricing software package.

1990–1991, National Science Foundation, Washington, D.C. Director, Decision, Risk & Management Science Program. Administered review and recommended awards of grants from a $3 million budget.

- With other grant officers, successfully lobbied for creation of a social sciences directorate at NSF.

- Awarded first grants to industry as part of NSF's private sector initiative.
- Successfully championed the funding of educational grants to teach students decision-making.
- Successfully lobbied for doubling the research budget on biotechnology social impact research.

1987–1990, Operating Sciences Department, GM Research Laboratories, Warren, MI. Manager, Decision Support Systems. Managed a diverse team of nine professionals in marketing, intelligence vehicles and risk analysis.

- Managed development of first needs-based segmentation.
- Managed development of in-vehicle navigation system.

1985–1987, GM Trilby Vehicle Design Project, Troy, MI. Supervisor, Mission Analysis Group. Managed a four-person team developing a mission statement for the Trilby prototype vehicle.

- Led business case analysis for proposed new vehicle.
- Developed a template specifying how the "voice of the customer" could feed into vehicle engineering.

1982–1985, Societal Analysis Department, GM Research Laboratories, Warren, MI. Staff Research Engineer. 1978–1981, Associate Senior Research Engineer. Conducted research & consulting work in economics, finance and environment.

- Discovered the importance of second choice data in potentially segmenting products. This idea was central to the development of GM's initial product segmentation.
- Developed a model of air pollution for Environmental Activities Staff.

TEACHING EXPERIENCE

2002–present, Adjunct Professor, Industrial & Operations Engineering Department, University of Michigan Ann Arbor, MI. Taught Course in Decision Analysis.

2000–2002, University of Michigan, Dearborn, MI. Adjunct, Lecturer, School of Management. Taught Courses in Operations Management.

1995–2000, Oakland University, Rochester, MI. Adjunct Full Professor, Systems Engineering Department. Taught courses in engineering risk analysis at Oakland University campus. Taught courses at Vienna on behalf of Oakland University and Vienna Technical University.

1996–1998, Wharton, Philadelphia, PA. Guest Lecturer, Marketing.

EDUCATION

2005, Sacred Heart Seminar, Detroit, MI. Master of Arts in Pastoral Studies (summa cum laude).

1979, University of California, Berkeley, CA. Ph.D., Industrial Engineering & Operations Research. Thesis: "Studies in Mathematical Group Decision Theory" (Dr. T. Marschak). Awarded 3-Year National Science Foundation Fellowship.

1979, MBA, Finance.

1977, MS, Industrial Engineering & Operations Research.

1976, Michigan State University, Lansing, MI. MS Systems Science with specialty in Economic Systems.

1976, BA in Public Policy. Graduated Magna cum Laude.

1975, BS, Physics. Awarded 4-Year Full Scholarship, National Merit Scholarship.

REFEREED PUBLICATIONS

(74) "How to Make Risky Decisions Visually." *Visual Communication,* 2007.

(73) "Statistical Decision Making without Math." *Chance,* 2007.

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(9) "Deducing Warr's Power Function." *Social Forces* (September, 1982).

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(7) "The Psychology of Individual Choice." *Proceedings of the American Statistical Association.* American Statistical Association, Alexandria, Virginia (1993).

(6) "Murphy's Law and Non-Informative Priors." in C.R. Smith (ed.) *Maximum Entropy & Bayesian Methods.* Seattle, Washington, 1991.

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(4) Book Review of 'Rationality & Consensus in Science and Society." *Nous (December, 1986).*

(3) Book Review of Shapira. "Risk-Taking: A Managerial Perspective. *Interfaces* July, 1996.

(2) Book Review of Bell & Schleiffer. "Risk-Management" *Interfaces* Sept. 1996

(1) "Quantifying Societal Concerns in R&D Project Selection" in M. Shahinpoor & J. Weinrhach. *Environmentally Conscious Design & Manufacturing.* ECM Press, New Mexico, 1996.

PROFESSIONAL ACTIVITIES

AMERICAN STATISTICAL ASSOCIATION

Program Chair, Section on Marketing in Statistics, American Statistical Association, 2002–2004

General Chair, Section on Risk Analysis American Statistical Association, 1997–99

Program Chair, Risk Analysis Section, American Statistical Association, 1996–97

Program Chair, Risk Analysis Section, American Statistical Association, 1995–96

Member, Council of Representatives(for Risk Analysis), American Stat. Association, 1994

Member, Council of Sciences, International Society for Bayesian Analysis, 1994–1995

Session Chair, 1987, International Society of Forecasting

Session Chair, 1989, Southern Economic Association Meeting

Program Committee, International Symposium on Automotive Technology & Automation

Advisor on NSF Contract

INFORMS Society

Councilmember, Decision Analysis Society, 2002–2005

Chair, INFORMS Award Committee for the Teaching of Practice

Councilmember, Institute for Operations Research & Management Science (INFORMS), 1995.

Councilmember, Operations Research Society of America (ORSA), 1994

Member, Management Sciences Roundtable (Member, Membership Subcommittee)

Chair, Marketing Strategy Committee, Institute of Management Sciences (TIMS), 1993–94

Co-Chair, Fall 1994 TIMS/ORSA Program Committee(Responsible for invited papers)

Member, Meetings Committee, INFORMS, 1995

Councilmember, ORSA/TIMS Decision Analysis Section (1987–1990).

Chair, ORSA/TIMS Marketing Strategy Committee (1993–1994)

Decision Analysis Cluster Chair, 1987, 1994 TIMS/ORSA Meetings

Session Chair: 1985, 1986, 1988, 1992 TIMS/ORSA Meetings
Vice-President, Southeast Michigan Chapter of ORSA/TIMS, 1992–1995
Secretary, Southeast Michigan Chapter of ORSA/TIMS, 1987
Co-Founder, Southeast Michigan Chapter
American Marketing Association
Review Board, *Journal of Marketing*
Ad Hoc Reviewer, Management Science, Jr. of Academy of Mgt., Production & Operat. Mgt. Soc., etc.

PRODUCTION & OPERATIONS MGT SOCIETY

Vice-President for Publications, Production & Operations Mgt. Society (1999–2000)
Vice-President for Finance, Production & Operations Mgt. Society (1995–1996)
Member, Board of Governors, Production & Operations Mgt. Society (1992–1994)
Area Editor, Production & Operations Mgt. Journal (1993–1995)
Member, Josephy Orlicky Operations Mgt. Award Committee (1993)

GOVT. COMMITTEES

National Advisory Council on Environmental Policy—Envir. Protection Agency
Member, Pollution Measurement Subcommittee
Chairperson, Materials Accounting Data Working Party
Member, Toxic Data Reporting Subcommittee

ALUMNI ASSOCIATIONS

James Madison College, Michigan State University
Alumni Association President, 1985–88, Boardmember, 1981–83, Vice-President, 1984–85
Vice-Chair, James Madison College Board of Visitors, 1995–1997
Chair, Program Committee, James Madison College Board of Visitors, 1997–1998

Delivered many papers at
TIMS/ORSA, International Federation of Operations Research, International Society of Forecasting, Public Choice, Bayesian Research Conference, American Physical Society, Economic Sciences & Public Choice Conference, Foundations of Utility & Risk Conference, Judgement/Decision-making Conference, NBER–NSF Seminar on Bayesian Inference in Econometrics & Statistics, University of Chicago, Northwestern University, University of Michigan, University of Arizona, University of California at Irvine.

Ad Hoc Reviewer for
Physics Letters, IEEE Transactions, JASA, Mgt. Science, International Economic Review, American Political Science Review, Journal of Risk and Uncertainty, National Science Foundation grant applications, Kentucky Planning Office grant applications.

Society Memberships:
Institute for Operations Research & Mgt. Science
Society for Risk Assessment
International Society for Bayesian Analysis
American Physical Society
International Platform Association
Royal Economic Society
American Economic Association
Public Choice Society
American Statistical Association
Phi Beta Kappa
Judgment/Decision-Making Society
Phi Kappa Phi

FELLOWSHIPS/HONORS

National Merit Scholarship

National Science Foundation 3-Year Fellowship
Alumni Distinguished Scholarship, Michigan State University
Lilly Fellowship
Award of Excellence, General Motors R&D, for R&D Project Selection Process
1998 President's Council Award, General Motors Corporation, for work on Portfolio Concepts Process
2002 UAW–GM People Make Quality Happen Award
2003: GMNA Award for Creative & Incredible Performance in Engineering Design
2004 GM Chairman's Honors
2006 Decision Analysis Publication Award

DISCUSSION

Chairman BAIRD. Thank you very much. Thanks to all our witnesses. I want to welcome Dr. Roscoe Bartlett to our panel here. Thank you very much, Dr. Bartlett. We have also been joined by Dan Lipinski. Thanks, Dan, for being here. I am sorry, Dr. Dan Lipinski. One of the nice things about this committee is we actually have people who know something about science on it which is a nice thing. Jerry McNerney is telling me he has to leave fairly shortly, so I am going to yield my first five minutes to Dr. McNerney. First question.

Mr. MCNERNEY. Thank you, Mr. Chairman. I have to say, I found your testimony very interesting and stimulating; and from what it sounds like, we need to develop a herd mentality toward conservation and develop strongly held beliefs. Of course this is something that we want to move toward in bringing conservation and good behavior about. Modeling is an important part of that. Could you tell me, Dr. Bordley, and maybe any of the other witnesses, what state are we at in terms of modeling behavior of society as a whole in terms of directing behavior towards something like more conservation behavior or attitudes? Is that something we can get our hands around? Is that something we need to have more funding in to get more students involved in it or where are we with that?

Dr. BORDLEY. Right now, obviously we have got a lot of modeling. For example, Nick's multi-logent models to try to better understand customer behavior and make kinds of decisions. We are clearly—obviously we are clearly not exactly on the mark in predicting people's behavior as well as we would like. You have big fluctuations, like oil price changes can come up and dramatically change the market. I mean, you get hit with curve balls.

So we have an awful lot of work going on in the modeling. We are drawing on all the social sciences, and quite honestly, we are nowhere near where we would like to be in terms of accurate models. We are a lot better than where we were five or seven years ago, but it is definitely an area of current research; and we pay very close attention to the evolving social sciences to develop better models.

Inputs to models are always a big issue and uncertainty about inputs, too. You know, you don't understand all the things that are driving customer behavior, what kinds of search advisors they are looking at. So there is a lot of things that make modeling hard as well as the proper assumptions to make about customer behavior,

which is why those realization that customers don't follow economic rationalities to—you know, big deal for us.

Mr. MCNERNEY. One other question to give more time. The modeling is an important tool, but our influence in the fed is also an important tool. How can we make policy that would influence the automakers and the other manufacturers to make the right choices because they have a lot of leeway in terms of how they direct customers? I mean, you see advertisements where they are promoting SUV's, big vehicle purchases. How can we and the fed influence the manufacturers to make the choices to direct their customers toward conservation?

Dr. BORDLEY. Well, I guess one of the things unfortunately is we found that as I mentioned the internet, Consumers Report, whatever. Increasingly people are looking to information sources outside of General Motors or the car makers in evaluating basically what kinds of vehicles they are going to buy. You know, Consumers Report is strongly influential, basically. You have Kelly Blue Book, lots of sources out there. So advertising is still a factor but it is nowhere near as important as it used to be, and we are finding to some extent that, you know, we are in a very competitive market. Things have just changed so much, and so, you know——

Dr. CIALDINI. Dr. McNerney, I might have an answer as well for that question and that is in the messaging literature, in fact, we just heard about Dr. Kahneman who won the Nobel Prize a few years ago. His theory, a prospect theory, suggests that if we inform an audience what they stand to lose if they fail to move in the direction that we are suggesting, that will be more mobilizing than telling them what they stand to gain if they do move in that direction.

So our message to the large automobile manufacturers can be structured and framed in terms of what stands to be lost, what will be missed if they fail to take the action, rather than what kinds of gains they will attain if they do.

Mr. LAITNER. Dr. McNerney, if I might, I am a modeler. I spent 10 years with the USEPA doing modeling, and I left the agency because I think they are pursuing a very bad practice of economic modeling. Their models tend to assume, for example, what they call the full employment assumption. You may think it is jobs, but to an economist that means that all resources, whether capital, whether labor, or energy, are fully utilized and already efficiently allocated. So along comes Congress and wants to do something about climate or energy policy or international security, their models by definition imply a net cost to the economy because we are already optimal, anything we do must impose a cost. But in fact, I think we would recognize that there are so many inefficiencies throughout the economy that if their models had a better ability to capture the technologies already available to us and the behaviors that could see a different way of doing things, a different way of innovating, a different way of adopting technologies, you might have a more satisfying outcome; and one of the things I think this subcommittee could do is send a signal to the economic modeling community and say, hey, there are better technologies your models are not capturing. There are better behaviors that you could be implementing and better policies than the price signal alone you could

be incorporating in your modeling efforts, and you would see a much more satisfying end result. As an example, finally, modelers tend to use what we call a constant elasticity of substitution. You can imagine invariant over time the same elasticity regardless of changes in perception, availability of technology, changes of incomes. That is not a very satisfying way to provide you with the kind of policy insights you may require to know what better policies make sense for this economy.

Chairman BAIRD. We see that also in health care policy, dramatically illustrated there. Dr. Ehlers.

Mr. EHLERS. Thank you. It is fascinating to listen to this and imagine what we could be doing. Of course, some folks would consider this mind control. I would prefer to consider it as unleashing the mind, getting it away from built-in prejudices. But what I am curious, and this is for all of you, what role do you see the Federal Government playing in changing consumer behavior, particularly as it applies to energy usage and dealing with the energy situation we have today? Any suggestions, recommendations, et cetera?

Dr. BORDLEY. I guess I had a thought that I raised with the Chairman beforehand which is you like to look for win-win situations, you know, where the customer wins and the environment wins. One of the things that people don't like is being stuck in traffic jams, and they don't like stopping and starting at various traffic lights. And there is a continuing effort, you know, in traffic science, you know, this whole business about trying to help coordinate when people leave on trips so they avoid congestion and get to their routes more efficiently and more effectively. It is a win-win situation. The advent of the internet, which as I mentioned is a real big, major deal in the car industry, allows for a lot more improved communication and coordination between individuals that allows them to, for example, avoid traffic jams, you know, and spend less time at stopping lights and so on and so forth. The advent of technologies like OnStar that allow you to communicate with the vehicle likewise improves that. So there is an example I think of one thing that can happen to encourage that kind of coordination so people, you know, waste less time in traffic jams or at stop lights and at the same time waste less fuel, you know, win-win for all concerned using the coordination powers of the Internet.

Mr. EHLERS. But if you succeed at that then my method won't work. My method is to try to do what most people don't do. That is why I come to work before most people and go home after most people do. That is not a very popular alternative, but it certainly gets me both ways much faster.

Dr. BORDLEY. That is where the social sciences really come in because obviously if we all do the same thing, we are all going to be in the same traffic jam. So the question is, it is almost like auctioning, which is one of the areas of social science, you are almost auctioning off the space, like we can make an agreement like, for example, the Chairman leaves 10 minutes early for work, you leave on time for work, I leave 10 minutes later, we all avoid traffic jams. So some kind of coordination. People loosely try to do that, you know, we all leave early or whatever as far as that goes. But we can coordinate a lot more precisely with the internet, and it will take some social science work on auction theory about how to do

that; but that is one possibility, that technologically we have the technology to do it but it is going to take the social science issues to figure out how to coordinate among us so we can collectively reduce the amount of time we are wasting and the amount of energy as well. Does that make sense?

Mr. EHLERS. Yeah. Any other comments about the role of the Federal Government in changing consumer behavior and energy issues? Dr. Wegener.

Dr. WEGENER. Thank you. Certainly when the Federal Government invests in research, there are a number of ways in which that research can make a difference in what you are describing. Certainly investing in basic research can provide tools to individuals like Dr. Laitner described where they have a product but haven't brought it to market, haven't found ways to make it work. And basic research that may be across many different content domains, health, energy, other types of topics, can provide tools for those companies, for those marketers and such to take a good product and make it work in the marketplace. Certainly the model that we use in the Energy Center where I work as well is that in the technology development itself, it is a different kind of perhaps research investment and maybe for interdisciplinary teams and such rather than the basic work, but that can help those technology developers to identify and address on line and up front what those public obstacles may be, and that will pay dividends down the road in the same places. But deal with it before there is a product and marketing after the product has been developed, but deal with it before the obstacles are encountered.

Mr. EHLERS. Dr. Ellig.

Dr. ELLIG. Two quick suggestions. One thing the Federal Government could do it take a careful look at institutional barriers that might be thrown up by other levels of government in some cases. For example, if I go home and look at my electric bill, the price that I pay for electricity tells me it doesn't matter when I use it, whether I use the washing machine or the dishwasher at 5:00 on a July afternoon or 2:00 in the middle of the night in December, it doesn't matter. And there is some significant rigidity introduced by the way electricity has been priced in the U.S. which pretty much in many cases discourages people from shifting their use to off-peak times and doing things that would be energy efficient; and there are some experiments out there, both laboratory experiments, and experiments in the real world with real consumers that show that when people have the opportunity to pay a price that varies based on market conditions, they actually do alter their behavior and move their use to off-peak times.

The other thing just thinking about the traffic issue and having spent some time in the Federal Government in a management position, to the extent that federal agencies can better define what they are accomplishing in terms of outcome for the public and then link the performance, evaluation, and compensation of employees to that, it is easier to let people work without much supervision which means it is easier to keep people productive when they are telecommuting. I happen to work for an institution where we are completely evaluated based on what do you accomplish, not when are you in the office, how much face time do you have with relevant

people. Having been in the Federal Government, I know that the idea that you would evaluate people based on what they accomplished rather than face time, time in the office, number of hours, is foreign to a lot of folks even, and it is because of a tremendous focus on trying to measure outputs and inputs, rather than actual results.

Mr. EHLERS. And in many cases it is hard to measure either one. Thank you.

Chairman BAIRD. Dr. Ehlers, thanks very much. We face a somewhat similar challenge here in Congress, the issues we are talking about, vis-á-vis trying to involve social sciences more and the policy-making and actually gain respect for them. In the halls of Congress when it comes to NSF funding, we have had some interesting battles about whether social science somehow would be a second-class citizen in NSF funding.

I am interested, Dr. Wegener—and you are in an institution where they specifically apparently incorporated that. So my question would be how would the physicist, the engineers, the others interact with you? Have they come to see the value or do they say, oh God, now we have got to go talk to those social scientists and pretend we care. So I am interested in that, and then I would be interested in any of your comments for how your disciplines and the insights for your disciplines can help your associations and those of us who care about social science can convey to our colleagues the importance of this endeavor we are talking about. So first, Dr. Wegener, and then open it up.

Dr. WEGENER. Yes, so I deal with those issues every day now it seems in terms of—and with mixed results I would have to say, that for some of our scientists in other parts of the technology development wings of our Energy Center, they absolutely understand the need for issues like attitude change and consumer behavior, although you might be able to predict that some of these areas for example in the area of biofuels where some of the technologies that are being developed would include genetically modifying cellulosic feed stocks for biofuels, for example, have already noted resistance from environmental groups and others about that kind of technology. And so they understand that there is a human, social aspect to the technology development itself. And so they have been eager to talk with us about those issues. You might also imagine the folks that study nuclear power for example who know that there are social pressures and opposition in some cases to that technology are certainly interested to talk with us.

In some other areas, we are just not really on the map for those scientists yet, although I have not I would say met a lot of real resistance to talking about those issues; but I think our successes have been varied and in some predictable ways for technologies for which they already notice that there is that social issues.

Dr. CIALDINI. I have had success with my colleagues in the natural and physical sciences by validating the worth of their efforts and suggesting that what we can do is assure that those efforts will be implemented and adopted as a consequence of the hard work that they have done.

Mr. LAITNER. If I might respond, Mr. Chairman, as an economist and a modeler, I think the best way to begin is that Kenneth

Boldling, an American economist, once commented that images of the future are critical to choice-oriented behavior. If the modeling doesn't allow different images to unfold in the way we might deploy technology, the way we might involve other kinds of policy than a mere very high price signal, that we may not see any kind of reaction because we are hesitant. We think we are going to end up with nothing but a penalty. If your model assumes that a $100 investment in a new refrigerator is a pure cost as opposed to an investment with a return on it, you get a whole different set of results.

So we are trying to work with sociologists and others to understand that we can shift perception on the innovation side and that we can shift perception on the consumer side in order to facilitate an adoption of technology. So rather than this idea of the constant elasticity, behavior that never changes regardless of the size of the price, the severity of the problem, always the same behavior, we are trying to dissolve that and show that there are ways of incorporating different behaviors that do result in a positive and a benefit to the economy.

Chairman BAIRD. If I would apply that argument along with the kind of comments from your colleagues to the right, that might be the kind of argument we could try to help our colleagues here understand, that the efficacy of the investment in the physical, engineering, and mathematical sciences will be enhanced not detracted from by an investment in the corresponding social sciences. And I think that is incumbent upon the social sciences themselves to demonstrate that in some fashion.

Dr. BORDLEY. If I could also speak. I basically—I have sort of worked from both ends. I have done most of my work in modeling but I have also worked on the other end, you know, where you are actually trying to put stuff together and everything else like that. Vehicle development or—when you take a new technology, basically trying to build a vehicle or complex system, there is a very complex coordination system among lots of different individuals at various kinds of levels. You know, it is a massively complex kind of thing. Individuals have different kinds of incentives, this whole project management kind of thing. You are talking about thousands of people basically, getting down to the actual guys who basically, you know, screw on nuts or whatever, take things apart and, you know, I have been in both worlds. And I think that is an area, you know, technology transfer, I mean, it involves people ultimately. We can get distracted about these kinds of things and directional things in saying here is a great new technology. But translating that into a product that can actually be built, you know, cost effectively and made into the market by real people. That is a lot of very social science, you know, kind of interaction, very complex, and at least—I mean, in my mind basically, that is not an area we shun at all because that is clearly a big issue. So I think it is a very clear area.

Chairman BAIRD. Dr. Ellig.

Dr. ELLIG. Yeah, I think graduate education plays a big role in how people develop attitudes toward other disciplines, toward other tools and so forth. And so to the extent that we can get graduate-level education for social sciences and natural sciences to help folks appreciate, you know, the other methods and what the other folks, the other disciplines have to offer. There is probably a big payoff

there in terms of creating a body of people who are then predisposed to work with scholars and other disciplines and use other methods rather than saying, oh, we are the only ones who really understand the world.

Chairman BAIRD. I appreciate that perspective. In fact the *America Competes Act,* the NSF reauthorization bill that Dr. Ehlers and I worked on does a number of things to try to encourage interdisciplinary research. Dr. Bartlett.

Mr. BARTLETT. Mr. Chairman, thank you very much for arranging this hearing. I think that the social sciences in our energy future will have the biggest challenges and perhaps the most responsible position.

There are three groups that have common cause in wanting to move from fossil fuels to alternatives. You have been mentioning just one of those groups, and that is the group that believes that our use of fossil fuels is increasing CO_2 which is changing the climate and resulting in global warming. There are those who will argue that if you look back through the past you will see that the CO_2 increases occurred after the global warming, therefore the result of global warming, not the cause of global warming. There will be others who will argue that the Earth at one time had been very much warmer. There were, as a matter of fact, subtropical seas in northern Siberia and the north slope of Alaska and so forth or else there wouldn't be gas and oil there, right? There will also be others who argue that, gee, a warmer Earth wouldn't be all that bad. If I am living in Siberia, you would have a hard time convincing me that a warmer Earth would be all that bad.

And so you have the problem of convincing everybody that this is something that we need to vent our energies to because they may argue that the Earth is warming and we have nothing to do with it; so the Earth may be different but it won't be necessarily worse. So it is going to be hard to marshal everybody to follow this drummer.

The second group that has common cause in wanting to move from fossil fuels to alternatives, the group that believes that because we have only two percent of the world's oil and use 25 percent of the world's oil and import almost two-thirds of what we used, that this is a totally unacceptable national security risk and we really got to do something about that. And what you need to do, of course, is move from fossil fuels to alternatives so that we are less dependent on oil since we have only two percent of it and use 25 percent of it. We need to change that.

Not everybody will agree that this ought to be a priority that would result in them changing their lifestyle because they will argue, gee, we think that if we just had better dialogue with those Arab nations, they will play nice and the guy who has the dollars buys the oil anyhow and it really won't matter if we don't have the oil because it is out there in the world, and it is a global economy and we will have the oil.

There is a third group little mentioned but growing in recognition. That is the group that believes that the energy is just not going to be there. In 1956, M. King Hubbard predicted the United States would peak in 1970. Right on schedule, we peaked in 1970. By 1980, we absolutely knew we were sliding down the other side

of Hubbard's feet, and our response to that was to drill more, totally, totally the wrong response. For the last 30 months, oil production world wide has been—by the way, I noticed that sir, while you were referring to EIA, please have a lot of reserve and confidence in what EIA is telling you there. They are a bunch of economists who are predicting that if you understand the past you can predict the future. And they are exactly right if our resources are infinite. They are not infinite. In a thousand years of recorded history, we are about 150 years into the age of oil. The best evidence is that in another 150 years, we will be through the age of oil. No more for all practical purposes. No more oil, gas, or coal. What kind of a world will our great, great grandchildren live in.

So you have a huge challenge, and marshalling people to do the right thing—and I think that properly articulated, it is undeniable that oil is not forever, that we will reach a peak at some time. I think the evidence is pretty much overwhelming. Conventionally, we have already reached that peak. We are now static because we are having some unconventional oil like Albert tar sands and really heavy sour oil that we are exploiting today.

So absent national leadership, we don't have much energy in this country. We have even less responsible national leadership. Absent national leadership, what can you all do so that we move along the right path?

Mr. LAITNER. Well, Dr. Bartlett, if I might lead off, there is a fourth group I might add to that list and that is a group that says between now and say the year 2030, this nation will absolutely have to invest literally trillions of dollars in new energy supply, infrastructure, highways, buildings, and that if we are going to have to make that investment anyway, why wouldn't we want to ask the question, what is the smart mix of resources that best get the job done that satisfy multiple concerns, whether you believe in climate, whether you believe in peak oil, or whether you have other concerns? Why wouldn't we want to put all of our resources, energy efficiency, nuclear, hydrogen, renewables, unconventional fossil fuels, get them all on the table, do an honest assessment of their cost and their performance, see which blend, not picking winners, but generally what direction we could move in as an economy and satisfy those concerns by then incorporating both the hard science and the social sciences to help address that very difficult question. We are either going to lock in a hard future because we are not making a smart decision about the investments today or we are going to open up opportunity for some innovation which I said earlier in my opening remarks. We have the means to move ourselves into a solid economic prosperity and a sustainable path if we choose to do it, but that requires taking the field with a full complement of players and really addressing the issue up front.

Dr. WEGENER. I am glad that Dr. Bartlett raised this issue because certainly we have folks within our Energy Center that are also careful to say that we are talking about a limited and polluting resource, and that limitation is important. I do have an economist colleague at Purdue who says, well, we will never actually run out of oil, not because it is not limited but because it will become so scarce, it will become so expensive to use it people won't anymore. The problem is if we wait until that point where the eco-

nomics alone push us to do other things, our economy will have taken so much of a hit already that we will not want to face it. And so it is important for us to be pro-active and to work ahead of that eventuality rather than to wait for it.

Dr. ELLIG. I think we probably have to have a big dose of humility in speaking about how we, whether it is us experts or lawmakers or regulators or anyone, is going to shape things to deal with things that could happen in the future and appreciate that there are very real limits to either what folks like us can know or to frankly, you know, what folks you all can accomplish through law and through regulation and so forth. And so we should just be careful to realize that anytime one of us says something must be done or anytime one of us says here is what the problem is, that is reflecting not just maybe some technical expertise but also a set of value judgments and some assumptions about the future that may or may not be right.

Chairman BAIRD. Those bells you hear, those of you as social scientists remember Pavlov's dog. We now have 15 minutes to get to the meat. And so that means our final questioner will be Dr. Lipinski, and I very much appreciate that and we will finish after Dr. Lipinski and thank you very much. If people leave now, it is because they are going to votes, not they are being rude.

Mr. LIPINSKI. Thank you, Mr. Chairman. We have plenty of time since the 15 minutes is really more than 15 minutes, but I won't go on that long.

I want to thank Chairman Baird for holding this hearing today. I am a social scientist. I was teaching political science before I was elected to Congress. I also have a background. Before that I was an engineer. I studied an interesting program called engineering economic systems at Stanford and had Amos Tversky as a teacher there also. So all of the—of what you said I think is very interesting, very important for our understanding as we here try to—if we work on creating public policy to try to, you know, get the outcomes that we would like to see, there are so many factors that go into what those outcomes are going to be. There are so many different directions I could possibly go, but let me start with a more general question and then I want something more specific. My first question is I know Dr. Ellig talked about graduate-level education is so important in terms of really teaching graduating students that interdisciplinary work is important and it is good. I would like to know anyone who has any—what their view is right now of how much incentive there is right now among scholars doing social science to actually do interdisciplinary work because certainly as a political scientist I do not see a whole lot where I was at in my experience. I know it differs by institution, but overall, do you see there being that much incentive out there to do that kind of work? Is that rewarded in any way in academe? It certainly seems like it is rewarded out in industry. Anyone who has any comments on that.

Mr. LAITNER. Dr. Lipinski, I might open up because we have seen that unfold with our forthcoming conference in November in Sacramento. Apologies it may not be in your district. The building—or the Behavioral, Energy and Climate Change Conference that is being convened, and I have been stunned and my colleague,

Dr. Karen Earhart-Martinez with me here today, has been even more so because she has been fielding an incredible number of questions from a multi-disciplinary field across all parts of the country, people really wanting to see more of this interdisciplinary approach and incorporating the social sciences into the thinking about energy policy. So I might comment that convening the conference on a shoestring budget brought forth a really unprecedented number of inquiries and interest to see not only in terms of policy but the question you asked, what kinds of interdisciplinary actions can occur, and the good news is I am learning about even more I did not know existed. I did not know about Dr. Wegener's efforts until this testimony here today, and we are just learning about Bob who is I am glad to say is going to be one of the speakers at that conference in November. So the good news is it is almost as if it is been under a pressure cooker, people just churning and wanting to get out and be much more involved in an interdisciplinary way but not having the means to do so, both the funding and the connections and the infrastructure to make that possible. But that is starting to happen, but I think you are going to see a lot more compelling interest in that kind of a direction.

Mr. LIPINSKI. Dr Ellig.

Dr. ELLIG. I think at least in economics, the incentives facing the more junior, untenured professors are still to, you know, publish in the top journals by doing the things that economists are normally expected to do, rather than doing a lot of interdisciplinary stuff unless the interdisciplinary work involves some new type of neato technical technique because then it can get into the top journals where technique is prized very highly. And so I think where you have seen economists doing good interdisciplinary work is when either in unusual cases where there is a particular academic department that explicitly decides it is going to be different—I have to say my colleagues at George Mason University comprise one such department—or where there is some sort of an institution on campus that is explicitly designed to promote this, like the Center, Dr. Wegener is with, or you know, once you get up to the Nobel level and other situations where more senior scholars aren't subject to some of the more mundane incentives of their discipline, then they have a lot more freedom to kind of, you know, go out and follow wherever the path may lead.

Mr. LIPINSKI. And I am very happy to hear that we are—the disciplines are moving in that direction but what Dr. Ellig said, certainly it was my experience in political science in terms of what was, as a junior scholar, valued; and I certainly think that we need for the sake of the social sciences and, you know, for the sake of helping our country and our world move forward, interdisciplinary work is certainly very necessary. I always look back, and this is a much more general factor that influences people is the way that they are brought up, and I always say I am a child of the '70s, grew up in the '70s, and saving energy and the environment were very important and showed up so much in popular culture; and as a kid I grew up with those things. They still are with me today, and I see that as one factor influencing my behavior; but I wish we had more time but I think that is going to be it. But I am very interested in all of your research in what we need to do, what the

factors are that influence people's work. It is up to the Chairman if——

Chairman BAIRD. Very, very, very briefly.

Dr. WEGENER. I would like to say very briefly I think that in a lot of places that there are not the incentives that there could be to encourage this kind of interdisciplinary work. People are largely doing it out of their own desires rather than incentives to bring them there. But also I think it is really important for us to strike a difficult balance between that interdisciplinary work but strong training in disciplines that people can take to those interactions, and that is always a difficult balance to find.

Chairman BAIRD. I want to thank our panelists. As a way to close this, Dr. Laitner, I am going to give you one opportunity for the shameless plug for the conference because I think it is absolutely the perfect sequel to this hearing. Can you tell us about the conference very briefly and location, time, and date.

Mr. LAITNER. Thank you very much, Mr. Chairman. Yes, it is a conference entitled *Behavioral, Economic and Climate Change Conference* designed exactly to bring together the panoply of disciplines, whether anthropology, sociology, psychology, economics, a way to see what might be done to provide amore satisfying and understanding and movement toward a prosperous energy policy, one that addresses a number of these concerns in Sacramento November 7th to 9th. In my testimony I do give the URL and other information.

Chairman BAIRD. Terrific.

Mr. LAITNER. But thank you.

Chairman BAIRD. What is URL?

Mr. LAITNER. Uniform Resource Locator, the website.

Chairman BAIRD. Oh, I know that, but what is——

Mr. LAITNER. We are apparently not communicating.

Chairman BAIRD. I know what URL means. I mean, what is the URL for the conference?

Mr. LAITNER. It is on the ACEEE website. If you go to *www.aceee.org* you will find it there.

Chairman BAIRD. That is all right.

Mr. LAITNER. Thank you.

Chairman BAIRD. That is pretty good. You appreciate the normal ignorance of Members of Congress, and I can't fault you for that. Let me thank our panelists and my colleagues for a very interesting hearing, all of those who helped to put this together. With that, the hearing stands adjourned, and I thank everyone for participating.

[Whereupon, at 11:26 a.m., the Subcommittee was adjourned.]