UCLA Extension Public Policy Program
Annual Symposium Series on
THE TRANSPORTATION, LAND USE, ENVIRONMENT CONNECTION

Global Energy and Climate Change

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UCLA Lake Arrowhead Conference Center
Lake Arrowhead, California

Summary of Proceedings

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Foreword

This report is a summary of proceedings from a prominent policy and research symposium on **Global Energy and Climate Change**, held October 2006 at the UCLA Conference Center in Lake Arrowhead, California.

UCLA Extension Public Policy Program convened the symposium, which was the sixteenth in an annual series created to address the importance of ***The Transportation, Land Use, and Environment Connection***. Each year a specific focus is selected for detailed examination of the interrelationships among these three areas. The goal of this year's topic was to examine the use of energy resources in regards to transportation and land use, linking those uses to changes in our climate on a global scale.

The core of the program focused on the following topics:

- Energy and climate change implications for public policy
- Links of global climate change and land use/transportation
- How businesses view uncertain energy and climate futures
- Global energy reserves, usage, and prospects
- Near and long term possibilities of future fuels and vehicles
- Roles of alternative fuels and propulsion
- Transportation energy and greenhouse gas emission planning outside of the U.S.
- Reponses to global energy and climate issues in Sacramento and Washington
- Local to international efforts linking decision-making to global energy/climate issues
- Making wise policy under uncertain conditions

To ensure that the symposium identified with the needs of policymakers, practitioners, and researchers, the program was developed with the considerable help and underwriting from numerous sponsoring and cooperating agencies and organizations. These include governmental, business, environmental, and public interest groups (Appendix D). They deserve special recognition for their personal and organizational investments in the program, most as part of the Arrowhead Steering Committee.

I gratefully acknowledge the collaborative partnership that is fostered between UCLA Extension and the UCLA Institute of Transportation Studies in convening this annual symposium series. The diligent and thought provoking contributions of co-chair Brian Taylor, Associate Professor and Vice Chair, Urban Planning, UCLA School of Public Affairs, and Director, UCLA Institute of Transportation Studies are invaluable.

Thanks are also due to two individuals who prepared this comprehensive proceedings report: Adina Ringler and Michael Smart, both affiliated as graduate students with the UCLA Institute of Transportation Studies.

It is the hope of the symposium organizers that this forum will contribute to ongoing policy dialogue and lead to the introduction of solutions through research and practice.

Catherine Showalter
Director, UCLA Extension Public Policy Program

TABLE OF CONTENTS

Page

I. INTRODUCTION 1

II. SYMPOSIUM PROCEEDINGS 2

Session 1: Energy and Climate Change: Implications for Public Policy 2

Session 2: Links between Global Climate Change and Land Use/Transportation 11

Session 3: The Business of Uncertain Energy and Climate Futures: A Roundtable Discussion 14

Session 4: Global Energy: Reserves, Usage, and Prospects 21

Session 5: New Vehicles, New Fuels: Near Term Possibilities 25

Session 6: New Vehicles, New Fuels: Longer Term Possibilities 29

Session 7: What in the World? Transportation Energy and Greenhouse Gas Emission Planning Outside of the U.S. 35

Session 8: Responses to Global Energy and Climate Issues in Sacramento and Washington 41

Session 9: Linking Decision Making to Global Energy and Climate Issues- Opportunities and Uncertainties 46

Conclusion 52

Appendix A: Symposium Program 53

Appendix B: Speaker Biographies 60

Appendix C: Participant Roster 70

Appendix D: Symposium Co-Sponsors 79

Global Energy and Climate Change:

The Transportation – Land Use – Environment Connection

UCLA Lake Arrowhead Conference Center
Lake Arrowhead, California
Sunday afternoon, October 22 through Tuesday morning, October 24, 2006

Introduction

Global Energy and Climate Change, the 2006 UCLA Lake Arrowhead Symposium on *The Transportation, Land Use, Environment Connection*, brought together scientists, researchers, practitioners, and policymakers to discuss the complex relationships between transportation and climate change. No topic is more current or more pressing to address than climate change, so it was appropriate that this year's symposium focused on the relationships between land use, transportation, and green house gas emissions. In the past year, world temperatures have reached record highs, oil prices climbed to new peaks, and the market for clean energy technologies grew dramatically. These trends illustrate both the imperative to move beyond outdated patterns of energy use and the enormous opportunities awaiting enlightened innovators with the courage to pursue new approaches. Visionary leaders are finding exciting new ways to confront these challenges. Many companies and communities are cutting costs with energy-efficiency programs. Municipal leaders are promoting better-designed cities. Investors and entrepreneurs are racing toward alternative fuels and plug-in hybrid engines.

This year, the **Global Energy and Climate Change** symposium discussed specific steps for cutting emissions of heat-trapping gases and shaping a clean energy future. In broad outline, the path is clear: we need to use less energy and find cleaner sources. We need to break down barriers – including lack of information – that slow the adoption of clean energy technologies. We need sufficient funding to bring down costs for clean technologies and polices that promote their adoption. This conference provided an opportunity for such dialogue. It brought together policy-makers and experts in governments, international organizations, industry, research institutes, and municipalities from many countries. Participants explored perspectives on environmentally sustainable transportation; attempted to reconcile goals for transportation, environment, technology, energy, and development; contributed to the development of principles that will guide nations in implementing environmentally responsible transportation programs; and identified policies and measures that should be adopted to achieve sustainable transportation.

The proceedings that follow summarize the discussions that took place during the **Global Energy and Climate Change** symposium. Panelists discussed the nature of the problem, possible solutions and concrete steps that can make a difference. Each of the nine sessions is presented under a separate heading, beginning with synopses of the panelists' presentations and concluding with an account of the discussion period that ended the

session. This report is intended to serve as a reference for those who organized and attended the symposium, but is also available as a resource for anyone interested in these issues.

Symposium Proceedings

Sunday, October 22, 2006

Session I:

Energy and Climate Change: Implications For Public Policy

Catherine Showalter (Moderator), Director, UCLA Extension, Public Policy Program
David Menninger, Interim Dean, Continuing Education and UCLA Extension

The opening session laid the groundwork for the wide-ranging three-day symposium which discussed the links between local land use and transportation systems, and global weather systems and energy markets. **Catherine Showalter** and **David Menninger** welcomed the attendees to the 16th Annual Symposium, focusing on Global Energy and Climate Change—a current hot topic in research, policy, and the media. This year's topic brought in new individuals from outside California and from other countries, which contributed to lively discussions and an excellent learning opportunity. The following presentations set the stage for the rest of the symposium with an overview of current scientific evidence on climate change, the role of the transportation sector in energy consumption and atmospheric emissions, a framework for evaluating energy and climate change policies, and strategic political considerations in energy and environmental security.

Debates among scientists who study the effects of human activity on climates, and policymakers seeking both economic growth and environmental sustainability have intensified in recent months as fuel prices have climbed to unprecedented levels. How are fuel prices likely to fluctuate in the years to come? What effects will higher fuel prices have on travel and commerce? What effects do transportation systems have on global climate change? How might changes in climates affect both land development and transportation networks? What, if any, cleaner, cheaper fuels and propulsion technologies are on the horizon? And what are policymakers – local, state, national, and international – doing to cope with these issues in effective and affordable ways?

These and related questions will be answered by a wide variety of experts on these topics, expanding on what we know, what we need to learn, what others are doing, and what is not being done to address changes in global energy markets and climate patterns in the years to come.

Symposium Co-Organizers:
Catherine Showalter, UCLA Extension Public Policy Program
Brian Taylor, UCLA Institute of Transportation Studies

Symposium overview

Brian D. Taylor, Associate Professor and Vice Chair of Urban Planning, UCLA School of Public Affairs; Director, UCLA Institute of Transportation Studies

Taylor gave a thematic overview of the symposium and opened with the familiar saying of, "Think Globally, Act Locally." However Taylor took this saying one step further and challenged audience members to "think globally, act in a considered, consistent, and effective way locally." There are many challenges to this mindset because uncertain futures prompt many questions about current decision-making. And it is these challenges which prompted this symposium to bring together participants from disparate disciplines. Debates among scientists who study the effects of human activity on climates, and policymakers seeking both economic growth and environmental sustainability have intensified in recent months as fuel prices have climbed to unprecedented levels.

An uncertain future prompts many questions about current decision-making. What should transportation, land-use, and environmental analysts and policy-makers know about climate change? Some of the key questions motivating this symposium are:

1. What should transportation, land use, and environmental analysts and policy-makers know about research on global energy markets and climate change?
2. How are projected trends in energy prices and climate conditions likely to affect land use and transportation systems in the coming years?
3. How, in turn, are local, regional, and national transportation, land use, and environmental policies likely to affect (or not affect) global energy and climate changes in the years to come?
4. How are fuel prices likely to fluctuate in the years to come and what effects will higher fuel prices have on travel and commerce?
5. How might changes in climates affect both land development and transportation networks?
6. What, if any, cleaner, cooler, and cheaper fuels and propulsion technologies are on the horizon?
7. What are local, state, national, and international policy makers and analysts doing to cope with these issues in effective and affordable ways?

Our goal is to bring together a wide variety of experts on these topics to speak on and debate – from many perspectives – what we know, what we need to learn, what others are doing, and what is not being done to address changes in global energy markets and climate patterns in the years to come. It is difficult charting the best course into an uncertain future, but we all have a role in linking causes, effects, and public policy into making concrete changes.

This opening session laid the groundwork for the wide-ranging three day symposium. Four presentations will address current scientific evidence on climate change, the role of the transportation sector in energy consumption and atmospheric emissions, a framework for evaluating energy and climate change policies, and strategic political considerations in energy and environmental security.

Climate change science: What we know and don't know

Thomas C. Peterson, Research Meteorologist, NOAA's National Climatic Data Center

The science behind climate change is rapidly being acknowledged as the most important environmental issue of our time. **Peterson** presented fresh, relevant scientific data and provided context and perspective. His presentation started with defining the climate change issue and set forth powerful evidence that this bout of climate change is not merely part of natural cycles. The majority of scientists now agree that the earth's climate is warming, as indicated by a rise in the average surface temperature of the earth. Warming is thought to be the result of human-generated emissions, principally of carbon dioxide (CO2). Carbon dioxide, like the greenhouse gases methane (CH4) and nitrous oxide (N2O), allows solar radiation to pass through the atmosphere, but prevents surface radiation from escaping to outer space—effectively "trapping" it. This process leads to an overall increase in surface temperature because sunlight warms the surface and gets reemitted as Infrared.

So what is the problem? This natural process has been around for millions of years and is responsible for the earth to be inhabitable. The problem is that these processes are increasing. Humans are responsible for the dramatic increase in CO2. The observational evidence for positive climate change is circumstantial but extensive; direct measurement has established that atmospheric carbon dioxide levels have increased since the industrial revolution and the related surge in fossil fuel consumption. Global temperatures are up 0.7 - 1.4 degrees F over the past 100 years. Glaciers are retreating world wide. Sea level has risen 4 - 8 inches due to thermal expansion.

Peterson pointed out many common misconceptions about climate change. He began with the common misconception that solar variations are responsible for global warming. Satellite measurements (late 1970s) show no appreciable changes in total solar output at time of rapid global temperature increases. However, consistent with the warming is evidence of:

- Glacial retreat
- 10-15% reduction in Arctic sea ice extent (1970s)
- Snow-cover decrease (10% since 1970s)
- Freeze-free periods lengthened (20th century)
- Sea-level increased 4-8 inches (since 19th century)
- Lake and river ice shortened season (~ 2 weeks, 19th to 20th century)

Global warming does not change the variability we have in climate, but on average it is getting warmer, as documented by satellite data. Observed changes and predictions in weather patterns include heavy precipitation, tropical storms, and drought. Transportation is particularly sensitive to changes in extremes. Some impacts will be negative, such as increased potential for rail track buckling, and some impacts will be positive, such as the likely opening of the Northwest Passage. In all cases, planning that considers climate change will be important.

Transportation, energy, and emissions: An overview

George Eads, Vice President, CRI International

Eads began his presentation with an overview of the amount of energy consumed by the transport sector. Each of the four sectors of the U.S. economy — industrial, commercial, residential, and transportation — is responsible for a significant share of national emissions. All of these sectors are heavily reliant on energy derived from fossil fuels, which emit CO2. The United States produces one-quarter of the world's global green house gas (GHG) emissions. The transport sector is a very large user of energy and one of the largest emitters of CO2. In 2002, the transportation sector accounted for 26 percent of all energy consumed and was responsible for 21 percent of all CO2 emissions; this number is expected to rise to 29 percent for energy usage in 2030 and 23 percent for CO2 emissions. This makes American transportation a substantial factor in the global climate change equation and, as such, one of the primary targets of any comprehensive emissions reduction strategy.

Surface transportation includes cars, trucks, buses, trains, and ships, all of which rely predominately on fossil fuels. With growth in the economy overall, activity in the transportation sector has grown as well, resulting in a steady increase in the number of vehicle miles traveled in passenger and freight vehicles over the past two decades. Well over 90 percent of transport fuels are oil-based. Three transport modes account for about 80 percent of all transport energy use: air, freight trucks, and light duty vehicles (LDVs). The same three modes also account for about 80 percent of transport vehicle CO2 emissions. At present, the Organisation for Economic Co-operation and Development (OECD) countries are responsible for nearly 70 percent of transport energy use, but this will change as developing countries grow. The principal driver of transport energy and transport CO2 growth has been – and will continue to be - growth in the demand for personal and goods transport services. Personal transport demand is predicted to grow substantially in India, China and Latin America. The personal transport demand projections do not imply private motorized vehicle ownership rates typical of OECD countries; nor do they imply personal transport levels per capita that are equivalent to today's OECD country levels.

The projections of personal and freight transport activity for 2000-2050 show that personal and freight transport activity will both grow, with expansion being especially rapid in certain parts of the developing world. However, these projections also demonstrate that the growth will not be adequate to provide the average citizen of some of the poorest developing nations and regions with mobility opportunities that are in any sense comparable to those experienced today by the average citizen in the developed world. This disparity is referred to as the "mobility opportunity divide." **Eads** believes that this mobility opportunity divide must be narrowed. This statement does not imply that the average African should travel as many kilometers each year as the average American or European. The mobility opportunity divide will cease to exist when people everywhere have comparable opportunities to "move freely, gain access, communicate, trade, and establish relationships."

Eads provides a rough sense of the present magnitude of the mobility opportunity divide and how it may evolve if present trends continue. By 2050, Eastern Europe and the

Former Soviet Union will have closed the gap with OECD Europe and OECD Asia in terms of personal mobility opportunities. Latin America will show a significant narrowing of its gap. But per capita travel by the average inhabitant of Other Asia, India and the Middle East will remain at about 20 percent of the OECD Europe/OECD Asia level. Annual travel by the average African in 2000 was only 13 percent of the annual travel of the average inhabitant of OECD Europe/OECD Asia, and this number is expected to decline by 2050 to 8 percent. In other words, for the average inhabitant of Africa and the Middle East, the mobility opportunity divide is projected to widen. These growth rates also imply growth for future income levels.

To obtain a sense of the potential impact of various technologies and fuels in reducing transport-related GHG emissions, **Eads** showed a number of simulations. He began by examining the impact of single technologies on worldwide road transport CO2 emissions. Such technologies included – dieselization, hybridization, fuel cells, "carbon neutral" hydrogen, and biofuels. This exercise was intended to help understand the impact on GHG emissions from road vehicles if such technologies were implemented.

From this single technology assessment it is evident that even if implemented worldwide, diesels and hybrid ICEs fueled with conventional gasoline and diesel fuel, or fuel cells fueled by with natural gas-derived hydrogen, can no more than slow the growth in road transport CO2 emissions during the period 2000-2050. Only the use of carbon-neutral hydrogen in fuel cells and advanced befouls in ICE-powered vehicles can largely or totally offset the growth in CO2 emissions produced by the growth in road travel during the period 2000-2050.

This does not mean that vehicle energy use characteristics are irrelevant. They may not have a major impact on the trajectory of road vehicle GHG emissions over the very long term, but they *will* have a major impact on the amount of low-carbon or carbon-neutral fuel that must be produced to power the world's road vehicle fleet. This means that they can have a very important impact on the *cost* of significantly reducing GHG emissions from road vehicles. Based upon these results, **Eads** concludes that it will only be through a combination of fuel and powertrain solutions that significant CO2 reduction will be attained. No single technology pathway stands out enough to compel its selection as the sole long-run solution.

Eads concludes with four observations:

1. Growth in demand for transport services (personal and freight) has been the primary driver of transport energy demand and transport-related GHG emissions. Demand for transport services will continue to grow as incomes grow. The rate of growth of demand for transport services is not immutable, but shouldn't underestimate difficulty of change.
2. Eventually, transport must be largely eliminated as a significant source of GHG emissions. To do this, transport GHG emissions must be decoupled from transport energy use; requires renewables and/or carbon sequestration of emissions from production of synthetic fuels.
3. Transport energy use is likely to grow more rapidly than demand for transport services due to the increased energy requirements of producing carbon-free transport fuels.

4. In the very long run, transport vehicle energy efficiency is likely to become virtually irrelevant to transport GHG emissions; it will only determine the amount of carbon-free transport fuel that must be produced.

Evaluating the costs and benefits of energy and climate change policies: An overview

Joe Aldy, Fellow, Resources for the Future

Environmental protection and economic progress are critical to California's thriving future. The purpose of this panel is to discuss how to create market-based solutions that are equitable and effective in reaching aggressive climate change emission targets. The relationship between economic development and energy consumption is important in the context of a number of pressing policy issues. The increasing demand for energy as economies develop can influence when the world's oil production may peak. Growing energy consumption also poses a variety of public health and environmental risks that can spur government and market actions to modify the fuel mix and adopt new emissions control technologies. As economic growth encourages greater fossil fuel combustion, the increase in carbon dioxide (CO2) emissions can exacerbate the risks of global climate change.

Aldy discussed the costs and benefits of energy and climate change policies. A benefit-cost analysis provides a framework for evaluating policies to address climate change. In order to balance the benefits and costs of mitigating climate change risks, it is necessary to analyze the incremental benefit of mitigating the last ton of greenhouse gas (GHG) emissions. This effort should equal the incremental cost of that mitigation. It is important to recognize that some additional climate change will occur in the future. **Aldy** then introduced the concepts of a spatial scale and temporal scale. When looking at the problem spatially, a ton of GHG emitted in Boston has the same climatic impact as a ton of GHG emitted in Beijing. This is an example of a global public good—benefits of mitigating emissions are global but costs of mitigation are local. When looking at the problem temporally, GHG emissions today could remain in the atmosphere for hundreds to tens of thousands of years. Mitigating emissions today delivers benefits well into the future but imposes costs on the present. Most benefits of mitigating GHG emissions occur in the distant future. This makes policy changes especially difficult when forecasting for the next 100 years. Problems 100 years ago were very different from the problems we have today. Hence, there are many challenges in monetizing impacts identified by natural scientists and it is difficult to forecast out into the future.

The distribution of impacts will be felt mostly in the developing countries, with the biggest temperature and weather changes. Distributional impacts may present challenges in Africa, Latin America and small islands, which have the least capacity to adapt to climatic changes. The rapid rate of change in developing countries is occurring without enough time for adaptation, whereas more developed countries have a higher capacity to adapt to climate change. This uncertainty commands action now.

Aldy then discussed the determinants of costs and went over several different scenarios, including: business-as-usual emissions; substitution to carbon-lean fuels; improving the efficiency of energy consumption; technological change; and designing the optimal

policy portfolio. With business as usual forecasts, carbon emissions continue increasing to 2030. **Aldy** then examined a substitution to carbon-lean fuels. The costs will be lower the easier it is to switch to low-carbon energy, such as changing electricity production from coal and gas to renewables and nuclear. For the transportation sector, there are few substitutes for petroleum. Improving the efficiency of energy consumption can be reflected in prices and information. Consumers care about more just energy expenditures associated with products they buy. Technological change also holds great potential for research and development (R&D) in the future. Promoting technological development can help to ensure that zero-carbon technologies are feasible and cost-competitive in future.

Aldy's conclusion called for the need for well-designed, cost-effective policies, which can send price signals that spur technology diffusion and development and lower emissions. It is important to understand the cost of mitigation to design the next track of policies.

Global Politics of Energy and Environmental Security: An Assessment

Jason Grumet, Executive Director, National Comission on Energy Policy

Each of the major fossil fuels - oil, natural gas, and coal - faces significant challenges and presents interesting opportunities. World energy markets experienced turmoil in the past year. With global demand growing sharply and fears of instability among key suppliers, oil prices soared. The deepest impact was felt in poor countries. Energy prices and the physical security of energy supplies were top priorities for political leaders in many countries.

The U.S. is the top world oil consumer and accounts for 25 percent of global consumption. Saudi Arabia and Russia are the top world oil producers. The U.S. is the third largest producer, but only has 3 percent of world's proved reserves. Ninety seven percent of U.S. transportation is petroleum dependent. From an economic standpoint, it has nothing to do with where the oil comes from, but it has to do with how much oil we use. In order to improve oil security, three steps are necessary: 1) improve the reliability and resiliency of the global oil supply chain; 2) dramatically improve transportation efficiency (fuel economy); and 3) diversify transportation fuels.

Grumet emphasized that it is important to look at the supply side quotient. He stated that a barrel of oil produced is not the same as a barrel of oil saved. A barrel saved is worth about four times as a barrel produced. We have to think in terms of the global market. It is necessary to hold oil consumption constant while our economy grows in order to make ourselves more resilient to oil price shocks. In order to achieve these successes, it is necessary to displace 8 thousand barrels per day (MBD) of oil by 2030. Improved efficiency by 2025 must be placed on heavy-duty trucks, passenger vehicles and delivery trucks. It is necessary for the fuel economy to improve by four percent a year.

Alternatives to conventional oil include hydrogen, unconventional oil, coal to liquids, traditional ethanol, and cellulosic befouls. These alternative fuels are ways to substantially increase our fuel economy through the diversification of our fuel supply. In

terms of Climate Change, **Grumet** believes technology is the answer. The question is who pays to accelerate technology development and deployment. It is necessary to combine a long-term market signal and technology incentives.

Discussion

Lee Schipper began the discussion with what he cautioned to be a sensitive and political question. He asked if there are any prominent scientists left who do not believe that the warming is anthropogenic? **Peterson** answered yes, there are a number of people who still disagree, but they're not working in this field. They've got a history like John Christie who was a missionary in Africa during the oil embargo. However, **Peterson** was not concerned with this small group of people. There are very few scientists who say it's not anthropomorphic and the people who do are a small minority and aren't working in this field.

Michal Moore noted that MCAR had a model which predicted the jet stream shifting off to the east as a result of global warming. His question was about the modeling used to make these long-term predictions. Were they similar to MCAR and did they look at long-term shifts where rainfall is being dumped? What about temperature regime changes? **Peterson** answered that changes in weather patterns will affect wave patterns – but since he is not a modeler, this is not his area of expertise and he is not familiar with that particular study. He noted there was increased precipitation seen in Alaska in most models, but other models showed great variation in all other areas of the USA.

The next question was regarding recent TV specials on this issue of global dimming. Global dimming is when the particulate matter in the air (from air pollution) actually reflects sunlight. It is hypothesized that global dimming could be viewed as a mitigating factor to global warming, and if particulate matter is reduced, it will accelerate global warming. **Peterson** addressed this question by stating that he is not an expert on global dimming. He is not sure what affect this will have on global warming predictions.

Axel Friedrich disagreed with some of the points in the second presentation. He stated that it was virtually impossible to have these technologies in 30 years. Therefore, efficiency is necessary, even if you get the carbon out of the fuel. Efficiency has to be the number one priority.

Norm King asked a clarification question to **Eads**. He didn't understand what was meant by it taking about ½ gallon of oil to produce corn, which uses a lot of fertilizers and pesticides. Have you taken into account these additives and their environmental effects? **Eads** responded that there is a lot of argument over the oil displacement effect of biofuels. All of these synthetic fuels take energy to make. However, it is energy of a different sort. They use more energy, but essentially you're still displacing oil.

Steve Brye asked about a simulation that showed the effects of changing different types of fuels. His question was what if people drove less? Wouldn't that be another option and how come it is not presented in the slide? **Eads** answered yes, it would change things. However, the simulation was just meant to show what would happen if we changed the propulsion. It is also important to work on the demand for transport side. The answer lies in a combination of technologies, fuels and demand management.

Dave Souten brought up a question regarding energy efficiency over the past 20 years. He noted that it has been getting better and then flattening out – what are the causes? **Eads** responded that there are two primary causes: increased fuel economy and pushing oil out of power generation. He says that is it necessary that we focus on transportation and fuel economy. We would have to roughly double our fuel economy to have the same effect that we had 20 years ago.

Roland Hwang asked a question about energy security in the next two years in Congress. He stated that there have been a lot of predictions and climate will be a real driver for the energy debates in 2008, especially since oil prices have gone down. **Hwang** asked **Eads** what he sees as the interplay with energy policy and climate change. **Eads** responded that this was a very insightful question. Oil is dominated by national security concerns. Substantively, we need to keep energy policy and climate change totally together. However, politically, we keep them totally apart. The political issue is more potent than the climate change approach. Environmental concerns are important, but security is huge. So we might build a coalition on oil separately than on climate change. Because of this separation, different people line up for both of those causes. Oil intensive industries and the military care a lot about oil security but so does Dominoes Pizza for delivery; they want increased efficiency as well. This brings more people into the debate so they might be one coalition.

The Honorable Christopher Cabaldon raised a question about the relationship between the well to wheel and the power of fuel economy versus land use and transportation strategies that reduce the travel demand. The Clean Air Act brought about changes in land use through smart growth which lowered travel demand. This demonstrates the relative power of fuel economy and land use decisions. But if efficiency is better, then these relationships are undermined. Travel demand and land use might be more powerful tools than just focusing on fuel economy. Cabaldon asked, what is the likely power of the efficiency standards versus land use and transportation strategies? **Eads** answered this question by thinking about the actual impact. Land use does matter, but it is a slower driver to fuel economy. Land use changes take between 50-70 years. Fuel economy is faster. However, it is not either or, both have to come into play. Long-term and short-term strategies are both necessary and you can't rely on either entirely.

Tom Kelly asked a question regarding the benefits from climate change. He argued that climate change is not going to be a good thing for anyone. **Aldy** addressed these concerns by stating that low levels of climate change will provide economic benefit to colder regions.

Axel Friedrich stated that oftentimes there is an overestimation of the mitigation costs and an underestimation of the benefits. He brings up the example of Bangladesh. A lot of people live at sea level in this country, so migration will be a huge issue with sea level rise. This will be a huge cost, but it is underestimated. Why? **Aldy** responds that there are many reasons. First, economists don't underestimate or overestimate. Economists don't always know how to monetize things. We throw out things we can't monetize. CBA has started to pay attention to non-monetized costs and benefits. Traditional command and control is a wash – some are more expensive than originally thought and some are less expensive than originally thought. Market-based programs are more flexible. Allowing for more flexibility through the market makes it more efficient. It is more universal to

look at market-based approaches these days.

Session II:

Links Between Global Climate Change and Land Use / Transportation

Brian D. Taylor (Moderator), Associate Professor and Vice Chair of Urban Planning, UCLA School of Public Affairs; Director, UCLA Institute of Transportation Studies

This second session explored the transportation – land use connection to global climate change. The first presentation examined how possible changes to weather patterns and sea levels may affect cities and the transportation networks that link them in the coming years. The second talk addressed whether and how land use and transportation policies may help to mitigate rates of climate change in the years and decades ahead.

Projected effects of global climate change on land development and transportation infrastructure

Joanne Potter, Senior Associate, Cambridge Systematics

This presentation examined the effects of long-term climate change on development patterns and infrastructure investment. **Potter** pointed out that transportation infrastructure has a long lifespan, and that the development and use of this infrastructure may need to be modified in order to cope with climate change issues. In order to do this, climate change will need to be added explicitly to the decision-making process. However, **Potter** pointed out, there is not enough research available at present to guide the inclusion of climate change in the decision-making process. Decision-makers may therefore draw upon experience with other extreme situations, such as cold-weather research. Most of the literature has traditionally focused on the impacts of transportation on global climate change, not the other way around.

Potter noted that the Transportation Research Board (TRB) and DELS have begun a look at new transportation design standards for an uncertain climate future. In addition to design standards, the project is developing operational strategies for uncertain climate conditions. The research draws on lessons from other major areas of uncertainty, such as earthquake planning.

The United States Department of Transportation (US DOT) and the United States Geological Survey (USGS) cooperated on a study of the impacts of global climate change on the Gulf Coast. The study was conducted prior to the 2005 Gulf Coast disaster of Hurricanes Katrina and Rita. The Gulf Coast was selected because it is nationally significant, with its ports accounting for 60% of national energy imports. Furthermore, the region is home to an extensive intermodal network, with highways and railroads connecting significant port facilities, airports, and major population centers.

The Gulf Coast study assessed the vulnerability of this intermodal network to disruption caused by global warming. In particular, the study examined the effects of sea level rise and increasingly frequent extreme weather situations. Its goals were to identify

significant risks, develop a risk assessment methodology, and identify strategies for adapting infrastructure to an uncertain climate future.

Potter pointed out that increased storm surge necessitates heartier design standards and increased maintenance of facilities. Furthermore, changes in precipitation patterns could affect drainage and storm water retention, requiring further engineering solutions to maintain the usefulness of transportation facilities during storms. Sea level rise poses another major threat; a rise of four feet would submerge many of the regions' major population centers.

Strategies that the USDOT / USGS study suggests include: increased maintenance of facilities and improved response time in emergency maintenance; structural reinforcement of existing facilities; increased system redundancy to provide transportation alternatives in the event of an emergency; and the relocation of facilities that appear to face ongoing high levels of risk. In sum, the planning, maintenance, and use of transportation systems will have to "embrace uncertainty", acknowledging the possibility of climate change impacts and preparing for a multitude of possible future scenarios.

Climate Change and Transportation and Land Use Planning

John Poorman, Director, Capital District Transportation Committee

Poorman began by pointing out that his perspective on global climate change is likely quite different from that of most audience members. As the director of a Metropolitan Planning Organization (MPO) in the Albany, New York region, **Poorman**'s expertise lies in the area of transportation and land use planning, while he pointed out that his knowledge of the science of climate change is somewhat limited. Thus, his presentation focused on the question, "can transportation and land use planning mitigate the rate of global climate change?"

Poorman focused on those changes that can be made at the regional (or MPO) level to "make a dent" in the rate of global climate change. For transportation and land use planners to approach this topic effectively, they must be both holistic (willing to consider all options) and honest (willing to discuss frankly what, for example, transit can and cannot do). Honesty involves respecting the laws of physics, economics, politics, and household behavior; the future will not be radically different in these regards, and planners should not assume otherwise. However, while these laws and behaviors will not change, the availability and cost of choices that are common today will become scarcer and more expensive in the future.

Poorman pointed out that radical changes in Americans' lives are not viable options, as the *possible* isn't always *probable.* For example, while road pricing has been possible, and even advocated by transportation planners for decades, it remains politically improbable in the United States. **Poorman**, paraphrasing Alan Altschuler, reminded the audience that public policy exists to accomplish a finite goal while disrupting as little as possible; radical impacts on citizens' lives are not tolerated in the absence of an obvious and grave crisis. Furthermore, Americans prefer to look to technology as a solution to crises.

However, **Poorman** pointed out that technological change almost always comes unexpectedly and has unintended consequences. For example, it would be unwise to assume that a technological improvement that reduced gasoline consumption by 50% would actually lead to a net halving of gasoline consumption. One may assume that, ceteris paribus, drivers would respond to the lower cost of fueling a vehicle by driving more.

Poorman pointed out that household travel behavior is remarkably consistent though the public policy choices that serve as inputs to travel behavior choices can vary greatly. One example of this is the difference in travel behavior between Rotterdam and Amsterdam, two cities in the Netherlands. Both cities are very similar in tax policy, transit provision, and other conditions, but differ in other significant ways, such as urban form. As a result, travel patterns are quite different in both cities. Citizens of Rotterdam do not respond differently to stimuli than do citizens of Amsterdam; the offered stimuli are simply different.

Poorman then presented his perspective ways to mitigate global climate change. He stressed that market forces can not reduce the rate of global climate change. Macro-level policy decisions and local planning choices *can* help reduce the rate of climate change, though they may not necessarily do so. Macro-level policy decisions have the greatest power to reduce climate change, while local planning decisions (such as pedestrian-oriented land use patterns) will likely have minimal impacts on climate change. While these changes will likely only have small impacts on greenhouse gas emissions, this does not mean that making these local changes is not worthwhile.

Discussion

Lee Schipper stated that, if Los Angeles were denser, its residents would travel less. He asked the panel and audience for estimates of the impacts of density and transit-oriented development (TOD) on travel behavior and housing costs. **Schipper** stated he was aware of Todd Littman's estimates, but would like to hear others.

Poorman responded that there are many such studies, and that they indicate that land use planning and growth regulations could have a sizeable impact on travel demand. However, he questioned the political will to impose such changes. It seems that there is little consensus on the purpose of increasing density. In some communities, such as Albany, density and TOD is seen as a quality of life issue, while in others it is primarily an environmental concern. Finally, even if travel behavior were to change, its impacts on climate change would likely be small; one should keep this in mind and not "promise too much."

Roland Hwang asked **Poorman** what he meant by "macro-level" policies having the most potential to reduce climate change. What, for example, would be feasible in the coming five years?

Poorman pointed out that a great deal of sprawl is caused by uneven property tax levels in a metropolitan area. If regions were to "level the playing field" by removing inherent tax disincentives in the central city, suburbanization would likely decrease. He

commented that the regulatory environment has greater impacts on climate change than do either land use or transportation planning.

Michal Moore believed there to be a discontinuity in **Potter's** remarks. He pointed out that local governments are driven by self-propagation and tax-revenues, while the scientific community is driven by stochastic models of likely outcomes. Local governments are making the decisions, and therefore will likely ignore much of what is known about global climate change.

Potter responded that local governments are largely reactive, and are driven by the market. If consumers are more aware of what's at risk and what can be done about climate change, local governments will react in a rational manner. However, the public opinion must be guided by honesty; for example, rail advocates should not claim that light rail will reduce congestion when there is no evidence this will happen.

Donald Shoup commented that **Poorman's** framing of the climate change issue was very appropriate. The question should indeed be how to *mitigate* climate change. From a policy analysis perspective, this can be reframed as "does the policy accelerate climate change?" **Shoup** believes that minimum parking requirements and low-density zoning do indeed accelerate climate change.

Steve Brye commented that TOD does not have to be a long-term strategy. Retrofitting of existing neighborhoods could lead to more sustainable travel patterns.

Poorman replied that the retrofitting of neighborhoods is a priority in the Albany region. Initially, commuter rail was seen as the number one priority in Albany for more sustainable travel patterns, but today the focus is more on increasing the density of close-in, already transit-supportive neighborhoods. The region is not "chasing development" in the suburbs; instead, it is focusing its attention on existing, transit-supportive areas.

Nathan Landau commented that blaming sprawl for today's climate change is problematic. Decentralization was a response to real needs for better housing, and is a product of both market forces and policy choices.

Session III:

The Business of Uncertain Energy and Climate Futures: A Roundtable Discussion

Norm King (Moderator), Director, Leonard University Transportation Center, CSUSB

To complement the focus on science, data, and public policy evaluation in the two opening sessions, this evening panel explores private-sector perspectives. How will future changes in energy prices, climatic patterns, and policies that aim to address energy and climate changes, affect business? The discussion focuses on measures that particularly relate to land development, shipping and travel. Some of the major questions this discussion will attempt to answer are: Can we simultaneously increase global security and reduce global warming? How do we value ecosystems? Can a ton of carbon be given value? Is it important to determine what is necessary for the US to take a leadership role?

Finally, at what point is the investment greater than reducing the risks?

Petroleum Interests

Randy Armstrong, Manager Compliance Assurance, Shell Oil

Armstrong shared his experiences and thoughts on Shell Oil Company and climate change. He began his presentation by stating that there has been a 50 percent increase in energy demand in the world. Thus it is necessary that supply must increase to meet the demand. The population is expected to rise to 9 billion by 2050, mainly in poorest and developing countries. Shifting the development profile to a "low poverty" world means energy needs double by 2050. Shifting the development profile further to a "developed" world means energy needs triple by 2050. The amount of energy available far exceeds any imaginable demand. Some of the proposed solutions are to increase the real costs of energy. Solutions to the "Energy Challenge" must be acceptable to society. Shell is reinvesting in new energy through exploration, liquefied natural gas (LNG), heavy hydrocarbon production, efficiency improvements, gas to liquids, wind, solar, hydrogen, clean coal, and sequestration. People often ask about nuclear power, but there is a big problem over what to do with the waste. When dealing with transportation, it is important to make more efficient vehicles, low or zero emitting fuels, and develop an array of personal choices for consumers. Such choices, which Shell is supporting, include: gasoline, diesel, natural gas, liquefied petroleum gas (LPG), ethanol (corn/sugar, cellulose), biodiesel, and hydrogen. Policies which best support the activities required to meet the "Energy Challenge" include: R&D support, voluntary reduction efforts, tax policy, education, and adaptation support.

Development Interests

Dan Cashdan, Senior Managing Director, HFF Securities

Cashdan presents the real estate's industry's view regarding climate change. He begins by presenting three sets of players: developer owners, investors (who are motivated to make profits), and tenants of space users. There is concern about climate change developing in all three of these sectors. The largest real estate developers have all assigned staff to study energy issues. The biggest tenant, the government, is paying more attention to energy use and efficiency. Investors are the farthest behind in the curve. **Cashdan** asks the audience to think about if this is a relevant topic for the real estate industry? He thinks it is. The U.S. Green Building Council (USGBC) is one example of the real estate market rising to address issues of climate change. Green building can help address pressing environmental problems in the urban environment. A green home uses less energy, water and virgin materials, while construction waste and the presence of toxic products are minimized or eliminated. The components of green building include site development, materials, water conservation, energy efficiency and health. Sustainable development has had a large impact on the building design and construction field in the last decade. The Urban Land Institute (ULI) also developed a sustainability council, offering city planners the opportunity to interface with developers on issues of sustainability and green building.

The environmental and health benefits sited by the U.S. Green Building Council in the development of the Leadership in Energy & Environmental Design (LEED) sustainable building rating system include tangible improvements to the status quo of building. Such improvements enhance and protect ecosystems and biodiversity, improve air and water quality, reduce solid waste, and conserve natural resources. LEED is a national standard for what constitutes a "green" building. Within this broad spectrum, green building design strives to balance environmental responsibility, resource efficiency, occupant comfort and well-being, and community sensitivity. Wal-Mart has made enormous strides on this topic by the greening of Wal-Mart Stores. They are making great strides to reduce energy consumption. Wal-Mart expects to be a major player in the carbon credit business. These examples illustrate the important role real estate plays in addressing issues of climate change.

General Business Interests

Gerald Secundy, Vice Chair, State Water Resources Control Board

Secundy spoke of his role with the water board and specifically brought up questions of who owns what water and what can they do with it. He asked the audience to think about what water has to do with energy and climate change. Secundy stated that the second largest consumption of energy is water. It uses somewhere between 15-20 percent of all electric energy in the U.S. Forty percent of the water in Los Angeles comes from ground water and 40 percent comes from up north and has to be pumped over the mountains. This is related to climate change because when the sea level will rise, more saline water will enter the delta. We have two choices to address this problem: 1) either put in barriers or 2) treat the saline water. Sea water intrusion comes in along the coast and is a consequence of global climate change. Other predicted changes will affect the snow pack. We will loose our natural storage of water in the form of snow, and more water will fall as rain. Snow pack is basically a natural reservoir. If we don't have this natural reservoir, we will have to build one to store more water. We are going to be growing as a state and as a country, with 80 percent of the growth in California from people already here.

We need to accommodate this growth, but we cannot continue to pave over paradise. Permeable surfaces are one way that we can naturally recharge our water basins. Low-Impact Development (LID) is a new way of thinking about stormwater management and is an effective strategy for controlling contaminated urban runoff. LID uses techniques that reduce the impact of development through the use of systems that retain, detain, filter, treat, use, and reduce storm water runoff. The primary goals of LID design are to reduce runoff volume through infiltration, retention, and evaporation, and to find beneficial uses for water rather than exporting it as a waste product down storm sewers. LID practices can be applied to all elements of the urban environment, turning parking lot islands, street medians, planter boxes, and landscaped areas near buildings into specialized storm water treatment systems. Retention basins, used to collect runoff from areas of redevelopment or new construction sites, are already required in many cities. Innovative designs for urban areas may include roof gardens, methods for capturing and using rainwater, and use of permeable pavement in low-traffic areas, parking areas, and walking paths. It is necessary to change our culture in the way we construct and build things. Not everything has to be concrete. We have a love affair for rolling green lawns,

but maybe Southern California is not the best place for this. We need to start building sustainable communities in order to assure our future water supply.

Goods Movement

T.L. Garrett, Vice President, Pacific Merchant Shipping Association

Garrett spoke of ways to reduce the amount of energy used in "goods movement" — the ship, rail and truck traffic associated with transporting goods to the port and throughout the state. The ports of Los Angeles and Long Beach aim to reduce air pollution by upgrading the vehicles that use the nation's busiest harbor complex by land and sea. The ports are responsible for 40 percent of the cargo that comes into the US. Hence, goods movement is an integral part of our everyday life. The industry continues to get more efficient and more effective. When taking economies of scale into consideration, ships are extremely energy efficient and produce low amounts of GHG emissions. However, this industry can still be improved. One way to improve the industry is to require the owners and operators of cargo-handling equipment such as cranes and forklifts to use only the cleanest-burning equipment on the market. **Garrett** expects that rule to achieve a significant reduction in smog-forming nitrogen and airborne particulates will drop by 75 percent simply by policing incoming ships. According to the South Coast Air Quality Management District, air pollution related to goods movement causes 750 premature deaths in California every year, with diesel particulate as the prime culprit. Another strategy is the vessel speed reduction program. It takes a lot of energy to push a ship through the ocean, so by slowing down the speed, operators will be able to save energy and a lot of money. As ships have gotten bigger, they have traded those efficiencies for speed. **Garrett** concluded that they would prefer international standards and regulations as a way to reduce energy and emissions. He called such incentives a proven, effective way of encouraging corporations to become early adopters of improved anti-pollution technology without suffering a competitive disadvantage. "Market-based incentives are very viable," **Garrett** said. "They are an elegant and brilliant approach to making positive changes."

Goods Movement

Eugene Pentimonti, Senior Vice President, Government Relations, Maersk Line Limited

Efficient goods movement is more important than ever to America's economic prosperity. The statistics back it up: the U.S. transportation infrastructure makes it possible to move $6 trillion worth of freight each year. Goods movement accounts for an increasingly larger slice of the economic pie. Transportation services are now responsible for roughly 11 percent of the gross domestic product, with Wal-Mart being one of their biggest customers. There are currently over 13 million people who work directly or indirectly in the field. Crowded interstates, highways and ports that are stretched to the limit have become commonplace and threaten to curtail the efficiency that consumers and businesses have come to rely upon. And rising fuel prices have made energy costs the fastest growing component of the industry and have heightened awareness of the need to conserve energy. Congestion and capacity problems are producing negative environmental consequences, with air and noise pollution and other quality-of-life impacts affecting people that live near ports, rail yards, and along high-traffic corridors.

As the system's infrastructure and environmental problems mount, so too do the costs – in dollars and public health impacts. It is necessary to reduce the amount of fuel it takes to operate a container from one point to the next. Some strategies are to operate with ultra low sulfur diesel, but it would take millions of dollars to modify the vessels. Performance indicators are another strategy to reduce emissions and the amount of fuel needed to move a container across the ocean.

International Business Interests

Nancy Kete, Director, EMBARQ World Resources Institute

Kete began her talk with a focus on cities and a slideshow presentation of the Sustainable Transportation work done by EMBARQ. Cities are the focal point and drivers of societal development in all countries. They are also the largest consumers of natural resources and by far are the biggest sources of pollution and greenhouse gases on the planet. **Kete** believes that cities will define the 21st century because more people live in cities than in the countryside. Today it is a challenge to name half of the 300 cities in the world with populations over 1 million. Nearly 3 billion people – or every other person on earth – live in a city. By 2015, there will be 3.9 billion people living in cities.

Kete then addressed issues of urban mobility. She stated that it is much easier to be energy efficient if you can concentrate people in a dense setting. The quality of life is better in cities than in the romanticized version of the countryside. However, issues of transportation get worse with increasing wealth. As a city or country gets richer, there is no reason to believe that problems will fix themselves. She used China as an example to illustrate the complexities between urban transportation and increasing wealth. While clean fuels and clean engines will help, what about congestion, long commutes and the dangerous mix of trucks, buses, cars, bicycles and pedestrians that share city roads in China? How does a business model built on selling ever more cars contribute to sustainable cities? Can car companies go a step further and really think about the best way to meet shareholder expectations of profits while serving the mobility needs of the people of China and helping her cities achieve a sustainable future? Transportation decisions are inherently political and controversial.

EMBARQ's most recent success was the launch of a new Metrobus system in Mexico City this summer. The new mass transit system consists of 80 low-pollution buses carrying 250,000 passengers per day. These now replace 350 high-polluting and dangerous buses previously run by 262 chaotic, unregulated operators. The new bus system is designed to improve the quality of life of the city's citizens by reducing pollution, congestion and commute time. A similar partnership between *EMBARQ* and the city of Porto Alegre, Brazil, was signed earlier this year and is now being recognized by the Clinton Global Initiative for its commitment to address climate change and urban poverty.

Kete concluded that fixing transport systems requires new models. Through the formation of public-private partnerships, EMBARQ has turned the attention of the private sector towards the needs of cities, their citizens, and their environment. EMBARQ has also proven that the design and implementation of sustainable urban transport models in

the developing world can translate into economic opportunities for the forward-thinking business.

Discussion

Dean Taylor began the discussion with what he thinks to be a serious problem in this industry—there is not a common metrics to analyze these problems. **Kete** responded by stating that setting a common index will complicate some of the solutions. It is important to analyze the various benefits separately – to put all of this into a single index would really obscure the various successes. Setting a common index would complicate the various solutions that may exist.

Lee Schipper had a question regarding the real estate interests. He asked if there was a greater movement towards infill development. Over the years we've had a decentralization of goods and services, such as bigger car washes, bigger markets, bigger stores in the suburbs. Do you think that these big scale services will change and move back to smaller walkable shopping centers? Such strategies will reduce travel kilometers. What we thought was cheaper was further away, but now we are discovering the true costs associated with travel. Does the real estate industry see that? **Cashdan** answered that the real estate industry spends a lot of time thinking about these issues. But there is no real answer about how it will play out. The industry is seeing a return to the urban core. Four hundred million new people are expected in the next 20 years, so there will be development everywhere. The real estate industry has been talking for the past 20-25 years about a return to the urban core. It has taken a long time to get going, but all major cities and secondary cities are returning to the urban core. The population growth means we'll continue to see development at the fringe, but at higher densities.

Axel Friedrich asked several questions regarding demand and responding to demand. He stated that about 20-30% of NOx comes from ships, which has a high impact on climate. Do we need to keep shipping goods or can we think about changing behavior and not shipping goods? **Garrett** responded that the NOx emissions from ships are actually about only 4%, not 20-30%. The fundamental question is what are you willing to give up? What are you going to sacrifice in your lifestyle? There's no cleaner way to move goods than ships. The consumer decides the volume of goods they want to consume. Market forces are at work.

Huasha Liu asked if there were any cleaner ways to move goods by ship. **Garrett** responded that the industry is looking for cleaner ways and it is a constant evolving process. There's no cleaner way for the current price charged.

Margaret Bruce had a comment regarding energy efficiency. One way is to individually meter occupancy tenant spaces. If you measure something you are more likely to manage it. She stated that small organizations need to be more involved in energy efficiency. **Cashdan** responded to her comment and said it is true that individual tenants don't have a reward for doing better and this is a big problem. Interaction between tenants and utilities is very difficult. Utilities resist anything that reduces consumption. And they don't want to have to change the metering. However, rewarding better behavior is the goal to strive towards.

Roland Hwang asked a question regarding climate stabilization. He stated that Armstrong's presentation gave us a clear impression of where the oil industry is going. There is a lot of pressure on Shell to look at unconventional sources like shale. But for climate stabilization, we need to make 60-80% reductions by 2050. Hwang's concern is that the direction the oil industry is looking is more carbon intensive. Shell is eager to do the oil shale. These are huge generational investments and huge sunk costs. **Armstrong** responded to these comments. He stated that the observation that conventional fuels are running out is correct. Shell will be looking at heavier hydrocarbon fuels and carbon sequestration to deal with this. Shell is working on a process that would recover oil from oilshale in place. This takes the development of technology that we don't use at this present time.

Tom Peterson commented that ships are very efficient, but what are the numbers? He asked **Armstrong** to give the audience something that we can understand. How much energy does it really take to move something across the ocean? **Armstrong** responded that it takes about 2/10 a gallon per mile per ton. This is 500 times more efficient than an airplane. Trains are about 4 times better than a truck, and a ship is about 60 times better than that.

Steve Brye commented that it's common for seminars like this to report back to the national academies. His question was regarding the shipping industry. Other than making better engines, is there anything you can do with wind in order to lessen the impact of the goods movement? **Pentimonti** answered that certainly there are more efficient ways of moving things across the ocean. However, the answer lies in finding more efficient ways of getting power to ships, such as nuclear power. Huge sails would probably make the ships less efficient, but it would be an interesting study.

Mike Savonis asked a question about business interests and their concerns with climate change. He says that we can't trust voluntary intervention, so how should government intervention be structured? **Pentimonti** answered that the industry needs to stand up and volunteer, but the government has to set the parameters. It is important to allow for flexibility to find cost effective methods. Let the industry decide how best to reach their targets. However, there has to be rewards along the way, not just an incentive for zero emissions. **Cashdan** added that this was a great question. It's important to think about the function of the government. In the next 2 years how should we use tax dollars in this country? We can make the choice to get off coal in a decade if we decide to really go after that. We can make the choice and the investment. It's a purchase decision.

Norm King closed the session by saying that while he does not disagree that taxpayer money is important, he believes it's a fee issue of what the consumer should pay. One of the facts in society is that we're increasing the number of externalities that we are not accountable for in our cost structure. We have to gradually begin to fold those externalities back into the price. It's accepting personal responsibility for the cost you are imposing on others. Business doesn't reject that, they just want clarity and goals.

Session IV:

Global Energy: Reserves, Usage, and Prospects

Donald Shoup (Moderator), Professor, Urban Planning, UCLA School of Public Affairs

Rising energy prices, particularly for transportation, have garnered a lot of attention in recent years. Are these changes part of normal cycles and fluctuations, or do they portend an era of rising energy prices? If the latter, how are energy markets expected to change in the coming years? This session examined these questions by first reviewing projections on reserves and prices of conventional energy sources, the market potential for future energy sources in the coming years, and the implications of rising and/or volatile energy prices on the economy and travel in the future.

Donald Shoup opened this session, commenting that volunteerism will not be the solution to global warming. Planning and policy choices will have created much of the problem, and these will have to be a large part of the solution.

Understanding energy markets I: Future reserves, production, and prices for conventional energy sources

John Kilduff, Senior Vice President , Energy Risk Management Group, Fimat USA, Inc.

Kilduff presented on the economics of the energy market. Specifically, he examined short-, medium-, and long-term projections for energy prices. Since 2000, crude oil prices have experienced a sustained rally. India and China have driven up demand for crude, but even more important has been an ongoing political destabilization in oil-producing regions. Uncertainty about the continuity of oil supply has been responsible for all price increases above roughly $40 per barrel. For example, Hezbollah's attacks on Israel in 2006 had the effect of driving oil prices to $80 per barrel, even though Israel has no oil supplies. Should there be a successful attack on Saudi Arabia, oil prices would likely jump to greater than $100 per barrel. Iran has the ability to shut down the Straits of Hormuz, through which much of the world's oil supply passes. This would lead to massive increases in oil prices. **Kilduff** further pointed out that oil is traditionally a major flight-commodity, to which capital is attracted in periods of uncertainty.

The United States is still the world's largest consumer of oil. China is the second largest consumer, and its rate of consumption is increasing rapidly, with a 15% increase in 2004, virtually no increase in 2005, and a 12% increase in 2006. India is actually importing fewer refined products today than in the past. Both countries' economies have been hurt by higher energy prices.

Kilduff pointed out that the supply (amount) of oil is not the controlling factor today, but rather uncertainty about the continuity of supply. Investors have flocked to energy as a hedge against inflation and terrorism, and crude oil is a very good hedge against terrorist attacks; if terrorists succeed, oil prices increase drastically.

Kilduff finds that there are three schools of thought on oil reserves:

1. Peak Oil Theorists: Oil supply will dwindle in the coming years.
2. Creation Theorists: We will continue to find oil reserves.
3. Data Theorists: There are billions of barrels of oil left.

Finally, **Kilduff** pointed out that technology solutions follow from crises; passenger vehicle fuel efficiency increases came after the oil crises in the 1970s. Since then, there has been little substantive change.

Understanding energy markets II: Future reserves, production, and prices for alternative energy sources

Heather MacLean, Associate Professor, Civil Engineering, University of Toronto

MacLean began by stating that low-carbon fuels will need to be part of a solution that includes land use changes and other measures. Low-carbon energy sources can help to reduce greenhouse gas emissions; currently, the production of electricity accounts for 40% of all anthropogenic greenhouse gas (GHG) emissions, while transportation accounts for roughly 33% of anthropogenic GHG emissions.

The Department of Energy projects that, by 2030, the use of alterative energy sources will change very little, while the use of coal for electricity production will increase considerably. Motivating any moves toward renewable resource use are concerns about the externalities of conventional energy sources, tax incentives, and technology development.

MacLean pointed out that "well-to-wheels" (lifecycle) studies show that the environmental benefits (or detriments) of befouls vary greatly by crop, production method, and other factors. Some befouls have net benefits, while others have net detriments.

Currently, about one fourth of U.S. electricity is produced from low-carbon fuels. The majority of this is currently nuclear power generation, though renewable sources such as wind power are growing rapidly. However, the major centers of wind power production would be in the upper Midwest; this is not where much of the energy would be consumed. Thus, transmission of power becomes a major problem. Hydro power production also has significant costs associated with it, such as displacement and environmental damage. Biomass as a fuel source has potential, but land use constraints, logistics, and availability of sufficient biomass are all limiting factors. Carbon-capture and sequestration technologies may be a significant part of future low-carbon electricity production, though these technologies are still new and relatively untested.

The transportation sector is currently 97% dependent on crude oil. Here, biofuels have some potential. However, land use constraints are also a major issue for biofuels. Fossil fuels may also continue to be used for transportation purposes with carbon capture and sequestration technologies attempting to mitigate climate change externalities. Again, these technologies are relatively untested, and their role remains uncertain.

Estimates for the cost-effectiveness, production capacity, and net carbon effects of biofuels vary greatly. Ethanol can likely supply 20% of today's light-duty vehicle needs, though the efficiency of doing so varies greatly by crop. **MacLean** pointed out that CO2 emissions cannot be the only factor considered. In sum, the future of alternative energy sources remains uncertain, though it is increasingly clear that there are greater and more immediate options for low-carbon electricity than there are for motor fuels.

The Effect of Fuel Prices and the Fuel Cost of Driving on the Demand for Driving and for Fuel

Kurt van Dender, Assistant Professor, Economics, UC Irvine

Van Dender began by examining changes in drivers' behavior in response to fuel price increases. In general, research has found that the elasticity of demand for driving has decreased from the 1960s to today. Whereas a study covering the past four decades found that a 10% increase in fuel prices led to a 2% decrease in driving, a study covering just 1997-2001 found that a 10% increase in fuel prices led to a 1% decrease in driving. The elasticity of demand has clearly declined over time, and consumers are less responsive to changes in fuel prices. Income growth explains a fair amount of this, as wealthier consumers spend a smaller percent of their income on fuel than do lower-income drivers. However, a larger increase in fuel prices would lead to a higher elasticity of demand.

This low elasticity of demand has policy implications. **Van Dender** pointed out that fuel taxes would have to be increased drastically to achieve a desired level of fuel consumption. As drastically increased fuel taxes are likely politically infeasible, Corporate Average Fuel Economy (CAFÉ)-style regulation of mandated fuel efficiencies is likely a more attractive option. However, as more fuel-efficient vehicles make driving less costly, there will be a small "rebound effect", whereby consumers take advantage of lower costs by driving more.

Studies have shown that the marginal external costs of driving on energy security and climate change are covered by the motor fuel tax, but the costs of congestion, infrastructure and noise are not. Thus, a small increase in the amount of driving comes with a high cost. In sum, while greater fuel efficiency may have positive impacts on climate change, increased driving will result in many other negative externalities.

Discussion

Andrew McAllister asked what the price of gasoline would have to be to achieve a significant change in travel behavior. Furthermore, he asked for a more detailed analysis of the change in demand elasticities over the past several decades.

Van Dender answered that the elasticity of demand would likely return to -0.2 at about $3.50 or $4.00 per gallon, assuming no growth in personal income. Elasticities of demand have declined steadily over the decades, though our certainty about the elasticities declines as we examine fewer years.

An audience member commented that the reduction in elasticities has been quite dramatic, and that the downward trend appears to be continuing. He asked **Kilduff** what the price of oil would likely be if uncertainty in oil-producing regions were eliminated.

Kilduff replied that the long-term stable price had been about $20 per barrel. With the increased investment in the sector, we may see a decline of the price to about $25 to $35 per barrel. Currently, the cost of oil based on supply and demand alone, as stated above, would likely be about $40 per barrel.

Woody Clark stated that he disagreed with all three analyses. Thinking globally, he stated, the United States could draw a lot from countries such as Germany and Denmark, increasing mass transit usage.

Kilduff replied that fossil fuels are still incredibly cheap, and that hydrogen will forever remain the fuel of the future. Other alternatives, such as light rail transit (LRT), are expensive, and cannot compete effectively with the automobile under today's conditions. Biodiesel is one of the options that appears to have the most promise in today's market.

MacLean replied that the analyses presented today examine policy options in the United States given a realistic starting point, and that European conditions are very different.

Van Dender pointed out that in the United States, transit's share of commute trips is only 6%. Origins and destinations are widely dispersed in the United States; therefore, if any investment in transit should be made at all, it should be in bus transit, not in rail. However, **van Dender** remains skeptical about transit in general.

Axel Friedrich pointed out that Germany's policy of high motor fuel taxes makes elasticities of demand much higher in that country.

Van Dender replied that access to alternative forms of transportation in Germany also increases the elasticity of demand for driving.

Friedrich added that biofuels have net detriments on CO2 emissions when one takes into account the entire lifecycle of the fuel. Thus, the German government has decided to invest very heavily in solar and wind power. Currently, these sources are subsidized, but the government expects these to become competitive by 2011.

Steve Kimsey commented that, while the presentations indicated an ability to raise the costs of energy to the consumer, there exists a lack of political will to do so.

Kilduff replied that the fuel tax is regressive, as the poor have fuel-inefficient cars and often no mass transit alternatives.

Michael Moore asked **MacLean** to elaborate on the greenhouse gas implications of biomass.

MacLean replied that it really depends upon the source of the biomass. From municipal solid waste, for example, there are large net benefits. Agricultural residues are similarly beneficial. When new crops are grown for biomass, however, the benefits are much less

obvious, as there are typically many fossil fuel inputs to the process of growing these crops.

An audience member from SANBAG contested the notion that petroleum will remain readily available in the long term. The USGS estimates that there are approximately 2.1 trillion recoverable barrels of oil left; to date, we have extracted roughly 1 trillion barrels. However, the ease of extracting oil will continue to decline, as all the readily-available sources are depleted. The extraction of this oil alone will be much more energy-intensive than has been the case so far.

Kilduff replied that there are, as mentioned above, three schools of thought on the remaining oil resources, and that peak oil theorists comprise one such group. It is true that the remaining resources are more difficult to extract, but new extraction technology is making this easier and less costly. Furthermore, there will likely be tremendous oil discoveries in the coming years, for example in the Gulf of Guinea, which may hold more oil than the entire North Sea.

Session V:

New Vehicles, New Fuels: Near Term Possibilities

Michael Shelby (Moderator), Chief Economist, Transportation and Climate Division in the Office of Transportation and Air Quality, U.S. EPA

The commercial success of hybrid-electric vehicles has raised awareness among public officials and the public about the possibilities for substantially cleaner and more efficient vehicles in the coming years. The presentations will examine: How and when do new fuels and/or engines become cost-competitive? What are the near-term possibilities for cleaner movement of goods? What are likely to be the relative roles of new engines, new fuels, and behavioral changes on future rates of fuel consumption and emissions?

Air quality concerns have increased the importance of alternative fuels and advanced transportation technologies like electric vehicles. By increasing alternative fuel use, consumers have fuel choices that compete with gasoline and diesel and reduce environmental impacts associated with driving. **Shelby** stated that it is a fact that CO2 emissions are going to rise in the next century. The magnitude of this problem is truly global. Every emitter is going to have to take significant steps, with transportation playing a significant role. Some of the solutions, which will be discussed in this panel, include alternative fuel vehicles and changing vehicle behavior. Clean vehicle technology, efficient travel demand management, and green fuels all hold promise to reduce green house gas emissions emitted by vehicles. Petroleum saving and GHG reductions are two benefits of new fuel technology. It is important to keep emissions at today's levels with all expected future growth. One major problem is to understand how to commercialize new technologies with up front costs. Although we have enough conventional oil to last a long time, we still need fuel conventional changes. **Shelby** believes that biomass will play a bigger role in the future.

Future Fuels and Vehicles: What are the Near and long Term Possibilities

Daniel Sperling, Director, Institute of Transportation Studies, and Professor, Civil & Environmental Engineering, UC Davis

The history of alternative transportation fuels is largely a history of failures. Methanol never progressed beyond its use in test fleets, despite support from President George H. W. Bush. Compressed natural gas remains a niche fuel. And nearly every major automotive company in the world has abandoned battery-electric vehicles. Only ethanol made from corn is gaining market share in the United States, largely because of federal and state subsidies and a federal mandate. Some alternatives have succeeded elsewhere for limited times, but always because of substantial subsidies and/or government protection.

Improved efficiency and fuel economy should be the number one energy and GHG priority, but these efforts are not enough to meet California, U.S., and global GHG goals. It is important to keep in mind that there is no silver bullet when it comes to alternative fuel vehicles, but many "shards." The most promising non-petroleum, low-carbon alternatives are: biofuels, electricity (PHEVs and BEVs), and hydrogen. These energy strategies would all be competitive at ~$55/bbl and all provide potentially large benefits. But they all face huge challenges and all will take time to implement. It is unlikely that one fuel will fully dominate the market. It is more likely to be regional differences, and likely to be a mix of options in the future.

Currently, gasoline is being "re-carbonized" due to increasing use of tar sands and heavy oil. Tar sands produces ~50% more GHGs/gallon than conventional gasoline. Vehicle travel continues to increase (~2%/yr), while transit only accounts for two percent of passenger travel (flat for many years). Increases in vehicle performance, size, and weight are offsetting vehicle efficiency improvements of 1-2%/yr. The net effect is that GHG emissions from transportation continue to increase in California, U.S., and the world. New cars are getting bigger, heavier and more powerful. A lot of people like to think that hybrids are the solution. It is a success in some ways. Although incremental enhancements are far from exhausted, there is almost no hope that oil or carbon dioxide (CO_2) reduction improvements in vehicles could even offset increases in vehicle usage, never mind achieve the radical de-carbonization and petroleum reductions likely needed later this century.

The principal long term energy options for vehicles include: Hydrogen (used in fuel cells), Electricity (used in battery electric vehicles and plug-in hybrids), and biofuels (used now in combustion engines with little energy/environmental benefit). Biofuels can be made from lignin cellulose (residues, grasses, trees), as well as starch and sugar (corn, sugar cane, etc). Corn ethanol supplies 3 percent of U.S. gasoline using 18 percent of U.S. corn production, with ~$3 billion in subsidies/yr.

The case for hydrogen is threefold. First, hydrogen fuel cell vehicles appear to be a superior consumer product desired by the automotive industry. Fuel cells fit into the automotive business model. Second, as indicated by the National Academies' study, the potential exists for dramatic reductions in the cost of hydrogen production, distribution,

and use. And third, hydrogen provides the potential for zero tailpipe pollution, near-zero well-to-wheels emissions of greenhouse gases, and the elimination of oil imports, simultaneously addressing the most vexing challenges facing the fuels sector, well beyond what could be achieved with hybrid vehicles and energy efficiency.

Current policy initiatives include:

- CAFE and California 1493 vehicle standards (30% reduction by 2016)
- Subsidies for ethanol (and oil and other fuels)
- Zero Emission Vehicle (ZEV) mandate (2500 fuel cell vehicles in 2009-11)
- California Hydrogen Highway
- Tax credits and High Occupancy Vehicle (HOV) lane access for some hybrids
- California Global Warming Act (AB 32)

Currently Ethanol and Plug-in Hybrids are gaining momentum, but there has been a backlash against hydrogen. The transition to a hydrogen economy will be neither easy nor straightforward. Like all previous alternatives, it faces daunting challenges. But hydrogen is different. It accesses a broad array of energy resources, potentially provides broader and deeper societal benefits than any other option, potentially provides large private benefits, has no natural political or economic enemies, and has a strong industrial proponent in the automotive industry.

Commentary

Margaret Bruce, Director of Environmental Programs, Silicon Valley Leadership Group

Bruce joined the Silicon Valley Leadership Group (formerly the Silicon Valley Manufacturing Group) as Director of Environmental Programs in March of 2001. In her role with the SVLG, Ms. **Bruce** works with local industry, environmental, and regulatory agency leaders in developing innovative and effective legislative, regulatory and voluntary action solutions to the environmental issues facing Silicon Valley and California. She has been especially involved in water, climate, hazardous materials and electronic waste issues.

Bruce discussed how every year the organization asks the Chief Executive Officers (CEOs) what they care about. Their responses include: affordable housing to employers, schools, environmental quality of life that is desirable, etc. She believes that taxes on gasoline are opaque to us as consumers. Our current transportation system imperils our water systems and takes up valuable land. But we as consumers are not aware of this. Fear, greed, and vanity—how do we motivate by fear? National security risks are here. **Bruce** believes that investment in new technology could make a difference in the world. She stated that one way to make an impact is to engage employees to drive less by enabling companies to telecommute. Another strategy is to engage in policy matters to lead us to the next generation. Why wait, we have to do something now.

Commentary

Roland Hwang, Senior Policy Analyst, Natural Resources Defense Council

Hwang began with a commentary on Moving America beyond Oil. The NRDC believes that we must get serious now about reducing GHGs. "A slow start means a crash finish." In order to reduce GHG emissions, we must avoid investments in unconventional oil production to avert dangerous global warming. Unconventional oil production includes: tar sands, oil shale and coal to liquids, which are all more carbon intensive than current oil production. Transportation solutions are known, but the challenge is political will. We need a package of solutions that includes efficiency, low carbon fuels, and demand reduction.

While **Hwang** does not agree with the statement that the reason Dan **Cashdan** is optimistic about the fuel cell is because car companies like it, he thinks that we have to be careful about this rationale. The NRDC is interested in issues of economics and the environmental benefits. In order to reduce U.S. emissions, we need to cut down on our energy usage. If we reduce electricity demand by 25% through better motors and controls, better lighting, better refrigeration, etc. we can reduce emissions by 325 million tons (1.3 wedges). If we reduce direct fuel use in buildings and industry by 40% through better building design, advanced industrial processes, and combined heat and power we can cut emissions by 275 million tons (1.1 wedges). If we increase vehicle efficiency to 54 miles per gallon through improvements to conventional vehicles, widespread deployment of hybrids, and possibly the introduction of fuel cells we can reduce emissions by 250 million tons (1 wedge). If we increase the efficiency of heavy trucks and aircraft, and build smart communities that provide viable alternatives to driving we can reduce emissions by 225 million tons (0.9 wedges). If we use renewable energy sources, such as wind power, to provide 30% of our electricity needs by 2050 and produce 40 billion gallons of biofuels we can reduce emissions by 325 million tons (1.3 wedges). If we equip 180 large coal fired power plants (180 GW) with carbon capture and storage and increase the efficiency of our energy supply system we can reduce emissions by 325 million tons (1.3 wedges). The AB32 Global Warming Solutions Act requires return to 1990 levels by 2020 likely through a combination of regulatory standards and market based measures (cap and trade). Transportation is the largest single source of GHG emissions and will need to contribute a substantial portion of the total reductions necessary. It is necessary to identify policies needed to create a market for low carbon fuels.

Discussion

Nancy Kete began the discussion by asking why LNG was not represented in the talk of alternative fuels. **Sperling** responded by saying that most people think it's just as limited as petroleum, except in places where there's a lot of local national gas. There is not a lot of interest from consumer perspectives.

The Honorable Tom Cosgrove commented that it is good to point out that we have per capita reductions in energy consumption, but also that we have a growing population. Technology seems to be one of the greatest benefits for reducing or avoiding pollutants and improving air quality. How can electric vehicles play a part in reducing the sort of

trips we make, relative to the other opportunities we've outlined here? **Sperling** responded that cheap green electricity with good batteries is essential. This will be an attractive option for plug-in hybrids. Plug-in hybrids will play a major role if we clean up the grid and start producing cleaner energy. It is also important to get away from the transportation monoculture, and start moving toward carsharing and smaller vehicles.

Jose Luis Moscovich asked a question about state targets. What kind of uncertainty do we have on each of the different methods for reducing GHGs? **Daniel Sperling** said that in the real world, per capita VMT is going up. The only way it will be reduced is if something dramatic happens. **Hwang** added that it is important to think about smart growth and other demand reduction strategies. However, we need to show how these strategies will actually reduce demand and identify the metrics to show the reduction.

George Eads made an observation that it is important to keep in mind all modes of transport, including light duty vehicles. Road freight is a very large part of the transportation system, as well as air transport. So when we are talking about these problems, be sure to keep the whole range of the transportation sector in mind. Even if all cars were zero emissions by 2050, we'd still have transportation GHG emission increase. **Bruce** addressed this comment by stating that avoiding inherent costs of purchasing from far away is one solution Silicon Valley is taking. For example, Kaiser Permanente started buying local food for the cafeteria. Efforts such as these will reduce VMT.

John Kilduff commented on telecommuting panacea. While you are getting the car off the road, the energy savings could be offset by the amount of energy you use in your home. More people will be sitting at home by themselves in their own air conditioned world in a McMansion. This might defeat the purpose of telecommuting. **Bruce** comments that this is a great point. It is necessary to retrofit our homes with energy efficient appliances to operate in an energy conscious way. We need real-time measuring of carbon content like we have nutrition information. That would help make working from home more efficient.

Session VI

New Vehicles, New Fuels: Longer Term Possibilities

Daniel Sperling (Moderator), Director, Institute of Transportation Studies, and Professor, Civil & Environmental Engineering, UC Davis

This second session explored longer-term changes to fuels and vehicles: what are the possibilities and how do they compare? This question was examined in a plenary talk, followed by a moderated panel discussion.

After Diesel: Technologies for Cleaner Cars, Trucks, and Trains

Magdi Khair, Emission Research Engineer, Southwest Research Institute

Khair discussed the role of the diesel engine in today's transportation system, finding that it has been the "power plant of choice" for commercial applications worldwide. The diesel engine is notable for its low fuel consumption and its durability. As the developing

world has achieved higher levels of auto mobility, there has been a dramatic increase in the use of the diesel engine.

However, the diesel engine has serious detrimental impacts on the environment. Responding to increased regulatory demands, engineers have made the diesel engine more fuel efficient and cleaner over the years. From higher compression rations, to turbo charging, to intercooling, efficiency has been improved and technology solutions have made a better diesel engine. **Khair** expects the emissions of the diesel engine to reach internal-combustion engine levels by 2014. However, these improvements have come with high costs.

Khair introduced the HEDGE concept: the High Efficiency Dilute Gasoline Engine, an engine that inherits some of gasoline's low emissions attributes with some of diesel's high efficiency attributes. This engine has performed well in tests, proving that in the short- and mid-term, incremental technological changes to existing engine technology may prove to be an effective way to reduce the environmental harm of travel by automobile. In the long term, **Khair** believes that other technologies, such as fuel cells, may prove effective.

Moderator **Dan Sperling** pointed out that there are two lessons to take away from **Khair's** presentation: 1) there may be different societal goals at work in many instances, e.g. reducing emissions while improving energy efficiency; and 2) technological innovation can make a significant impact in achieving these goals.

Electric Transportation and Goods Movement Technology

Bill West, Southern California Edison, *presenting for*
David L. Modisette, California Electric Transportation Coalition

Daniel Sperling announced that **David Modisette** was unable to attend the symposium, and that **Bill West** would present in his place.

West began by stating that electric technologies, including but not limited to electric vehicles and plug-in hybrid vehicles, are a viable component of a portfolio of strategies to reduce emissions and petroleum consumption. Air pollution and global warming are major drivers of the push for more electric vehicles, though reducing America's dependency on foreign oil is of growing importance.

Another reason for the push, particularly in California, for the electrification of personal vehicles, is the unique nature of electricity: it is not storable. Currently, the typical load profile of a power plant shows significant peaking at mid-day. The widespread introduction of plug-in hybrid electric vehicles (PHEVs) would add load to the grid during off-peak hours, increasing the efficiency of power plants from 70% to 80%, **West** estimates.

There are other, shorter-term, electrification strategies. These include truck stop electrification and port electrification. **West** estimates that there are over 75,000 long-haul trucks with sleeper cabs in California. Currently, these cabs idle overnight at truck stops; plugging these cabs in at truck stops would greatly reduce pollution and fuel

consumption and would save truckers money. **West** estimates that truck stop electrification by 2020 could result in the emissions reduction equivalent of removing 360,000 cars from the road.

Port electrification is a particularly hot topic in Southern California, and it could lead to a significant reduction in pollution. An average ship produces four tons of pollutants while docked in a harbor. Plugging in (cold-ironing) 100 ships would have the emissions reduction effect of removing 535,000 cars from the road. Furthermore, cranes and container cooling units could be electrified in the short term, leading to significant reductions in emissions.

Finally, **West** discussed the prospects of plug-in electric vehicles (PHEVs), which are similar to hybrid electric vehicles, but have larger battery packs, and can be recharged from a standard wall outlet. **West** estimates that PHEVs can reduce emissions by over 60% from that of conventional automobiles, and that PHEVs can achieve nearly 100 miles per gallon fuel efficiency. A current PHEV example is DaimlerChrysler's new Sprinter van, which has a 20-mile electric range and consumes 40% less fuel than a conventional Sprinter van.

An Overview of Biofuels

Steve Shaffer, Office of Environmental Stewardship, California Department of Food and Agriculture

Shaffer began by stating that there exists the potential for biofuels to replace 35 to 70 billion gallons of gasoline yearly. Combined with increases in energy efficiency, the introduction of biofuels could mean a total replacement of oil as a fuel source. However, there remain many unanswered questions about the viability and sustainability of biofuels. There are currently many conversion processes for biofuels, each competing for market penetration, subsidy, and widespread acceptance. Some of these conversion processes are cleaner than are others. There also remain questions about the sustainability of producing fuel crops, with the inherent increase in water and land consumption that this would entail. However, **Shaffer** warns against framing the issue as a question of food vs. fuel; instead, he urges researchers and policymakers to view the increase in biofuels production as an opportunity for collaboration with the agricultural sector.

Shaffer pointed out that there are many different feedstock sources for biofuels, including conventional crops such as corn, sorghum, and sugarcane, as well as agricultural, urban, and forestry residues and wastes. Additionally, new, dedicated crops are being developed for use in creating biofuels. These crops include switchgrass and aquatic systems such as algae. **Shaffer** stressed the need for biodiversity; governments should move away from wholesale subsidies for certain crops, such as switchgrass. Rather, performance measures should be used to reward environmental benefits independent of crop and processing methods.

Shaffer then turned to corn ethanol, about which he believes there to be considerable confusion. There is a great deal of corn being shipped from the Midwest to the dairy industry in California. The starch from this corn could be processed into ethanol, and the remainder of the corn could be used as cattle feed. The cow manure produced in this

process could also be used as biomass in power generation on-site. Shaffer believes there to be numerous such opportunities for agriculture and the energy sector to collaborate in coming years.

In sum, abundant biologically-derived renewable materials have the capacity to produce heat, electric power, transportation fuels and other useful products. Bio-energy helps contribute to the state's energy supply and is vital to waste and resource management efforts. Biofuels can be a significant part of our energy mix and will play an important role in meeting the Governor's targets for reductions in greenhouse gas emissions.

Natural Gas Engines for Heavy Duty Truck and Bus

Mostafa Kamel, Director, Alternative Fuels Product Development, Cummins Westport

Kamel presented on the opportunity for natural gas engines in heavy-duty trucks and buses. Natural gas is favored in these applications for its advantage over conventional fuels in CO2 emissions. Because natural gas resources are geographically constrained, there exist certain natural markets for the introduction of these vehicles. These markets include parts of the United States, Canada, France, Austria, China, the Philippines, Egypt, and others. Natural gas engines may be used in buses, refuse trucks, delivery trucks, street sweepers, and other heavy duty applications. Current natural gas engines produce a fraction of the greenhouse gases produced by conventional diesel engines, and new developments in engine technology will reduce emissions dramatically again by 2010.

However, natural gas buses are more expensive than are conventional diesel buses, and this has hampered their widespread introduction, excluding certain markets, such as Southern California. Both the natural gas vehicles and the natural gas filling stations are more expensive than are their diesel counterparts, though this gap is likely to shrink in coming years. Furthermore, as diesel prices have risen, the cost of natural gas has remained relatively stable, making it relatively more attractive. Coupled with growing concerns over energy independence, this has made natural gas a prudent option in many applications, and we are likely to see increased adoption of this natural gas engine technology.

Currently, only 14% of U.S. buses run on compressed natural gas (CNG), though this number is increasing; roughly 20% of all new bus orders are CNG vehicles. Fuel cost savings from CNG fleets can be significant, especially in high fuel use applications like transit bus and refuse collection operations. While transit bus operations are rapidly introducing CNG vehicles, refuse collection operations have been slow to adopt the technology, with only 1% of refuse collection vehicles using natural gas technology.

In sum, natural gas engines will be part of a broader energy strategy for the United States in the coming years. Natural gas resources are local, with large deposits remaining within the United States. The life cycle cost of natural gas engines is decreasing rapidly while conventional engine life cycle costs continue to climb. And finally, the emissions advantages of natural gas technology will play an increasingly important role as the nation looks for ways to reduce greenhouse gas emissions.

Prospects for Hydrogen in Automobiles and as a Long-Term Carrier in Future U.S. Energy Systems

Gene Berry, Engineer, Energy Storage and Conversion Group, Energy and Environment Directorate, Lawrence Livermore National Laboratory

Berry outlined the fundamental considerations of hydrogen as an energy carrier, describing ongoing work at the Lawrence Livermore National Laboratory on hydrogen storage and its use in a hydrogen hybrid Toyota Prius. **Berry** began by stressing that hydrogen is not an energy source in these applications, it is simply an energy storage medium. The energy stored by hydrogen can be created by thermal, chemical, or electrical processes, and the process of storing energy has inherent inefficiencies; the energy used to produce the hydrogen is greater than the energy won back by combusting it. However, if carbonless energy sources are used to create the hydrogen, these vehicles can decrease energy dependence and reduce greenhouse gas emissions dramatically.

Hydrogen vehicles have been researched for decades; indeed, BMW developed a hybrid liquefied hydrogen-gasoline vehicle 30 years ago. Honda has developed a hydrogen fuel cell vehicle that achieves a 90 miles per gallon fuel efficiency equivalent. However, all tests of hydrogen vehicles have had great difficulty with the storage of hydrogen fuel. There are four methods of storing hydrogen: as a liquid, a gas, chemically, or absorbed. Liquid hydrogen has been a favorite for long, but even a small leak in a liquid hydrogen tank can empty a tank in a matter of days. Compressed gas storage has similar problems, and the increased pressure leads to very high temperatures. Chemically bonding hydrogen to metals is certainly the safest process, but it is a slow and costly procedure. The reliability of storage procedures is increasing, though more work must be done in this area to ensure safe and effective hydrogen storage before this technology will be widely accepted.

Clean electrical generation is necessary for hydrogen fuel to have a climate change impact. If hydrogen fuels can be produced using electricity generated from wind, solar, and other carbonless sources, hydrogen can become a clean, effective fuel.

Discussion

Phil Misemer asked **Khair** whether the HEDGE concept was applicable to light duty vehicles, heavy duty vehicles, or both.

Khair responded that it is applicable to light and medium duty vehicles.

Sperling commented that Honda has produced a diesel engine that is very elegant and simple, and that this development has been driven largely by regulation.

A question was raised as to the ability to retrofit existing diesel engines. **Khair** replied that the technologies outlined in his talk were not retrofit technologies; retrofitting is possible, though it has a different set of technologies not covered here. A Department of Energy project recently retrofitted a diesel engine with various technologies, such as a particulate filter, and this retrofit met 2010 diesel requirements.

A member of the audience asked **Khair** to comment on the competition between diesel and natural gas solutions.

Khair replied that engines can run on liquefied natural gas, but that this technology requires a great deal more infrastructure investment in, for example, filling stations, than does diesel.

Lee Schipper commented that many people, including the participants in the symposium, may not take the externalities of greenhouse gas emissions seriously enough.

Steve Brye added that hydrogen is used as rocket fuel; if policymakers took climate change as seriously as they do rockets, there would be infrastructure in place to fuel automobiles with hydrogen. **Brye** asked for comments on why there has been so little investment in hydrogen technology.

Axel Friedrich commented that the German government has been looking at a hydrogen-based energy market, and has found that it is not economically viable, with the possible exception of stationary electrical generation.

Berry replied that hydrogen should, in fact, only be used for transportation purposes.

Sperling commented that hydrogen is only used for energy storage; thus, it is useful in transportation applications. However, the real challenge, he posited, was to change behavioral paradigms to combat global warming.

Brye asked **West** whether Southern California could require cold-ironing for locomotives, as New York City does.

West replied that there are various reasons why cold-ironing for locomotives is not embraced, though diesel locomotive manufacturers are looking at retrofit technologies for just such an eventuality. He commented that electrification of railways is a good idea.

An audience member asked what the technical hurdles are to introducing plug-in electric hybrids.

West replied that the primary hurdle is the battery of the vehicle, though this is improving rapidly. The lithium-ion battery in particular shows a great deal of promise for making PHEVs economically feasible.

Tom Cosgrove commented that the city of Lincoln is the first city in California with a neighborhood electric vehicle (NEV) transportation plan. As part of this plan, lampposts are fitted with electrical sockets. The city's strategy is to invest in infrastructure in advance of the widespread adoption of the technology. **Cosgrove** then asked about efficiency gains in the transmission of electricity.

West replied that there has been a lot of research in transmission and new composite materials, and that efficiency gains were likely in the future.

Carrie Downey mentioned to Shaffer that, though generation resources using biomass are located in certain areas, consumption takes place in other areas, and that an efficient transmission system is required between the two points.

Shaffer concurred.

An audience member asked **Shaffer** about invasive species being used for biomass. He asked if *arundo donax* could be used in the place of sugarcane.

Shaffer replied that researchers are looking at a number of biomass options. For example, studies have been conducted in Arizona and New Mexico using tumbleweed as a fuel crop. Gourds and melons have been used in experiments, also. Finally, crop rotation will be necessary in any instance to help stabilize the soil.

Session VII:

What in the World? Transportation Energy and Greenhouse Gas Emission Planning Outside of the U.S.

***Dave Calkins (Moderator)*,** Partner, Sierra Nevada Air Quality Group

Global energy and climate change issues are just that: global. This second evening session will explore policy and planning efforts to increase energy efficiency and reduce greenhouse gas emissions in some developing and other developed countries.

Calkins opened this discussion by stating the importance of learning from foreign countries. In the next presentations, we will learn about foreign government policies and other voluntary and mandatory programs. We will see if other countries have the used command and control or incentives. Are there increasing efforts at the local level in your country? At the municipal level? And how do you make it happen?

Europe

Axel Friedrich, Head of Environment and Transport Division, Umweltbundesant, Germany

Friedrich began his presentation by stating if you take 50 actions at the same time, we can get rid of GHG in transport. In the European Environment Agency (EEA), there has been a big increase in GHG in transit. In Germany and UK, people believe that climate change is the biggest threat in the world. Integration of environmental concerns into sector policies has long been recognized as an important strategic approach to environmental policy-making in the European Union (EU). Improvements in fuel efficiency and pollution control over the last two decades, while not inconsiderable, have been more than offset by increases in the ownership, use, and power of motor vehicles of various kinds. The number of vehicles is growing almost everywhere at higher rates than both population and gross national product (GDP). Overall road traffic grows even more quickly. The largest increases over the next several decades are likely to occur in non-OECD countries, particularly in the Asia-Pacific region. Air transport is growing even

more rapidly than road traffic, while use of public transport, which is generally more environmentally benign, is declining in many countries.

There has been a rise in energy consumption in road transport in 15 EU Member States between 1995 and 2003. The environmental and health impacts of transport, present and potential, are increasingly well understood. Governments have in recent years become increasingly concerned with setting long-term transportation goals that are consistent with sustainable development objectives. More than ever, because transport presents such special challenges, dialogue among disciplines, among levels of government, and among economic sectors is required to move forward.

Friedrich spoke of the voluntary agreement with the European Automobile Manufacturers Association (ACEA), Japan Automobile Manufacturers Association (JAMA) and Korea Automobile Manufacturers Association (KAMA). It is a voluntary agreement of the EU- commission and the EU council with ACEA to reach 140 gt/km in 2008 as a sales average of all sold vehicles in the EU. For JAMA and KAMA the goal is 140 g/ km in 2009. In 2012 the goal is 120/km if technically feasible. The Commission, being determined to address energy efficiency and CO2 emissions from cars, will if necessary propose in 2007 legislation to ensure that the 120 g CO2/km target is achieved by 2012 through a comprehensive and consistent approach, in accordance with the agreed EU objective. In parallel it will propose to strengthen EU requirements for labeling of cars. **Friedrich** also spoke of the correlation between fuel prices and transport fuel intensity. Taxes and consumption are highly correlated. The more you consume, the more you have to pay in taxes. He proposed to develop modeling tools to monitor and to project environmental conditions. This would assist countries in making action plans with clear goals for sustainable transport. **Friedrich** finally spoke of the implementation of the EU Biofuels Directive. In accordance with the biofuels directive, the Commission will bring forward a report in 2006 on the directive's implementation, with a view to a possible revision. It will address the issues of: national targets for the market share of biofuels; using biofuels obligations; requiring that, through a system of certificates, only biofuels whose cultivation complies with minimum sustainability standards will count towards the targets. Efficiency of given modes makes a difference in Germany, but mode split change has a bigger impact.

China and Mexico

Lee Schipper, Director of Research, EMBARQ The World Resources Institute (WRI) Center for Sustainable Transport

Schipper began his presentation by stating that he is not going to talk about national plans because he doesn't believe in them. **Schipper** works for EMBARQ, whose strategy is to foster viable government-business-civil society partnerships whose members are committed to finding solutions to the transportation-related problems facing the cities in which they operate. Established in May 2002, with the support of the Shell Foundation, EMBARQ - The World Resources Institute Center for Sustainable Transport - acts as a catalyst for socially, financially, and environmentally sound solutions to the problems of urban mobility. Working with politically and financially empowered authorities at local and global levels, EMBARQ can dramatically reduce the costs, risk, time, and

complexity required to diagnose key transport problems, and design and implement sustainable, "best practice" solutions.

EMBARQ is making big change in Mexico City. In May, 2002, EMBARQ, signed a Memorandum of Understanding with the city government to create the Center for Sustainable Transport (CTS in Spanish), a clean urban mobility organization equipped to tackle local congestion, traffic accidents, and pollution problems through the implementation of sustainable transport solutions. This formal agreement with Mexico City outlined a strategy to allow EMBARQ and the CTS to serve as consultants to the city, promoting and advising projects to drastically reduce congestion, increase access to public transport, and make transit cleaner and safer in Mexico City. The four primary projects are: 1) Bus Rapid Transit: Design and assist with the development of a BRT system on city's primary avenues; 2) Diesel Retrofit: Retrofit the city's heavy-diesel bus fleet with catalytic converters and ultra low sulfur diesel after proving significant emissions reductions; 3) Test Clean Fuels and Buses: Test of best engine/fuel combinations for new high-capacity, low emission transit buses for future city purchases; 4) Non-Motorized Transport: Promote walking and cycling as sustainable transportation alternatives. These strategies have made great impacts for CO2 reductions in Mexico City, as well as air quality improvements.

Schipper then spoke of social sustainability, which contributes to building community. Governance is what makes the rules work. Working towards the goal of sustainable transportation systems is key. If you solve the tail pipe problem and fuel efficiency, you will still be plagued by a bad transport system.

However, China's growth and industrialization is a major factor for global GHG emissions. China's significant economic development over the past two decades has led to its rapid growth in industrialization, urbanization and subsequently, motorization. Its economic improvements have led to an increase in disposable personal income, while the increase in population has also resulted in additional consumer demand. Finally, the opening of the automobile market to foreign investors since the 1980s has created one of the largest automobile markets in the world. It is thus not surprising that the demand for private motorization has increased substantially over the past two decades, contributing to about 20 percent of the total increase in motor vehicles, where the total number of registered vehicles is now 27 million.

The externalities of motorization could be costly and include undesirable environmental and social consequences that could be reduced by various technology and policy measures if decisions are made promptly. Air and noise pollution due to transportation are now common in many urban cities, where air qualities are beyond national standards. Congestion and traffic safety have also become serious problems. Greenhouse gases (GHG) emissions, though not significantly emitted by the relatively small transport sector, have the potential to increase as motorization continues to grow. With the expanding burdens of energy security and environmental pollution, China is increasingly concerned with its growth in the transport sector and the need for fuel consumption diversity. Current policies are drafted to encourage energy efficiency, together with stringent fuel economy and quality standards imposed by the Government of China.

When comparing and contrasting Mexico and China, **Schipper** points out that cities in Mexico are built around the car and are more sprawling, whereas Chinese cities are built around the pedestrian and tend to be denser. In Mexico, there is high car ownership (>100/thousand), poor fuel economy, and a low share of urban trips are by non-automotive modes. In China, there is low car ownership (<12/thousand), higher fuel economy standards, but low prices. In terms of transportation, Mexico is more influenced by the U.S., whereas China is developing its own path.

Schipper concludes with asking the question: Are Mexico and China de-carbonizing? In Mexico the Metrobus is a huge step for reform, but the next step is to implement stricter fuel economy standards and put restraints on car use (possibly through congestion pricing). In China, fuel economy standards are a valuable first step, but it is important to establish real urban transport – not just token bus rapid transit (BRT). The next steps are car restraints and protection for NMT. Overall, fuel economy is necessary but not sufficient; good urban transport is necessary but not sufficient; more demos of success are needed in both countries. Good urban transport is necessary and it is important to make it convincing.

Argentina

Lucila Serra, Coordinator, Center for Global Change Studies, Torcuato Di Tella Fundacion, Buenos Aires

Currently fossil fuels dominate Argentina's energy consumption. In 2000 Argentina was South America's third largest energy consumer and emitter of carbon, resulting from the consumption of fossil fuels (with Mexico first and Brazil second). During the 1990s Argentina's energy demand grew annually at an average rate of 6%. Energy consumption in Argentina has been dominated by the industrial and transport sectors, and until the country's financial collapse in 2001, were expected to continue growing rapidly. Argentina's total energy consumption in 2000 was 2.7 quadrillion Btu, or 0.7% of the worlds total energy consumption.

For green house gas emissions, the Transport Sector represents 14% of the total emissions; enteric fermentation represents 20% of the total emissions; and the production of cement and metals represents 80% of the industrial processes emissions. The impacts caused by fossil fuels include: 1) Human health impacts, such as respiratory problems, heat-related deaths and illness, spread of disease (insect-borne diseases), drought (devastating effect on food resources, drinking water supplies); 2) Economic Impacts, such as national security, the end of cheap oil and gas, property loss & skyrocketing insurance claims; and 3) Environmental impacts, such as air pollution, water pollution, loss of biodiversity, desertification, and droughts. **Serra** states that while all countries will experience impacts, the developing world is most vulnerable to climate change. For Argentina, it is vital to address climate change because it is a new and additional barrier to sustainable development and it's adverse effects divert resources essential to social policies (such as housing, health, education and environment). Thus, it is of the country's interest to contribute to the international climate policy regime after 2012. In the last three decades Argentina has been working towards actions to mitigate climate change. Such actions include: Hydroelectric power (50% of electricity generation); substitution of fuel oil for natural gas in combined cycles; subsidies to wind energy; National Biofuels

Act (5%); National Hydrogen Act, and the largest automotive fleet run with natural gas (1,100,000 vehicles). **Serra** concludes that climate change is a top policy priority in Argentina. Securing energy supply for its economic growth and curbing environmental pollution are top policy priorities. Argentina embraces technology cooperation with different parties in the field of climate change and clean energy. Argentina is now recovering from an economic and social crisis, and these systems are gradually getting reactivated, generating new investment and possibilities of development.

Canada

Michal C. Moore, Senior Fellow, Institute for Sustainable Energy, Environment, and Economy, University of Calgary

Canada is a country that is energy and resource rich, rather than technologically rich. Major Canadian industries include: Thermal energy generation, oil and gas extraction and processing, pulp and paper generation, cement and lime production, chemical production, mining, smelting and refining, iron and steel production. Many of these industries serve the U.S. The Canadian population is concentrated near the borders. Hydrocarbon resources (e.g. oil sands) are concentrated in non-shield areas. Oil sands and unconventional oil production have begun to rapidly increase. However, it is an energy intensive process to get the oil out of the oil sands. **Moore** states that the development and growth in the oil sands, which is a tremendous problem, is one of the best things to happen to Canada. Initial export focused on US, but it is now increasing to China and in the future to India. With the expansion of oil sands activity, GHG emissions have increased and exceeded Kyoto targets. Overall energy demand in Canada has increased, even with improved energy efficiency. Challenges that will influence oil sands operations and consequent GHG emissions include competitive markets, long term cost of fuel, transport challenges, future cost of carbon reduction credits, difference in domestic versus international markets, and policy uncertainty.

Moore believes that climate change can open up passage ways, which will open up geopolitical struggles. Climate change has also led to changes in permafrost levels, which makes it difficult to access the oil sands. **Moore** concludes with advice given and beginning to be taken: "There are a number of compelling legal and economic reasons that corporations would be well advised to give careful consideration to the issue of climate change and even develop their own climate change action plan in advance of any regulatory requirement. . . . [T]here is reason for genuine concern that liabilities may be lurking for those who neglect the issue now, to the later detriment of the corporation and its shareholders."

Discussion

Larry Allen began the discussion by asking, what kind of opposition did Germany face from the vehicle fleet owners with regards to taxes? How did you overcome these problems? **Friedrich** stated that taxes are always a problem. In the UK, there is a tax on pollution levels, which is sort of regressive. The poor have older cars, so they get taxed more heavily. We say that taxes not only reduce pollution but also create safe jobs. Climate change costs over 50 billion per year, so the government has a great interest in stopping it. Education is also an important component to gain public approval.

Timothy Papandreou commented on **Schipper's** presentation in that he has been waiting two days to hear a talk like this from someone who is looking at a sustainable future, not just technological solutions. What can we import back to the United States within the existing transportation governance? How can we make the US more sustainable? How can we get people out of their cars and envision a car free future? **Schipper** responded that the US is a very greedy country. We can afford to pay $3.00 a gallon, but we don't want to and we see that we can force the price back down with public opinion. We've gotten so hung up on things being cheap and technical fixes – we can't accept the major change – until things get so bad. On Washington's agenda is cheaper fuel. As we have seen in this symposium, there is disagreement over what works and what doesn't. It's important not to give up hope, but the task is so huge. There are as many people in Atlanta as there are in Barcelona, but how do we get Atlanta to look like Barcelona? We have to start being able to say yes and stop being NIMBYs (Not in My Back Yard). We have to allow our corridors to be the ones we densify through infill development.

A question was asked about the general perception of climate change in Argentina and the sense of urgency. **Serra** responded that people are more concerned with poverty, security issues, and the energy crisis, but the government decided to make climate change a major priority. The government has been working towards public awareness and public policies. Argentina is just coming out of a real economic crisis and we are still trying to get on our feet again. To make climate change a priority and fundable will require help from outside. **Serra** also commented that transportation is more of a local issue in Argentina. And in this sector we're looking for small molecular solutions, not looking for a silver bullet.

Steve Brye commented about carbon sequestration. He stated that it's wonderful if it works, but disastrous if it doesn't. He relates it to when we thought nuclear was totally safe and saying it wasn't was blasphemous. **Brye** then asked about the risks of a leak. Are there other approaches that might work better? **Moore** agreed that the risks are high. When there's a major leak, it's likely to be catastrophic somewhere sometime. If a leak occurs, nothing locally will happen – but it will be catastrophic in the long term. How do you make someone pay when you can't match a leak to a scale of disaster? We just have to be really safe about figuring out how to sequester for a long time. This is not a riskless society. **Brye** then asks a follow up question about death of animals and people with releases of sequestration? What are the risks of asphyxiation? **Moore** responds by saying that he doesn't mean to sound callous, but the population density in the places of sequestration in the first round will be so low that while the biosphere will be a problem, humans won't be directly affected.

Roland Hwang asked a question about Canada adopting CA vehicle standards? **Moore** responded that all 12 Canadian cars have CA vehicle standards. Taking CA standards is a deflection of a macro-regional issue. Transportation emissions are not a major concern in Canada. Providing offsets for the dirtiest plants is more important. If oil sands are developed, the act of providing a sequestration process will be a top priority. Building a cable to transmit that energy will allow hydro plants to develop in the far north.

Session VIII:

Responses to Global Energy and Climate Issues in Sacramento and Washington

Elizabeth Deakin (Moderator), Director, UC Transportation Center, Professor of Civil and Environmental Engineering, UC Berkeley

This penultimate session examined policy efforts to address energy and climate change by the U.S. federal government as well as in California and other states – particularly as they relate to transportation.

Elizabeth Deakin opened the session by commenting that very little discussion on land use had occurred at the symposium thus far. As an aside, she presented a slide show from **Donald Shoup** that showed a typical suburban shopping mall. She commented that the amount of land set aside for parking, especially considering the small percentage of that parking space that was used, was of serious environmental consequence. Large parking lots such as the one shown, she stated, damage the ecosystem by covering the earth with impermeable surface and creating heat islands. Furthermore, she commented, such parking lots are extremely hostile to pedestrians and cyclists. She urged participants to consider land use when thinking about climate change; too often the focus is only on vehicles and technology. She added that, as mentioned earlier, buses can be either inefficient or very efficient, depending on how full the vehicles are; coordinated transportation and land use planning can ensure that buses are full.

Federal Efforts to Reduce Oil Imports and Greenhouse Gas Emissions from Transportation

Greg Dotson, Minority Counsel, U.S. House of Representatives, Office of Representative Henry Waxman

Dotson began by stating that there has been a recent surge in federal interest in reducing oil imports and curbing greenhouse gas emissions. While there has been a great deal of interest on the federal level, he commented, there has been little action. Indeed, he commented, there has been a refusal to take meaningful and substantive action. The majority of action has occurred within the nonprofit sector.

The current administration, **Dotson** added, has set a nonbinding goal to allow U.S. greenhouse gas emissions to increase by 14% by 2012. Furthermore, the Bush administration has declared CO2 not a pollutant, rejected the Kyoto protocol, rejected any regulation of CO2, and opposed increasing Corporate Average Fuel Economy (CAFÉ) standards. While the administration has supported tax credits for hybrid vehicles, these incentives have been far outweighed by early incentives for sport utility vehicles (SUVs) weighing more than 6,000 pounds.

The Cantwell Amendment, recently defeated in the Senate, would have set the aggressive target of reducing oil imports by 40% by 2025. The administration, Dotson commented, was strongly opposed to this proposed amendment and similar legislation, and Republicans overwhelmingly voted against the amendment.

The administration's Environmental Policy Act (EPACT 05) requires the production of 4 billion gallons of renewable fuels per year in 2006 and 7.5 billion gallons in 2012. However, industry experts and the Environmental Protection Agency report that the demand for such fuels already outstrips these requirements. **Dotson** added that the majority of ethanol plants are coal-fired, which negates greenhouse gas benefits that might be won by the use of renewable fuels.

Dotson estimated that the cost of oil imports had risen from $250 million daily in 2001 to $650 million daily today. In Washington, support is growing to reduce this figure for multiple reasons: energy independence, national security, and the environment. He commented that legislation to reduce oil dependence is gaining support, and that increased media attention will likely drive this interest higher.

Assessing the Impact of the Federal Energy Bill's renewable fuels standard (and other alternative fuels) on GHG emissions

Larisa Dobriansky, Deputy Assistant Secretary, U.S. Department of Energy, National Energy Policy

Dobriansky opened by stating that the United States needs to increase investment in biomass research and development, and that recent increases in crude oil prices will likely drive this funding. She countered **Dotson's** presentation by stating that his analysis of the current administration's actions looked only at mandates, while leaving out incentives and voluntary programs that are, she feels, making a great deal of progress on energy security and climate change issues. She cited the Energy Star program as one such example. Mandates, in conjunction with incentives and voluntary programs, comprise the whole array of government actions on climate change, and these various approaches are, she commented, indeed spurring technological innovation.

Nevertheless, **Dobriansky** believes there is still much to be done on the federal level. The President's current focus on energy issues comes from his desire to reduce the country's dependence on foreign oil, and this focus may work well in conjunction with efforts to curb global warming. Biomass energy production is a major focus of the current administration's energy policy; incentives for bio-energy programs have already been put in place, and these appear to be working.

Dobriansky emphasized the need to move new technologies quickly from the demonstration phase into the market. The Department of Energy, in pursuit of this goal, is focusing on deployment strategies, believing that the Department should see more from the billions it invests in research and development. The Department of Energy is exploring strategic public-private partnerships, tax incentives, and other strategies to speed the deployment of new technologies.

Dobriansky further countered Dotson's arguments that EPACT 05's requirements for 7.5 billion gallons of alternative fuels by 2012 are too low by stating that, though it appears the market will produce nearly 10 billion gallons by 2012, the requirement sets a useful minimum in the case that conditions change significantly in the coming years.

Dobriansky further stated that community-scale development and sustainable land use planning will need to be a significant portion of a set of integrated strategies to combat global warming. She cited a pilot project underway in Chula Vista, California, to develop model energy communities in which energy-efficient processes are integrated into the design of the community energy system. This project hopes to optimize energy use and productivity, yielding increased grid reliability, minimizing peak demand, and substantially reducing pollution and greenhouse gas emissions.

Assessing efforts to regulate greenhouse gas emissions in California

Ann Carlson, Associate Dean, UCLA School of Law

Carlson opened by stating that California is leading the way to reducing greenhouse gas emissions, and that the rest of the country can learn from the development of programs in California. While in some ways, the federal Environmental Protection Agency (EPA) has helped California's efforts, in other ways, the federal government has hindered the state's efforts.

The California legislature has passed several important pieces of legislation in recent years. AB1493 requires the state air quality board to reduce emissions from automobiles, while AB32 requires an overall reduction in greenhouse gas (GHG) emissions, regardless of the source. This bill requires the state to return to 1990 GHG levels by 2020, and institutes a system of mandatory reporting for major sources. SB1368, a little-noticed bill, requires utilities entering in to long-term contracts to purchase from energy providers that are as clean as current natural gas power plants.

Carlson pointed out that the Clean Air Act categorically preempts all states except California from regulating motor vehicle emissions. California can be granted an exception on the condition that state standards are at least as stringent as federal standards, and only under the condition of "compelling and extraordinary circumstances." California's request for a waiver is currently under review by the EPA.

Currently, the State of Massachusetts and others are suing the U.S. EPA. In Massachusetts et al v. EPA, the state is arguing that the agency has ignored its statutory duty by failing to promulgate regulations controlling greenhouse gases. The EPA has claimed that CO2 is not a pollutant, while the plaintiffs contend that it is. The fate of AB1493, which treats CO2 as a pollutant, depends upon the decision made in this case.

However, **Carlson** pointed out, there are additional legal hurdles for AB1493. As mentioned above, the EPA may grant waivers to the state of California only in "compelling and extraordinary circumstances." It is difficult to argue that greenhouse gas emissions, a global problem, constitute an "extraordinary" circumstance in California as opposed to, for example, Nevada or Texas.

Discussion

Michael Moore asked **Dotson** if he knew of the market penetration of the F150 truck with dual fuel capacity.

Dotson replied that E85 (ethanol fuel) market penetration has been limited by the retail outlets for the product. Some consumers who have purchased a dual-fuel vehicle are unable to take advantage of this feature because there are no E85 outlets near them.

Moore asked if there appeared to be a "tipping point" at which Congress will likely take more aggressive action.

Dotson replied that it is possible that President Bush will announce a climate initiative in the next State of the Union in an attempt to take leadership on that issue from the Democratic Party.

Steve Shaffer commented that an organization known as "25x'25" advocates for rural land-based activities providing 25% of the nation's energy supply by 2025, through the deployment of technologies such as hydroelectric dams, photovoltaic cells, and biofuels.

Dotson agreed that new engagement from the agricultural sector in energy issues could have enormous impacts on national and state policy.

Bob Larson commented that E85 has substantial benefits, and that greater efforts to link E85 stations with flex fuel vehicles are needed.

Dotson commented that there are roughly 60 U.S. Senators who would likely vote for most pro-ethanol legislation.

Lindell Marsh asked **Dobriansky** where the demonstration project she mentioned will be located.

Dobriansky replied that it will be in Chula Vista, south of San Diego, and that the project is moving to deployment soon. She added that this project demonstrates the need to not only meet demand in cleaner, less carbon-intensive ways, but also to lower our energy consumption baseline as much as possible. In effect, it should be a major goal to manage energy demand.

Huasha Liu commented that, though it is vitally important to discuss such programs, it is equally important to take action to implement ideas to lower greenhouse gas emissions, and to implement these strategies soon.

Dobriansky replied that it is important to use the "whole arsenal" available at all levels of government, and that a great deal of citizen participation and local action are also required.

Diane Forte asked **Carlson** how AB32 might be linked to enforcement opportunities and concrete action.

Carlson replied that this remains unclear, as the bill is fairly vague.

Forte asked if it is possible to link CO2 to ozone in order to classify it as a pollutant.

Carlson replied that the classification of CO2 is entirely a matter of statutory interpretation, and that the term "pollutant" is very well defined.

An audience member added that there are risks associated with simply focusing on higher fuel efficiency, and that much more attention should be paid to smart growth and land use planning. He commented that the second biggest contributor to lower emissions that California expects is sustainable land use planning.

Bruce Riordan asked what role laypersons can play in urging public agencies to include explicitly climate change in their long-range planning.

Carlson replied that laypersons can write amicus briefs, though these rarely have much impact on the court. She added that public opinion does not and should not be the place to look for answers in court cases; Congress, she stated, should have spoken clearly on this issue, and Congress looks to public opinion.

Timothy Burroughs mentioned that, especially in California, planners are looking at the land use – transportation connection to the environment. The state, he stated, must look for greater local government participation in order to meet targets.

Steve Brye commented that the U.S. EPA has approved hundreds of Environmental Impact Statements (EIS) over the years that classify CO2 as a pollutant.

Carlson replied that the EPA has done many such things in the past that conflict with its current stance on CO2.

Robert Wyman added that EIS documents do not currently evaluate climate impacts of projects.

Carlson replied that it is likely that environmental plaintiffs will soon begin to make climate change claims.

Session IX:

Linking Decision-making to Global Energy and Climate Issues – Opportunities and Uncertainties

Brian D. Taylor (Moderator), Associate Professor and Vice Chair of Urban Planning, UCLA School of Public Affairs; Director, UCLA Institute of Transportation Studies

This closing session directed its attention both globally and locally by examining local and regional efforts to address both energy and climate change issues here in the U.S. and abroad – again with a focus on transportation and land development policies. What are some local actors doing to address these issues, and can acting locally make a difference? The session concludes by examining the question of what policymakers ought to do about these complex, global issues and when they should do it? How can we make wise decisions in times of uncertainty? When is it best to act, and when is it best to wait?

Efforts by local and regional governments in the U.S. to link transportation and land use planning to global energy and climate change issues

Debbie Cook, Council Member, Huntington Beach City Council

Cook began her presentation with an energy mandate: we cannot solve the climate change challenge without addressing **land use** and **transportation**. Forty two percent of Americans say that the number one national security issue is energy independence. To meet the unprecedented challenge these dramatic changes present, it is imperative that policymakers at every level of state and local government join with environmental, business, labor, public health, education, and social equity leaders to devise and implement solutions that will ensure long-lasting environmental protections for our local communities, our natural places, and the resources that sustain our health, economy, and quality of life. We know that climate change is a serious threat to our future and that the countless environmental challenges we now face will either contribute to or will be exacerbated by global warming. Now is the time to address these challenges. Now is the time to change the climate in our statewide, regional, and local policymaking. We have reached the tipping point for this issue. Conventional oil and gas production has peaked and we are beginning to turn to more carbon intensive sources. The question now is who will provide the leadership needed for change? If no one thinks there is a problem, nothing will change. However, we are receiving conflicting information from the media. When people are confused, they don't act. People believe that the government isn't doing anything.

Cook believes we need a combination of conservation, efficiency, electrified transport, CAFE standards, transit oriented development (TOD), green building standards, localized services and agriculture, planting of trees, and assumption of high energy costs. Renewables make up such a small portion of our energy usage. A gallon of gasoline is very intensive and energy quality is an important part. One of the environmental challenges **Cook** brought up is the tar sands discussion. North America has peaked in natural gas production and the way we are extracting oil around the world is

unsustainable. In China 5,000 men die every year in coal mining disasters. She asks the audience: What are *you* (as elected, staff, or citizen) willing to do to bring about a different outcome? **Cook** believes that California is doing an incredible amount of things. How do we communicate different levels? CDs are a good way to distribute information. However, there are real challenges ahead. It is important to get people motivated and excited about this project. She concludes by stating that "We as individual citizens must embrace the culture of conservation so that we change the balance...I am suggesting a national effort in the way we behave and use energy, including autos, homes, work..." We all have to dance on the edge of the scope of your authority. We need to be more urgent in everything we do.

Local efforts outside the U.S. to increase energy access and reduce greenhouse gas emissions

Timothy Burroughs, Program Officer, International Council for Local Environmental Initiatives (ICLEI)– Local Governments for Sustainability

Burroughs began by stating that local governments can make an enormous contribution in the greenhouse gas (GHG) solution. ICLEI is a membership organization committed to reducing GHG emissions through local government action. The organization provides technical assistance to communities wishing to become more sustainable. ICLEI believes that the physical design of an urban settlement has inertia that helps determine energy demand for 50 to 100 years. Local governments also own vehicles and buildings and produce GHG emissions, too – usually between 2% and 10% of a city's total GHG emissions.

Local governments can implement many sustainable energy policies. Chief among them are land use and transportation policies, though municipal solid waste facilities also produce significant GHG emissions. Local governments are best equipped to tackle these problems because they are closest to their constituents and are more responsive than is the federal or state government.

Burroughs pointed out that there are also co-benefits to measures to increase sustainability: primarily, these are budget-friendly measures. Coordinated land use and transportation planning can also protect public health and reduce congestion, ICLEI believes. By taking charge on the issue of global warming, local officials can also increase their image as leaders.

ICLEI approaches its technical assistance outreach by estimating a municipality's current emissions, setting a target, developing a reduction plan, and assisting in the implementation of this action plan. Burroughs stated that it is important to be able to quantify the GHG baseline of a community and to measure progress accurately from that baseline. Monitoring and evaluating progress along the way, ICLEI then assists local governments in setting new goals. Another key activity for the organization is technology transfer and cataloguing best practices found throughout the world.

Municipalities can implement various policies and programs to reduce GHG emissions. Some are "low-hanging fruit", easily accomplished, while others are long-term goals. Burroughs highlighted some of these measures implemented worldwide:

Surabaya, Indonesia

- 5% surcharge of gas
- Taxing old and polluting vehicles
- Odd-even car days on demonstration bus way
- Environmental trust fund established

- Baguio, Philippines
- Number-Coding Scheme for Motor Vehicles, with one rest day for each vehicle (no driving allowed)

Sao Paulo, Brazil

- Methane to Energy
- Guntur, India
- Streetlight Management: Install energy savers and meters at 352 junction boxes

Bhopal, India

- Streetlight retrofit for greater efficiency

Querétaro, Mexico

- Retrofit 10,000 street lights
- Increase efficiency of public buildings
- Modernize water pumping equipment
- Convert vehicles to LPG
- Separate solid waste at source
- Separate solid waste collection & composting

Keene, New Hampshire

- Conversion of municipal fleet to biodiesel

Finally, **Burroughs** introduced a software tool, the Harmonized Emissions Analysis Tool (HEAT), which helps local governments measure their current emissions and identify potential ways to reduce GHG emissions.

Making wise policy under uncertain conditions: Energy futures, climate change, and transportation

Robert J. Lempert, Senior Scientist, RAND

Lempert began by introducing the RAND Corporation. RAND is a nonprofit institution dedicated to conducting objective, nonpartisan research. Currently, RAND has a major climate change research endeavor underway. **Lempert** believes that, regardless of emerging solutions to the greenhouse gas problem, the Earth will experience significant climate change already set in motion. The exact effects of this climate change, however, are difficult to predict. For example, precipitation could either increase or decrease; it is extremely difficult to plan for this kind of uncertainty, but it is necessary. **Lempert** believes that our visions of the future are inherently anchored in the reality of today, and that we must be aware of this tendency in order to be able to plan for a radically different tomorrow.

Though there will remain deep uncertainty about the future of the Earth, the research community must construct models to make predictions, and policymakers must respond to this research with action. However, it has proven tremendously difficult to construct valid models of the effects of climate change, as it remains unclear which systems are in play and in which ways they will interact with one another. Thus, researchers must remain mindful of the vast uncertainty of their predictions, and policymakers must plan for various scenarios, choosing policies and actions that help prepare for as many future outcomes as possible.

Lempert introduced the concept of "incremental steps to radical change." This concept includes a variety of strategies to ameliorate the effects of global climate change already set in motion while reducing greenhouse gas emissions and further climate change. Through technology research, the development of a market for new technologies, and changing attitudes toward climate change, emissions can be reduced. The introduction of a carbon-trading market and performance incentives can furthermore create a climate in which the transition to low-carbon technologies occurs with few problems. **Lempert** believes, for example, that while the creation of a carbon market may prove difficult, sustaining the market will require little effort at all, as industry adapts and the market becomes accepted.

Discussion

Tom Kelly began the final discussion by stating that he wished this panel had spoken at the beginning of the symposium. **Kelly** clarified that the Kyoto Protocol does not end in 2012, as was stated in the earlier presentation. The next phase of Kyoto began after the last Montreal conference.

Nancy Kete commented on programs which limit driving on certain days, such as the program implemented in Mexico City. She stated that this was not an effective program because instead of driving own cars, people took taxis, which were highly polluting. She was alarmed to hear that people are following this model in other countries. Is this program a good idea? **Burroughs** responded that these types of programs have worked in some places, but not in others. It is equally important to study what works *and* what doesn't work. In Indonesia, they are achieving quantifiable results by enacting programs such as these. We need to learn why Mexico didn't work. It is important to try different creative policies to see what is possible. **Lempert** agreed that learning from our mistakes is valuable information. We have to try many different solutions. Given the magnitude of the climate program, we have to experiment with radical changes. **Cook** echoed these points and stated that local governments could serve as role models by enacting creative policies and allowing workers to telecommute one day a week.

Richard Napier commented that small changes today could make a big effect in 30 years. Napier wanted to clarify the take-home message from this final presentation. The three important points that he noted were: 1) education, which will have an immediate impact; 2) fuel efficiency of transportation; 3) work on new initiatives, incentives, regulations and mandates. **Lempert** commented that this is a good list, but he would like to add one more: think locally and place specific. A small change in design could make a big savings down the line. **Burroughs** added that we shouldn't underestimate the policies

of smart growth and land use. There are a lot of great changes happening now and we don't start from zero. We should look at what's already working and build on that.

Timothy Papandreou commented that the most important thing he learned at this symposium is the importance of working for the environment. We must all lead by example. **Papandreou** said that he is not afraid of getting fired, so that allows him freedom in his work. He also shared that he doesn't own a car, so it is possible to get around Los Angeles without a car. It is a personal choice he made. The future is about choices; if we can't conceive of a future where it is possible to be carless, then we are not thinking outside the box. We need to retrofit our cities instead of just talking about fuels. Cars should be for special trips only. **Papandreou** posed a question to **Lempert** about immigration flows from the losers in climate change refugees. What strategies have you considered? **Lempert** answered that we haven't looked at any strategies yet, but it's very important to do so.

A comment was made about the importance of urban structure. Instead of patting ourselves on the back for small local solutions, we need to start acting with a greater sense of urgency in the U.S. We need to focus on that as a very concrete form of local action that will have huge impacts, without worrying about the rest of the world. **Cook** responded that we really have our heads in the sand here. It is important to look at world news and see what other countries are doing, but also focus on local changes. The EU is poised to pass really stringent energy efficiency standards. This means we can't sell there if we don't meet those standards as well. This will impact our economy if we don't think in those terms.

Nathan Landau offered ruminations on land use issues. When we think of the time scale of the built environment, such as castles built in the 1300s, we are now constructing a disposable landscape. A big box store has a life span of 9 years. At what time frame could we really start to retrofit our cities? How long would it take before we notice? What's the time frame on this? **Lempert** agreed with **Landau's** comment. He stated that it is important to think about the decisions we're making now and what their impacts will be in the future. The time frame depends on what the strategy is and when we'll see the effects. Land use strategies are longer-term.

Steve Brye asked a clarification question about zero net emissions. What does this term mean and what are the implications of failure? **Lempert** answered that in order to stabilize GHG emissions, we need zero net human contributions. This is an incredible goal, but is an example of the radical change we need to get back to pre-industrial climate. There is no such thing as a stable climate. **Taylor** added that we are looking at changes in the slope of the growth rate.

Tom Cosgrove noted that land use planning is in the title of this conference, so how can we use planning to accomplish local change? We are dealing at the local level with communities that are widely varied. How can we address all these communities while still looking at the big picture? **Cook** believes that a regional approach might be the best way to address these issues. SCAG could act as a repository for information. We can also put pressure on League of California Cities to think about energy and global warming.

Bob Larson addressed the issue of a vehicle tax which Axel brought up in his talk about Germany (the Oekotax). **Larson** asked, how did these taxes get passed? Was there a big educational campaign on why this tax was good for Germany? This is an example of a top down approach. How important is it that there is bottom-up support? **Lempert** believes that working with local officials is very important because they have good contacts with Washington. All three levels of government have to work together, but unfortunately there is not a lot of coordination. Thus, there must be a combination of top-down and bottom-up approaches. The power of community members and local officials is very important.

Steve Shaffer emphasized the importance of land use planning and preserving California's agricultural land. However, there is a lack of funding for updating general plans. This must be changed. **Burroughs** agreed that this is a very important point because many plans are 10-20 years old. It is necessary to encourage cities to integrate land use planning into the general plan. Plans must also be updated to include a climate plan into the comprehensive general plan. Marin County is a leader in this.

The Honorable Steve Kinsey commented that Marin is trying to go fossil free by 2033. Some of the strategies include a carbon credit card for municipalities. Carbon credits have the potential to generate funding for municipalities. We also have to start putting smart growth in areas where we want it, not in the Central Valley for example. His final comment was that we waste a lot of time fighting each other instead of working together. **Burroughs** agreed that coordination among local government is necessary for a climate task force to work.

The last few comments involved using the 1970s Clean Air Act as a model to reduce GHG emissions. It is important to look at short term actions as well as long term solutions. **Judy Corbett** suggested that people who are interested in issues of land use should attend the National Smart Growth conference which will take place in Los Angeles in 2007. See: http://www.newpartners.org.

Brian Taylor closed the symposium and concluded by echoing the final panelists. He stated that if we agree about the urgency of problems right now, the actions we take can have effects in decades ahead. The question still remains, specifically how do we bring that urgency forward together and merge today's issues (affordable housing, etc.) with GHG reduction goals? These questions warrant more reflection.

Conclusion

The 16th annual ***Transportation, Land Use and Environment Connection*** symposium addressed a timely topic with its focus on **Global Energy and Climate Change** in 2006. It succeeded in underscoring the complexity of the issues related to our use of energy resources and changes to our climate on a global scale.

The discourse of the speakers and participants included the sharing of diverse perspectives of academicians, business and government professionals, environmentalists, economists, scientists, industry experts, and elected officials. The discussion was reflective, passionate, confusing and yet forward thinking. The variety of views underscored the immensity of the issues which cannot be understated and are not well understood as a whole.

In the search for solutions, strategies were offered and discussed which varied widely and ranged from immediate, simple and easily-implemented to long-term, far more challenging efforts. Vehicle and fuel technologies will certainly play a significant role in reducing greenhouse gas (GHG) emissions. Automobiles, trucks, and other vehicles can and will be made cleaner, more efficient, and less carbon-intensive. The pros and cons of different fuels were discussed, and although improving personal and commercial vehicle fuel efficiency is one tactic in any GHG reduction strategy, another equally important tactic involves the reduction of vehicle miles traveled (VMT). One such means is expanding the overall share of transit in U.S. transportation. In addition, land use patterns and regulations, including parking regulations, all have the ability to influence travel behavior, and should be part of a larger mix of emission reduction techniques offered in our communities.

One of the paramount notions put forward by the symposium was that the exact ramifications of energy choices and climate change are not yet clear or well understood, yet most researchers agree that steps must be taken now to help ameliorate the effects, whatever they might be. Strategies were offered as useful tools and it is apparent that they will have to account for this continued uncertainty and attempt to compensate for a variety of potential future scenarios. Public policy decision making in this climate of uncertainty is plagued with difficulties.

In summary, the issues are global and complex. The call to action is urgent, yet undefined. One notable achievement of the symposium was conveying this sense of immediacy in recognizing the plethora of issues surrounding **Global Energy and Climate Change**. In choosing appropriate actions, it is imperative that public policy decision makers take into account that knowledge of the effects of our actions in addressing these issues is limited and unfolding. The link with research has never been more critical.

Program

October 22-24, 2006

UCLA Conference Center at Lake Arrowhead

850 Willow Creek Road

Lake Arrowhead, California

OVERVIEW

The links between local land use and transportation systems, and global weather systems and energy markets were cast in the sharpest possible relief when Hurricane Katrina slammed into New Orleans late last summer. Debates among scientists who study the effects of human activity on climates, and policymakers seeking both economic growth and environmental sustainability have intensified in recent months as fuel prices have climbed to unprecedented levels. How are fuel prices likely to fluctuate in the years to come? What effects will higher fuel prices have on travel and commerce? What effects do transportation systems have on global climate change? How might changes in climates affect both land development and transportation networks? What, if any, cleaner, cheaper fuels and propulsion technologies are on the horizon? And what are policymakers—local, state, national, and international—doing to cope with these issues in effective and affordable ways?

These and related questions motivate the **16th annual UCLA Lake Arrowhead Symposium on the Transportation-Land Use-Environment Connection**. Our goal is to bring together a wide variety of experts on these topics to speak on and debate, from many perspectives, what we know, what we need to learn, what others are doing, and what is not being done to address changes in global energy markets and climate patterns in the years to come.

Symposium Co-Organizers:

Catherine L. Showalter, Director, UCLA Extension Public Policy Program

Brian D. Taylor, Associate Professor and Vice Chair of Urban Planning, UCLA School of Public Affairs, and Director, UCLA Institute of Transportation Studies

Sunday Afternoon, October 22

12:30 pm REGISTRATION CHECK-IN AND REFRESHMENTS

1:00 pm **WELCOME**

Catherine Showalter, Director, UCLA Extension Public Policy Program

David Menninger, Interim Dean, Continuing Education and UCLA Extension

ENERGY AND CLIMATE CHANGE: IMPLICATIONS FOR PUBLIC POLICY

This opening session lays the groundwork for this wide-ranging three-day symposium. Foundation talks will address current scientific evidence on climate change, the role of the transportation sector in energy consumption and atmospheric emissions, a framework for evaluating energy and climate change policies, and strategic political considerations in energy and environmental security.

Moderator: ***Catherine Showalter***

■ Symposium Overview

Brian D. Taylor, Associate Professor and Vice Chair of Urban Planning, UCLA School of Public Affairs; Director, UCLA Institute of Transportation Studies

■ Climate Change Science: What We Know and Don't Know

Thomas C. Peterson, Research Meteorologist, NOAA's National Climatic Data Center

■ Transportation, Energy, and Emissions: An Overview

George Eads, Vice President, CRI International

■ Evaluating the Costs and Benefits of Energy and Climate Change Policies: An Overview

Joe Aldy, Fellow, Resources for the Future

■ Global Politics of Energy and Environmental Security: An Assessment

Jason Grumet, Executive Director, National Commission on Energy Policy

3:30 pm BREAK

3:45 pm **LINKS BETWEEN GLOBAL CLIMATE CHANGE AND LAND USE/TRANSPORTATION**

This second session will explore the transportation-land use connection to global climate change. The first presentation will examine how possible changes to weather patterns and sea levels may affect cities and the transportation networks that link them in the coming years. The second talk addresses whether and how land use and transportation policies may help to mitigate rates of climate change in the years and decades ahead.

Moderator: ***Brian D. Taylor***, UCLA

■ Projected Effects of Global Climate Change on Land Development and Transportation Infrastructure

Joanne R. Potter, Senior Associate, Cambridge Systematics

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■ **What Contributions Can Land Use and Transportation Planning Make to Mitigating Climate Change?**

John Poorman, Staff Director, Albany Metropolitan Planning, New York

5:00 pm ROOM CHECK-IN AND OPENING RECEPTION

6:30 pm DINNER

Sunday Evening, October 22

7:45 pm **THE BUSINESS OF UNCERTAIN ENERGY AND CLIMATE FUTURES: A ROUNDTABLE DISCUSSION**

To complement the focus on science, data, and public policy evaluation in the two opening sessions, this evening panel will explore future changes in energy prices, climatic patterns, and policies that aim to address them from a private sector perspective—particularly as they relate to land development, shipping, and travel.

Moderator: ***Norm King***, Director, Leonard University Transportation Center, CSUSB

Moderated Discussion

■ **Development Interests**

Dan Cashdan, Senior Managing Director, HFF Securities

■ **General Business Interests**

Gerald Secundy, Vice Chair, State Water Resources Control Board

■ **Petroleum Interests**

James Randolf (Randy) Armstrong Jr., Manager Compliance Assurance, Shell Oil

■ **Goods Movement**

T.L. Garrett, Vice President, Pacific Merchant Shipping Association

Eugene Pentimonti, Senior Vice President, Government Relations, Maersk Line Limited

■ **International Business Interests**

Nancy Kete, Director, EMBARQ World Resources Institute

9:30 pm INFORMAL RECEPTION AND CONTINUED DISCUSSION

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Monday Morning, October 23

7:30 am BREAKFAST

8:30 am **GLOBAL ENERGY: RESERVES, USAGE, AND PROSPECTS**

Rising energy prices, particularly for transportation, have garnered a lot of attention in recent years. Are these changes part of normal cycles and fluctuations, or do they portend an era of rising energy prices? If the latter, how are energy markets expected to change in the coming years? This session examines these questions by first reviewing projections on reserves and prices of conventional energy sources, the market potential for future energy sources in the coming years, and the implications of rising and/or volatile energy prices on the economy and travel in the future.

Moderator: ***Donald Shoup***, Professor of Urban Planning, UCLA School of Public Affairs

- **Understanding Energy Markets I: Future Reserves, Production, and Prices for Conventional Energy Sources**

John Kilduff, Senior Vice President, Energy Management Group, Fimat USA, Inc.

- **Understanding Energy Markets II: Future Reserves, Production, and Prices for Alternative Energy Sources**

Heather MacLean, Associate Professor, Department of Civil Engineering, University of Toronto

- **How Have and How Will Changes in Transportation Energy Prices Affect the Economy and Travel Behaviour?**

Kurt Van Dender, Assistant Professor of Economics, UC Irvine

10:15 am BREAK

10:30 am **NEW VEHICLES, NEW FUELS I: THE LONG VIEW**

How and when do new fuels and/or engines become cost-competitive? By what standards should we make such judgements? How much transition should be handled by private markets, and what roles should public policy play? What are likely to be the relative roles of new engines, new fuels, and behavioural changes in regards to future rates of fuel consumption and emissions? These questions and more will be addressed in a plenary presentation, commentaries, and ensuing discussion.

Moderator: ***Michael Shelby***, Chief Economist, Transportation and Climate Division in the Office of Transportation and Air Quality, U.S. EPA

- **Future Fuels and Vehicles: What Are the Near and Long Term Possibilities?**

Daniel Sperling, Director, Institute of Transportation Studies, and Professor, Civil & Environmental Engineering, UC Davis

- **Commentary**

Roland Hwang, Senior Policy Analyst, Natural Resources Defense Council

Margaret Bruce, Director of Environmental Programs, Silicon Valley Leadership Group

12:00 pm LUNCH

Monday Afternoon, October 23

1:15 pm **NEW VEHICLES, NEW FUELS II: EXPLORING THE ALTERNATIVES**

The commercial success of hybrid-electric vehicles has raised awareness among public officials and the public about the possibilities for introducing substantially cleaner and more efficient vehicles in the coming years. Accordingly, this session will examine many of the most important alternatives to conventional fuels and propulsion. What are the pros and cons of each, and what is the prognosis for wide-spread implementation in the coming years?

Moderator: ***Daniel Sperling***, UC Davis

■ After Diesel: Options for Cleaner Trucks, Trains, and Ships

Magdi Khair, Institute Engineer, Southwest Research Institute

■ Electricity

David Modisette, Executive Director, California Electric Transportation Coalition

■ Bio-Fuels

Steve Shaffer, Director, Office of Agriculture and Environmental Stewardship, California Department of Food and Agriculture

■ Hydrogen

Gene Berry, Engineer, Energy Storage and Conversion Group, Lawrence Livermore National Laboratory

■ Natural Gas

Mostafa Kamel, Director, Alternative Fuels Product Development, Cummins

3:15 pm FREE TIME

5:15 pm RECEPTION

6:00 pm DINNER

Monday Evening, October 23

7:30 pm **WHAT IN THE WORLD? TRANSPORTATION ENERGY AND GREENHOUSE GAS EMISSION PLANNING OUTSIDE OF THE U.S.**

Global energy and climate changes issues are just that: global. This second evening session will explore policy and planning efforts to increase energy efficiency and reduce greenhouse gas emissions in some developing and other developed countries.

Moderator: ***Dave Calkins***, Partner, Sierra Nevada Air Quality Group

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Moderated Panel

■ **Europe**

Axel Friedrich, Head of Environment and Transport Division, Umweltbundesant, Germany

■ **China and Mexico**

Lee Schipper, Director of Research, EMBARQ the WRI Center for Sustainable Transport

■ **Canada**

Michal C. Moore, Senior Fellow, Institute for Sustainable Energy, Environment, and Economy, University of Calgary

■ **Argentina**

Lucila Serra, Coordinator, Center for Global Change Studies, Torcuato Di Tella Fundacion, Buenos Aires

■ **What Can California Learn from These International Examples?**

Fran Pavley, Assemblymember, 41st District, California State Assembly

9:15 pm INFORMAL RECEPTION/DISCUSSION

Tuesday Morning, October 24

7:30 am BREAKFAST

8:30 am **RESPONSES TO GLOBAL ENERGY AND CLIMATE ISSUES IN SACRAMENTO AND WASHINGTON**

This penultimate session examines policy efforts to address energy and climate change by the federal government here in the U.S. as well in California and other states—particularly as they relate to transportation.

Moderator: ***Elizabeth Deakin***, Associate Professor of City and Regional Planning; Director of UCTC, UC Berkeley

■ **Federal Efforts to Reduce Oil Imports and Greenhouse Gas Emissions from Transportation**

Greg Dotson, Minority Counsel, Office of Representative Henry A. Waxman, House Government Reform Committee, Minority Staff, U.S. House of Representatives

■ **Assessing the Impact of the Federal Energy Bill's Renewable Fuels Standard (and Other Alternative Fuels) on CHG Emissions**

Larisa Dobriansky, Deputy Assistant Secretary for National Energy Policy, U.S. Department of Energy

■ **Assessing Efforts to Regulate Greenhouse Gas Emissions in California**

Ann Carlson, Associate Dean and Professor, UCLA School of Law, and Co-Director, Frank G. Wells Environmental Law Clinic

■ **California's Climate Action Plan**

Linda Adams, Secretary for Environmental Protection, California EPA

10:15 am BREAK

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10:30 am

LINKING DECISION-MAKING TO GLOBAL ENERGY AND CLIMATE ISSUES—OPPORTUNITIES AND UNCERTAINTIES

This closing session goes both global and local by examining local and regional efforts to address energy and climate change issues here in the U.S. and abroad—again with a focus on transportation and land development policies. What are some local actors doing to address these issues, and can acting locally make a difference? The session concludes by examining the question of what policymakers ought to do about these complex global issues, and when they should do it? How can we make wise decisions in times of uncertainty? When is it best to act, and when is it best to wait?

Moderator: ***Brian D. Taylor***, UCLA

- **Efforts by Local and Regional Governments in the U.S. to Link Transportation and Land Use Planning to Global Energy and Climate Change Issues**

Debbie Cook, Council Member, Huntington Beach City Council

- **Local Efforts Outside the U.S. to Increase Energy Access and Reduce Greenhouse Gas Emissions**

Timothy Burroughs, Program Officer, ICLEI's Cities for Climate Protection

- **Making Wise Policy Under Uncertain Conditions: Energy Futures, Climate Change, and Transportation**

Robert J. Lempert, Senior Scientist, RAND

12:15 pm LUNCH AND ADJOURNMENT

APPENDIX B: SPEAKER & MODERATOR BIOGRAPHIES

JOSEPH E. ALDY is a Fellow at Resources for the Future, a non-profit, non-partisan organization that conducts independent economic research on environmental, energy, and resource issues. His research at Harvard University focused on climate change policy, mortality risk valuation, and the benefits of energy subsidies to low-income households. Prior to attending Harvard, Aldy served on the staff of the President's Council of Economic Advisers from 1997 to 2000 where he was responsible for climate change policy and other environmental issues. He served as lead author of the Administration July 1998 report "The Kyoto Protocol and the President's Policies to Address Climate Change: Administration Economic Analysis" and the CEA September 1999 report "The Economics of Greenhouse Gas Emissions Abatement in China, A Preliminary Assessment." Aldy participated in bi-lateral and multi-lateral workshops and meetings on climate change policy in Argentina, Bolivia, China, France, Germany, Kazakhstan, Korea, Israel, Mexico, and Uzbekistan as well as at COP-4, COP-5, the OECD, and the International Energy Agency.

JAMES RANDOLF (RANDY) ARMSTRONG, JR., Manager Compliance Assurance for Shell Oil Company, began his career with Shell 1975. Randy has over 30 years environmental experience and has held various technical assignments in operations, engineering, health, safety and environmental. Armstrong has compliance and engineering experience in air, water and waste. He has been involved in environmental issues ranging from the Great Lake's Basin study in the mid 70's to his present role of coordinating Shell's US activities on climate change. Past activities have included hazardous waste incinerator testing, biotreater design, groundwater recovery activities, landfill operations, and the implementation of Clean Air Act requirements.

GENE BERRY is an energetics and economics analyst in the Energy and Environment Directorate at Lawrence Livermore National Laboratory (LLNL). He began researching hydrogen as an alternative fuel at LLNL in 1993, conducting both energy and economic analyses as well as experimental work in high efficiency electrolysis and more recently, automotive hydrogen storage using cryogenic capable pressure vessels. He currently focuses on analyzing the potential synergies to be gained from integration of a future hydrogen transportation sector with carbonless electricity generation technologies.

MARGARET BRUCE joined the Silicon Valley Leadership Group (formerly the Silicon Valley Manufacturing Group) as Director of Environmental Programs in March of 2001. Margaret also serves as the Chair of the Board for Sustainable Silicon Valley and this year was appointed to the San Francisco Regional Water Quality Control Board. In her role with the SVLG, Ms. Bruce works with local industry, environmental, and regulatory agency leaders and elected officials in developing innovative and effective legislative, regulatory and voluntary action solutions to the environmental issues facing Silicon Valley and California. Margaret has approximately 20 years of experience in the Environmental, Health and Safety and Environmental Policy fields, with professional experience in consulting, federal government R&D, high-tech manufacturing, and non-profit business and environmental organizations.

TIMOTHY BURROUGHS is a Program Officer in ICLEI's Cities for Climate Protection campaign. As such, he provides resources, tools, and technical and policy assistance to local governments working to reduce the greenhouse gas emissions that cause global warming. Timothy came to ICLEI from the EPA Headquarters' Climate Change Division in Washington, DC. There he assisted with the development of the Climate Friendly Parks initiative, a partnership program between the National Park Service and the EPA that works to educate and empower the public on the issue of global warming. Before joining the EPA, Timothy worked as a wilderness instructor and environmental educator with Outward Bound and

as a Peace Corps Volunteer in The Gambia, West Africa. In the Peace Corps he worked at the local level on sustainable agriculture and beekeeping practices.

DAVID CALKINS (MODERATOR) has over 40 years experience in government and the private sector. Since leaving his position as Air Programs Branch Chief for U.S. EPA (Region 9) in 1995, he has worked as an independent consultant. His government career included time with the Bay Area Air Quality Management District, the World Health Organization in Geneva, United Nations Development Programme, the U.S. Agency for International Development, various environmental organizations, and the National Commission on Air Quality (a congressional commission). In addition, Mr. Calkins was personally involved in the last three Clean Air Acts (1970, 1977, and 1990), both in providing direct assistance in writing and reviewing mobile source and land use measures for congressional staffs. As a consultant, Mr. Calkins has worked in the U.S. and abroad. Among the countries that he has worked with are China, Peru, Indonesia, Mexico, Argentina, Spain, Romania, Philippines, India, Jordan, and Syria. Most recently, he participated in the development of an emissions inventory training manual for use in the less developed countries of Asia for the Stockholm Environmental Institute. He is currently working with the Asia Development Bank in planning for a major air pollution conference in Indonesia in December, the Better Air Quality-2006 conference.

ANN CARLSON who recently served as the UCLA School of Law Academic Associate Dean, teaches Property and Environmental Law, co-directs the Frank G. Wells Environmental Law Clinic and is a founding faculty member of the Public Interest Law and Policy Program. Her scholarship in environmental law focuses on important constitutional questions affecting environmental law and policy, including standing, federalism and preemption, as well as on the role social norms play in affecting environmentally cooperative behavior. She also edits the Southern California Environmental Report Card, published by UCLA's Institute of the Environment. Professor Carlson's article *Takings on the Ground* was selected in 2003 by the Land Use and Environmental Law Review as one of the ten best recently-published articles in the country. Prior to joining the faculty in 1994, Carlson practiced law for Hall & Phillips, specializing in public interest, environmental and consumer litigation. She was also employed in various offices of California state government, including the California Senate Office of Research and the Senate Revenue and Taxation Committee.

DANIEL M. CASHDAN is a Senior Managing Director of HFF Securities L.P., the real estate investment banking affiliate of Holliday Fenoglio Fowler, L.P. Prior to joining HFF, Mr. Cashdan was a Partner and Managing Director at Chadwick Saylor and a Principal of CS Securities, Inc., its broker/dealer affiliate. His responsibilities included managing client relationships and raising capital for Investment Banking clients of the firm. Prior to joining Chadwick Saylor, Mr. Cashdan was a Senior Vice President at Aldrich, Eastman, Waltch where he was responsible for new product development and direct pension marketing. Prior to AEW, Mr. Cashdan was President of Real Asset Management Inc., an affiliate of Dimensional Fund Advisors and the RREEF Funds. He has developed and marketed institutional real estate products for the past 20 years and has been actively involved with real estate investment and development for the past 25 years. Mr. Cashdan was Founder and Chief Executive Officer of RealEnergy Inc. He is a general securities principal, an author of numerous articles relating to real estate investment and finance, and a member of the Pension Real Estate Association and the Urban Land Institute.

DEBBIE COOK has served six years on the Huntington Beach City Council, serving as Mayor in 2002. She serves on numerous boards and commissions including SCAG Regional Council and as President of the OC Division of the League of California Cities. Councilmember Cook currently chairs the SCAG Energy Working Group, and is focused on engaging the public, elected officials, and policy makers in recognizing and planning for our energy future.

ELIZABETH DEAKIN (MODERATOR) is Director of the UC Transportation Center, which funds research at multiple UC campuses (www.uctc.net). She is also Professor of City and Regional Planning at UC Berkeley, and Co-Director of the new Global Metropolitan Studies Program

(http://metrostudies.berkeley.edu), a new interdsiciplinary program of research and education on metropolitan problems and opportunities world-wide. Professor Deakin has published over 100 articles, book chapters and technical papers on critical issues in transportation, land use, end environmental planning and policy.

LARISA DOBRIANSKY is Deputy Assistant Secretary for National Energy Policy at the U.S. Department of Energy. She coordinates and provides strategic policy direction for Departmental activities to implement national energy policy objectives. As manager of such programs as the U.S. Clean Energy Initiative's Efficient Energy for Sustainable Development Partnership and the lead for the new APEC Energy Working Group's Task Force on Energy Efficiency and Renewable Energy Financing, she has focused on the technology innovation process and the development of risk-based policy tools and financial products to accelerate clean energy technologies into the marketplace. In representing DOE in bilateral and multilateral forums such as, the Renewable Energy and Energy Efficiency Partnership (REEEP) and the U.S.-China Joint Working Group on the 2008 Beijing Olympics, she has strived to foster effective public-private partnerships, the transfer of clean energy technologies to developing countries, and market development through the building of local commercial infrastructure and enterprises. Her special areas of expertise are designing market development strategies for commercializing clean energy technologies, facilitating locally-managed financing programs in developing countries for energy efficiency and renewable energy, and structuring risk-sharing public-private partnerships to accelerate market transformation to best practices and cleaner technologies. In this regard, Ms. Dobriansky has helped spearhead the development of model integrated community energy systems, such as in Chula Vista, California. Formerly, she was senior Counsel in the Washington office of Akin, Gump, Strauss, Hauer & Feld, L.L.P., focusing on environmental and energy policy issues. Ms. Dobriansky joined the firm after serving in senior legal and public policy positions in the executive and legislative branches of the Federal Government. Prior to joining the firm of Akin Gump, Ms. Dobriansky served as senior counsel to the Subcommittee on National Economic Growth, Natural Resources and Regulatory Affairs, U.S. House of Representatives. In that capacity, she was responsible for the oversight and investigation of all federal environmental and energy agencies and for legislative actions to reform environmental management. From 1992 until 1995, Ms. Dobriansky was a deputy assistant general counsel in the Office of General Counsel, U.S. Department of Energy, where she served as a leading advocate of DOE legal and policy positions on regulating the environmental impacts of energy systems; balancing energy, environmental and trade interests; and promoting the transfer of clean energy technologies.

GREG DOTSON is Counsel for the Office of Representative Henry A. Waxman, House Government Reform Committee, Minority Staff, U.S. House of Representatives. Mr. Dotson has been Counsel in the Washington, DC, Office of Representative Henry A. Waxman since 1996. He has also served as Minority Counsel with the House Government Reform Committee since 1998. He works on issues relating to energy, environment, public health, and governmental oversight. He has worked on numerous energy and environment-related laws at all phases of the legislative process, including the Energy Policy Act of 2005. As part of the investigative and oversight responsibilities of the House Government Reform Committee, Mr. Dotson has focused on U.S. oil dependence, the California energy crisis, human pesticide experiments and other issues.

GEORGE EADS is a Vice President in the Washington DC office of CRI International, an economics, finance, and business consulting firm that works with businesses, law firms, accounting firms, and governments in providing a wide range of services. Between 1979 and 1981 Dr. Eads was a Member of President Carter's Council of Economic Advisers. From 1986 to 1994 he served as General Motors' Chief Economist and as a GM Vice President. Over his thirty-five year professional career, Dr. Eads has led or participated in numerous projects related to transport and energy. Between 1999 and 2004, Dr. Eads devoted most of his time to the World Business Council for Sustainable Development's Sustainable Mobility Project. During the Project's second and final phase, he was its Lead Consultant. In this capacity, he oversaw the drafting of the SMP's final report, *Mobility 2030: Meeting the Challenges to Sustainability.*

AXEL FRIEDRICH is the Head of the Environment and Transport Division at the Umweltbundesamt (German EPA) and is the single person most responsible for progress in the European Union on motor vehicle and other controls. Dr. Friedrich was awarded this year's Haagen-Smit Clean Air Awards on May 8, 2006 in the USA. The California Environmental Protection Agency and California Air Resources Board are recognized and honored Friedrich's many years of efforts to reduce road traffic pollution. Friedrich is the first European to be awarded the honor. He has worked at UBA since 1980, heading the Traffic and Noise Department since 1995.

T.L. GARRETT began as Vice President with the Pacific Merchant Shipping Association (PMSA) in January 2005. PMSA represents the shipping lines and terminal operators that move approximately ninety percent of the containerized cargo on the West Coast of the United States. Prior to PMSA he was an Environmental Supervisor for the Port of Los Angeles in charge of the Air Resources Section. During his 15 years with the Port and City of Los Angeles Mr. Garrett was the environmental project manager on a number of capital development projects and air quality programs for the Port and City. Before coming to the port he was employed at the Natural History Museum of Los Angeles County in the ichthyology section for ten years. His focus now is working with the PMSA members on the air quality issues confronting the industry.

JASON S. GRUMET was appointed Executive Director of the National Commission on Energy Policy in January 2002. In this capacity, Jason helped design the organization, recruit Commission members and open the Commission's office in Washington D.C. In concert with Commission Co-Chairs, Jason oversees the organization's strategic direction, technical analysis, policy development and advocacy. In December 2004, after more than two years of research and debate, the Commission released its long-term energy strategy, *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges*. Since the report's release, the Commission has advocated its recommendations to Congress, the Administration, industry, the States, and other leading energy policymakers and stakeholders. Prior to joining the Commission, Jason served as Executive Director of Northeast States for Coordinated Air Use Management (NESCAUM).

ROLAND HWANG is currently working on transportation energy issues for the Natural Resources Defense Council's San Francisco office as the Vehicles Policy Director. Mr. Hwang has been with NRDC since October 2000. He is an expert on clean vehicle technologies, fuels and policies. He served on the California Hydrogen Highway Network Advisory Panel and is currently serving on the technical advisory panel for the Automotive X Prize. Mr. Hwang is the author or contributing author of eleven NRDC reports including *In the Tank: How Oil Prices Threaten Automakers' Profits and Jobs, Securing America: Solving Our Oil Dependence Through Innovation, Creating the California Cleantech Cluster, Smog in the Forecast: Global Warming, Ozone Pollution & Health in California*, *Hybrid Electric And Fuel Cell Vehicle Technological Innovation, Dangerous Addiction 2003: Breaking the Chain of Oil Dependence, Fueling the Future: A Plan to Reduce California's Oil Dependence*. Mr. Hwang also brings to NRDC experience in energy demand forecasting and air pollution regulation. Before joining NRDC, Mr. Hwang was the Director of the Transportation Program for the Union of Concerned Scientists (UCS) in the Berkeley, California office. Mr. Hwang has also worked for the United States Department of Energy at Lawrence Berkeley National Laboratory (LBNL) in Berkeley, California and the California Air Resources Board (CARB) as an Air Pollution Engineer. At LBNL, he developed computer models to forecast energy demand in the U.S. residential and industrial sectors. At CARB, Mr. Hwang was involved in the permitting process for hazardous waste incinerators and developed procedures to assist air districts in evaluating toxic air emissions from landfills.

DR. MOSTAFA M. KAMEL is the Director, Alternative Fuels Product Development for Cummins. He joined Cummins Engine Company in 1980 and worked in the areas of engine performance and product development for Automotive, Industrial and Powergen applications. Dr. Kamel currently has leadership responsibility for Product Development of all automotive alternative fuels engine

development. He is author of several technical papers and recipient of SAE's Arch T. Colwell Award. Dr. Kamel has also been awarded three US patents.

NANCY KETE is the Director of EMBARQ World Resources Institute. A geographer, Nancy Kete has always been attracted to large-scale problems at the energy/environment interface. Her academic and professional work aimed at finding solutions to the acid rain problem in North America resulted in the 1990 Clean Air Act Amendments. She was the principal architect of the acid rain control provisions of that law, which represent the first large-scale practical application of a tradable emissions program. She has been senior policy advisor in the US government on matters of air pollution, global warming, an the interface of trade and environment issues. Ms. Kete has extensive negotiating experience, having been part of numerous US delegations to international environmental negotiations and having served as the Science Advisor for Environmental Affairs for the US Mission to the OECD, where she co-chaired the Joint Experts Group on Trade and Environment. After resigning from the US government she directed the Climate, Energy, and Pollution program for five years at the World Resources Institute, until she became managing director of EMBARQ, the WRI Center for Transport and the Environment.

MAGDI KHAIR is an Institute Engineer at Southwest Research Institute. He has worked with diesel, stratified charge, and gas turbine engines since 1970. He is currently involved with developing emission control systems to help diesel and alternative combustion engines meet future regulated limits. Mr. Khair holds 16 US patents in the areas of fuel injection, turbocharging, exhaust gas recirculation and filtration, and diesel aftertreatment systems.

JOHN P. KILDUFF, is Senior Vice-President and Co-Head of the Energy Risk Management Group at Fimat USA, Inc. He is responsible for providing corporate energy risk management services, which include daily market research, market analysis, advisory services, and directly managing the hedging of energy price exposures, through the utilization of various exchange listed and over-the-counter, custom tailored, derivative products. Mr. Kilduff has previously appeared before the United States Senate Committee on Energy and Natural Resources to give an assessment of the energy markets. In addition, Mr. Kilduff is a frequent commentator on NBC Nightly News, CNBC and other national media outlets, providing his insights into the energy markets. Prior to joining Fimat in 1998, Mr. Kilduff had held several senior positions at ABN AMRO Incorporated, Metallgesellschaft Corp., and Lehman Brothers, Inc.

NORMAN R. KING (MODERATOR) became the first Director of the Leonard University Transportation Center at California State University San Bernardino in January, 2006. The center is a newly established "Tier II Center" promoting research and outreach on transportation issues of the Inland Empire. Norm served as Executive Director of San Bernardino Associated Governments (SANBAG)/San Bernardino County Transportation Commission and the three additional SANBAG related authorities from August, 1996 to his retirement in December, 2005. He was a City Manager for 20 years serving the Cities of Claremont, Palm Springs and Moreno Valley. At one time he served on the staff of the U.S. Conference of Mayors and the National League of Cities in Washington, D.C. Norm has been the President of the International City/County Management Association (ICMA) and the City Manager's Department of the League of California Cities. He is past Moderator of the California Self-Help Counties Coalition and is a Fellow of the National Academy of Public Administration. He has taught part-time at Claremont McKenna College. He is Chairman of the Board of Directors of the ICMA Retirement Corporation, a financial service firm providing deferred compensation programs to 800,000 local and state public employees throughout the country. He also is a member of the Advisory Council of the Public Policy Institute of California (PPIC). Mr. King's articles on the management and economics of local government have appeared in several professional journals and books. He is considered a leading proponent of "demand management" and "market-based" public policies.

ROBERT J. LEMPERT is a senior scientist at RAND and an expert in science and technology policy, with a special focus on climate change, energy, and the environment. An expert in the field of

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HEATHER MACLEAN is an Associate Professor in the Department of Civil Engineering at the University of Toronto. Prior to obtaining her Ph.D., she worked in manufacturing, project management, and environmental engineering consulting for five years. Professor MacLean's research interests are in developing and applying systems approaches to evaluate the technical feasibility and sustainability implications of alternative energy sources and relevant end-use systems. Her primary research has evaluated a large set of alternative fuel/propulsion systems for light-duty vehicles. Since joining the University of Toronto in 2000 she has focused on biofuels and nonconventional sources of crude oil. Professor MacLean has worked closely with the auto industry for the last decade. She has published her work in peer-reviewed journals as well as presented the work at international conferences and symposia. In 2005 she was awarded a Government of Ontario Early Researcher Award for her alternative fuels research.

DAVID L. MODISETTE is the Executive Director of the non-profit California Electric Transportation Coalition, and has been since the Coalition was formed in 1991. The California Electric Transportation is a business association of California utilities and other companies working together on the broad spectrum of electric transportation and goods movement technologies. Dave is also a partner in the firm of Public Policy Advocates, LLC. He has over 30 years experience working on energy and environmental issues in California. David served as Project Director of the California Legislature's Joint Committee on Energy Regulation and the Environment, and earlier was Legislative Director for an Assembly Member. Dave also worked for 10 years at the California Energy Commission, where he was Division Chief of the Energy Technology Development Division.

MICHAL C. MOORE is Senior Fellow at the Institute for Sustainable Energy, Environment and Economy at the University of Calgary in Alberta. As a member of the Energy and Environmental Systems Group, he is part of a coordinated effort to understand the relationship of carbon management strategies associated with energy development. He is the former Chief Economist at the National Renewable Laboratory in Golden Colorado, where he lead a research team engaged in examining over-the-horizon issues for the Department of Energy and developing new methods for cross-cutting analysis. He is an economist and former regulator in the energy industry in California. Dr. Moore obtained a PhD from the University of Cambridge in England in Economics where he is a member of Darwin College. He is a former Commissioner with the California Energy Commission, where he held the designated Economist position. In that role he oversaw market structure issues, pricing of electricity and natural gas and data collection for the Commission as presiding member of the Electricity and Natural Gas Committee. He directed the $2B US program to maintain and expand the renewable energy industry in the state and presided over many complex siting cases for new fossil fired generation.

EUGENE PENTIMONTI has over three decades of broad-based management experience in the shipping industry, where he has played a key role in the planning, engineering, and construction of the industry's shift to containerization, and in evaluating and designing vessels. Among his specific accomplishments, Mr. Pentimonti helped to design and build five diesel-powered, non-Panamax C-10 vessels, each with a container-carrying capacity of approximately 4300 TEUs. He was also closely involved with the engineering, construction, and operation of the industry's first doublestack trains. Mr.

Pentimonti is currently senior vice president with Maersk, Inc., one of the world's leading shipping companies with a fleet of more than 500 container vessels. In this capacity, he is responsible for the company's legislative, regulatory, and international government affairs. Before joining Maersk, Mr. Pentimonti was president of Pacer Stacktrain, a division of Pacer International. Mr. Pentimonti's other career highlights include his work as a consultant to Parsons Brinkerhoff and the Lockheed Martin IMS Corporation and as senior vice president of the American Trucking Association. Mr. Pentimonti also spent more than 25 years with American President Lines in various planning, design, engineering, development, operating, and management capacities. In 1987, Mr. Pentimonti was appointed the industry chairman of the Maritime Administration's Cargo Handling Cooperative Program, a position he still holds today. He has also been actively involved with efforts to research and evaluate automatic equipment identification technology, and has served as a member of the National Academy of Sciences' Marine Board, and the Transportation Research Board's technical committee.

THOMAS C. PETERSON is a research meteorologist at NOAA's National Climatic Data Center (NCDC). For the half decade after earning his Ph.D., Dr. Peterson primarily engaged in creating NCDC's global land surface data set used to quantify long-term global climate change. As a result of the expertise in global climate analysis he gained while creating this dataset, he has been asked to serve on a variety of national and international panels. Currently he is a member of the Global Climate Observing System Atmospheric Observation Panel for Climatel; chairs the World Meteorological Organization Commission for Climatology Open Programme Area Group on Monitoring and Analysis of Climate Variability and Change; and serves as a lead author on the Intergovernmental Panel on Climate Change Fourth Assessment Report and convening lead author on the U.S. Climate Change Science Panel Synthesis and Assessment Product on Weather and Climate Extremes in a Changing Climate. He is the author or co-author of over 50 peer-reviewed publications. In the spring of this year Dr. Peterson was commissioned by the National Research Council to write a paper on "Climate Variability and Change with Implications for Transportation."

JOHN P. POORMAN has been engaged in urban and metropolitan transportation planning and development for over thirty years, and has served as the director of the Capital District Transportation Committee (CDTC) since 1981. CDTC is the designated metropolitan planning organization for the four counties containing the Albany NY and Saratoga Springs NY urbanized area. CDTC has been honored for its leadership in land use – transportation integration work, use of performance measures, and visionary regional consensus building. In addition, John serves as chairman of the New York State Metropolitan Planning Organization (NYSMPO) and is a past vice-chairman of the national Association of Metropolitan Planning Organizations (AMPO). He has also served on the Transportation Research Board's Executive Committee and the Eno Transportation Foundation's Board of Advisors. He served as project chair of the "Colloquy on the Coming Transformation of Travel", a national research effort in 2005 under the auspices of FHWA and NYSMPO. From 1984 through 2001, John taught as an adjunct faculty member in the State University of New York at Albany's graduate Urban and Regional Planning Program. He was a German Marshall Fellow of the United States' Environmental Fund in 1996.

JOANNE R. POTTER, a Senior Associate of Cambridge Systematics, focuses her work on interdisciplinary approaches to transportation and emerging environmental issues. Ms. Potter has worked with the Federal Highway Administration's (FHWA) Office of Planning and Environment to plan and implement programs and research since 1998. For FHWA, she is coordinating a joint study of the U.S. Department of Transportation (DOT) and the U.S. Geological Survey to investigate the potential impacts of climate change and variability on transportation systems in the Gulf Coast, conducted under the auspices of the U.S. Climate Change Science Program. Ms. Potter worked with a DOT team to create and implement the U.S. DOT Center for Climate Change and Environmental Forecasting (the Center). She coordinated a scenario-based planning process and was primary author of the Center's five-year strategic plan. She managed a 2002 interdisciplinary workshop sponsored by the U.S. DOT and Federal partners to identify research priorities on the potential impacts of climate variability and change on transportation. Ms. Potter is coauthor of *Transportation in an Age of Climate Change: What Are the Research Priorities?*, TR News 2003, and author of *Workshop Summary,* in *The Potential*

Impacts of Climate Change on Transportation: Workshop Summary and Discussion Papers, DOT 2003. She supported the U.S. DOT multimodal Environmental Task Force for TEA-21 reauthorization, and earlier this year facilitated a workshop of state Departments of Transportation and FHWA to discuss the planning and environmental provisions of SAFETEA-LU. She will be Principal Investigator of an upcoming study for the National Cooperative Highway Research Program examining the current state of practice in integrating environmental information and transportation planning.

LEE SCHIPPER has devoted his career to earthly problems of transport, energy and environment. He came to EMBARQ, the World Resources Institute (WRI) Center for Sustainable Transport, at its founding in April, 2002, where he is Director of Research. EMBARQ's Global Strategic Partners, the Shell Foundation and the Caterpillar Foundation, support EMBARQ's partnerships in Mexico, Brazil, Istanbul, India and China. Dr. Schipper came to EMBARQ from the International Energy Agency (IEA) in Paris, where he had been Visiting Scientist from 1995 to 2001. Previous to that he was Staff Senior Scientist at the Lawrence Berkeley National Laboratory for two decades. He worked in Group Planning at Shell International Petroleum Company in the 1980s and again in 2001. He has been a guest researcher at the World Bank, VVS Tekniska Foerening (Stockholm), the OECD Development Center, and the Stockholm Environment Institute. Dr. Schipper has authored over 100 technical papers and a number of books on energy economics and transportation around the world. He takes part in numerous prestigious international panels and studies on energy and transportation, and is on the editorial boards of five major journals in the fields. Dr. Schipper was a member of the Swedish Board for Transportation and Communications Research for four years, and is currently a member of the US Transportation Research Board's Committee on Sustainable Transport and Committee on Developing Countries. Once a member of the UCLA jazz quintet, he still leads a jazz quintet from time to time, and recorded "The Phunky Physicist", with Janne Schaffer, in Sweden in 1973.

GERALD (JERRY) SECUNDY is Vice Chair of the State Water Resources Control Board. Upon graduation from law school, Mr. Secundy entered the United States Peace Corps, serving in Cusco, Peru for two years as a director of a youth center. He then joined the United States Department of Justice where he argued environmental cases at the Appellate Level. Mr. Secundy joined Atlantic Richfield Company in 1970 as an environmental/international lawyer. He served as Manager of Investor Relations, Manager of Long Range Planning, and assistant treasurer of Atlantic Richfield Company. In 1989 Mr. Secundy was appointed Vice President Finance and Administration (CFO), ARCO Transportation Company; in 1990 he became President of Four Corners Pipe Line Company; and in 1994 he was appointed to the position of Vice President, External Affairs and Environmental, Health & Safety for ARCO Products Company. Mr. Secundy retired from ARCO in 1998. In that same year he established GDS Consulting, a mediation and business-consulting firm, of which he is President. From 2002 until 2004 he was Executive Director of Audubon California. He then became Executive Consultant to the California Environmental Dialogue of which he is a founding member. In March of 2005 he was sworn in as a Member of the State Water Resources Control Board.

LUCILA SERRA is an attorney and environmental consultant with experience in the climate change international framework and carbon market since 2002. She has worked in climate change issues, policies and regulations and in the identification and development of Clean Development Mechanism Projects under the Kyoto Protocol in Latin America. Ms. Serra also worked on origination, transaction management and execution for ERPA -Emission Reductions Purchase Agreement- structures and direct investments in the underlying project as a means to leverage carbon assets. She served as Coordinator at the Center for Global Change Studies from the Torcuato Di Tella Foundation in Buenos Aires, Argentina, working on renewable energy and energy efficiency projects, on the cooperation between organizations in the US and the EU and in the transfer of climate friendly technologies. Her consultancy activities encompass work for public and private entities from the US and EU on climate change policy and CDM project activities in Latin America, as well as UNDP and World Bank projects. She has worked for 3 years at the Climate Change Office, Ministry of Environment and Sustainable Development from Argentina where she was responsible for legal issues, the evaluation of CDM projects and the

development of climate policies and regulations. She also served as Negotiator for the Argentine delegation at the Conference of the Parties (COP) sessions of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Since 2006, Professor Serra has taught the at the postgraduate course "Climate Change and the Carbon Market" at the Catholic Argentine University (UCA) in Buenos Aires, Argentina.

STEVE SHAFFER is Director of the Office of Agriculture and Environmental Stewardship for CDFA, the position he has held since November 2000. The office is comprised of an outstanding group of scientists who address environmental issues related to agriculture using a multidisciplinary approach. In this capacity, Steve represents CDFA on a number of environmental, energy and natural resource management planning, implementation and monitoring activities as they relate to agriculture. Steve served on the Governor's California Performance Review, a comprehensive review of State government "to make it work better and cost less." Steve is currently serving on the board of the CA Biomass Collaborative, on the Interagency Bioenergy Workgroup, and the Climate Action Team. He has been working to support the production and use of biofuels since 1981.

MICHAEL SHELBY (MODERATOR) is Chief Economist in the Transportation and Climate Division, Office of Transportation and Air Quality at the U.S. Environmental Protection Agency (U.S. EPA). One of the Transportation and Climate Divisions' principal responsibilities is examining alternative vehicle technology and fuel pathways to reduce greenhouse gas emissions from the U.S. transportation sector. While at the U.S. EPA, Dr. Shelby has worked on a variety of economic issues associated with climate change in the past fifteen years. Prior to that emphasis on climate change, Dr. Shelby was involved in addressing acid rain and air toxic issues.

DONALD SHOUP (MODERATOR) has focused his research on public finance, transportation, and the land market. He has extensively studied the issue of parking as a key link between transportation and land use, with important consequences for cities, the economy, and the environment. Shoup's research has led a growing number of cities to charge market prices for curb parking and dedicate the meter revenue to finance added public services in the metered districts. His research on employer-paid parking led to the passage of California's parking cash-out law, and to changes in the Internal Revenue Code to encourage parking cash out.

CATHERINE SHOWALTER (SYMPOSIUM CO-CHAIR) is the Director of the Public Policy Program at UCLA Extension. She is known throughout California and the nation for her leadership role in areas that have long connected to the work of the public policy program, specifically, transportation demand management, environmental resources protection, and regional economic development. She has had executive responsibilities within the public, private, and not-for-profit sectors, and has earned praise and trust from all the constituencies with which she has worked. Catherine is skilled and experienced in disseminating technical information in a straightforward manner for ease in understanding by diverse audiences, nationally and internationally. Catherine led a non-profit organization, RIDES for Bay Area Commuters, Inc. She has had executive positions within government agencies, notably first as manager and then Director of Transportation Programs for the South Coast Air Quality Management District. And before turning to public service, she was the vice president of a specialized consulting firm, Transportation Management Services.

DANIEL SPERLING is Professor of Civil Engineering and Environmental Science and Policy, and founding Director of the Institute of Transportation Studies (ITS-Davis) at the University of California, Davis. He is also co-director of UC Davis's Hydrogen Pathways Program and New Mobility Center and is recognized as a leading international expert on transportation technology assessment, energy and environmental aspects of transportation, and transportation policy. In the past 20 years, Dr. Sperling has authored or co-authored over 200 technical papers, reports and eight books. He is Associate Editor of Transportation Research D (Environment) and a current or recent editorial board member of four other scholarly journals. He is a member of U.S. National Academies committees on Highway Gas Taxes, Hydrogen, Personal Transport in China, Surface Transportation Environmental Cooperative

Research Program Advisory Board, Biomass Fuels R&D, Enabling Transportation Technology R&D, Transportation and a Sustainable Environment, Transportation Options for Megacities, and Liquid Fuel Options. Dr. Sperling was selected as a lifetime National Associate of The National Academies in 2004, is founding chair and emeritus member of the Alternative Transportation Fuels Committee of the U.S. Transportation Research Board, and serves on many advisory committees and Boards of Directors. He consults for international automotive and energy companies, major environmental groups, and several national governments. Professor Sperling worked two years as an environmental planner for the US Environmental Protection Agency and two years as an urban planner in the Peace Corps in Honduras. During 1999-2000, he was on leave as a visiting scholar at OECD (European Conference of Ministers of Transport).

BRIAN D. TAYLOR (SYMPOSIUM CO-CHAIR) is an Associate Professor of Urban Planning and Director of the Institute of Transportation Studies at UCLA. He was recently a Visiting Scholar in the Department of Civil and Environmental Engineering at the University of Hawaii at Manoa. His research centers on both transportation finance and travel demographics. He has examined the politics of transportation finance, including the influence of finance on the development of metropolitan freeway systems and the effect of public transit subsidy programs on both system performance and social equity. His research on the demographics of travel behavior has emphasized access-deprived populations, including women, racial-ethnic minorities, the disabled, and the poor. Dr. Taylor's work in this area has also explored the relationships between transportation and urban form, with a focus on commuting and employment access for low-wage workers. His current research examines both security and ridership on public transit systems, and on the causes and consequences of traffic congestion. Professor Taylor teaches courses in transportation policy and planning and research design. Prior to coming to UCLA in 1994, he was an Assistant Professor in the Department of City and Regional Planning at the University of North Carolina at Chapel Hill, and before that a Transportation Analyst with the Metropolitan Transportation Commission.

KURT VAN DENDER is an Assistant Professor of Economics at the University of California, Irvine, and has served in that capacity since 2002. His research focuses on the design of policies to alleviate traffic congestion and policies to reduce emissions from passenger transportation. Van Dender has published widely in highly ranked economics journals, and his research has informed policy makers. For example, he was closely involved with projects supporting the development of the European Commission's policy on Fair and Efficient Transport Pricing. More recently, his work on the rebound effect has been used by the California Air Resources Board in shaping policies to reduce greenhouse gases from transportation, and in the U.S. Department of Transportation's reform of fuel economy standards for light trucks.

APPENDIX C:

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We acknowledge the following agencies and organizations for the financial support they contributed to this symposium, and also for their participation in its planning:

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