


**Shell Center**  
**for Sustainability**  
RICE UNIVERSITY



**1** Inaugural  
Conference

March 12-13, 2003  
Rice University - Houston, Texas





*“Sustainable development is all about trying to bring about green growth, which benefits both the national environment and the humans who depend upon it for clear air, clean water, healthy foods, and so much else.”*

—Dr. Malcolm Gillis  
President, Rice University

*“We see sustainable development as a practical way of integrating economic, social, and environmental needs throughout our operations—driven by systematic engagement with the concerns of those they affect.”*

—Sir Philip Watts  
Chairman of the Committee of Managing Directors,  
The Royal Dutch/Shell Group

## Shell Center for Sustainability Inaugural Conference Lessons Learned: Innovative Approaches to Sustainable Development

The concept of sustainable development provides a framework for addressing issues on an integrated basis in economic development, social development and environmental quality across generations so that development maximizes the long-term benefits to society.

“Opportunities exist today to achieve environmental improvement, economic growth, and social development through the deployment of new engineering and managerial technologies, training related to sustainability, and the development of public policy focused on enhanced sustainable development,” explained Christian Holmes, Executive Director of Rice University’s Shell Center for Sustainability, at the center’s inaugural conference on March 12-13, 2003, at Rice University in Houston. Holmes noted that the center’s role will be to “undertake research, education, and outreach efforts related to the role of the private sector in fostering sustainable development.”

The center, made possible through the generosity of Shell Oil Company Foundation and other donors, is an interdisciplinary program that will foster new technologies, processes, products, and markets that will strengthen the three pillars of sustainable development: economic growth, environmental improvements, and social progress. Supported by two other interdisciplinary programs at Rice—the James A. Baker III Institute for Public Policy and the Environmental and Energy Systems Institute—the Shell Center represents an important part of the university’s commitment to making a meaningful contribution to the great public questions confronting us at the beginning of the 21st Century.

The inaugural conference was held in the Shell Auditorium at the Jesse H. Jones Graduate School of Management and at James A. Baker III Hall. It drew a large and varied audience from around Texas, the United States, and the globe. Participants in the two-day event included scientists, business people, government officials, representatives of non-governmental organizations, the media, policy experts, students, and concerned citizens.

The inaugural conference was an opportunity both to take note of an ambitious new institute dedicated to research and education and to thank the public-spirited benefactors who had helped in its creation.

Through a plenary session and three specialized workshops, the conference offered a chance for the Shell Center to seek guidance from the many public and private “stakeholders” in a sustainable future. “Today is not only an opportunity to celebrate the creation of the center,” Holmes said in his opening remarks, “It is also an important opportunity to develop a plan of action going forward.”

Shell Center for Sustainability Inaugural Conference  
March 12-13, 2003

Keynote Speakers

Dr. Malcolm Gillis  
*President, Rice University*  
Dr. Paula Dobriansky  
*U.S. Undersecretary of State for Global Affairs*  
Sir Philip Watts  
*Chairman of the Committee of Managing Directors, The Royal Dutch/Shell Group*

Plenary Speakers

Dr. Francisco Dallmeier  
*Director, Monitoring and Assessment of Biodiversity Program  
National Zoological Park Conservation and Research Center, Smithsonian Institute*  
Mr. Guy Hascoet  
*Former French Minister of State for Social Economy*  
Mr. Christian Holmes  
*Executive Director, Shell Center for Sustainability and  
Environmental and Energy Systems Institute, Rice University*  
Dr. Richard Sandor  
*Chairman and CEO, Chicago Climate Exchange (CSX)*  
Mr. Bjorn Stigson  
*President, World Business Council for Sustainable Development*  
Mr. Hiroyuki Watanabe  
*Senior Managing Director, Toyota Motor Corporation*

Panelists

Mr. James Blackburn  
*Chair, Galveston Bay Conservation and Preservation Association*  
Dr. Matthew Fraser  
*Assistant Professor, Civil and Environmental Engineering, Rice University*  
Mr. Hank Habicht  
*Chief Executive, Global Environment Technology Foundation*  
Mr. Kurt Hoffman  
*Director, Shell Foundation*  
Dr. David G. Victor  
*Director, Stanford University Program on Energy and Sustainable Development*  
Dr. Kyriacos Zygourakis  
*Chair, Chemical Engineering Department, Rice University*

Workshop Co-chairs

Air and Urban Sustainability  
Dr. David T. Allen  
*Chair, Texas Council on Environmental Technology*  
Dr. Alberto Mendoza  
*Assistant Professor, Chemical Engineering, Instituto Tecnológico y de Estudios Superiores de Monterrey*

Energy

Ms. Amy Myers Jaffe  
*Wilson Fellow for Energy Studies, James A. Baker III Institute for Public Policy;  
Associate Director, Environmental and Energy Systems Institute, Rice University*  
Dr. Nancy Kete  
*Senior Fellow and Co-Director of the EMBARQ Center for Transport and Environment, World Resources Institute*  
Dr. Rahul Tongia  
*Research Engineer, Engineering and Public Policy Department, Carnegie Mellon University*

Water

Dr. Alain Dangeard  
*Chairman and CEO, M.E.E. Development*  
Dr. Mark R. Wiesner  
*Director, Environmental and Energy Systems Institute, Rice University*

## Themes

A host of respected experts, policy specialists, and practitioners addressed differing perspectives on sustainable development and key lessons learned in their experience of successful initiatives in the areas of air, water, and energy. Among the major themes stressed during the opening session were:

1. the necessity of identifying policies that protect the environment, enhance social progress, and bolster economic growth;
2. the importance of market-based solutions in fostering sustainable development;
3. the necessity of more accurate pricing of environmental goods;
4. the risk of overlooking the environmental impact of government policies in such areas as subsidies and taxation;
5. the key role of strong public-private partnership;
6. the importance of business being seen as part of the solution instead of a source of the problem;
7. the close relationship between poverty and lack of access to affordable energy and water;
8. the decisive role of technology in addressing both short- and long-term challenges;
9. the advantages of solutions that provide co-benefits, particularly in the closely related areas of energy and clean air.

*“Most importantly I hope that the Shell Center will be able to ignite in the students at Rice and elsewhere a passion for a sustainable approach to growth. I hope that they will adopt sustainability as a guiding value and that no matter what professions they choose—they will consider sustainability to be a tool that will enable them to have a positive impact on the environment, their communities, and economic growth.”*

—Mr. Christian Holmes  
Executive Director,  
Shell Center for Sustainability and  
Environmental and Energy Systems Institute,  
Rice University

## Summary of Key Findings and Recommendations

The following summarizes key findings and recommendations delivered by the keynote and plenary session speakers. These findings and recommendations do not reflect conference wide consensus; rather they summarize key points made by conference speakers.

1. Nonenvironmental policies in such areas as taxation, industrial policy, credit, and agriculture play a critical role in sustainable development. Too narrow a focus on environmental policy could lead to unintended—and potentially disastrous—consequences. (Gillis)
2. Governments—individually and in concert—play a critical role in helping business foster sustainability by creating stable, market-based frameworks that encourage and enable innovation. (Gillis)
3. The private sector plays a critical role in addressing the challenge of climate change in a world of increasing demand for energy. Profit-driven technological innovation is crucial. Two key factors affect meeting growing world demand for energy: resource availability and innovation. Energy resource constraints are unlikely until 2025 or even after; research and development in new energy technologies are going forward rapidly. (Watts)
4. Public-private partnerships and the vital role of technology are the building blocks in creating a revolution in energy affairs that would benefit developed and less-developed countries alike. The United States—whose research and development on climate equals the rest of the world combined—will play a decisive role in fostering that revolution. (Dobriansky)
5. European politics has adopted a more integrated approach to sustainability than its American and Asian counterparts. European political platforms integrate sustainability goals directly into their ideology and socio-economic programs in a more holistic manner. (Hascoet)
6. New markets, such as creating a market mechanism to set prices for greenhouse gas emissions, can play a key role in pricing environmental goods and preventing the kind of market failures and resulting environmental degradation seen around the world. (Sandor)
7. Improving sustainable mobility in a world of rising demand must mean a broad-based approach that includes modifying conventional engines, both gasoline and diesel, and introducing new vehicles, first hybrid and then fuel cell. (Watanabe)
8. The Smithsonian’s public-private partnership with Royal Dutch Shell Group in Gambia serves as a model for public-private partnerships targeted on biodiversity. (Dallmeier)

9. Efforts to improve air quality will require the integration of a bewildering array of regulatory, legislative, and private initiatives. Success will require new institutional relationships that recognize the imperative of public-private partnerships and market-based systems. (Habicht)

10. Given rising population and increasing affluence (particularly in developing countries), environmental burdens will become unsustainable without new or dramatically improved technologies. In the case of air pollution over the next 50 years, to completely offset effects of population growth, new or improved technologies must reduce emissions by 98 to 99 percent. (Zygourakis)

11. Lack of access by the poor to modern energy services constitutes one of the most critical links in the poverty cycle. The link must be broken if poor countries, communities, and households are to achieve sustainable development. The stark reality of the 1.6 billion people who lack access or cannot afford electricity must shape any discussion of energy and sustainable development. (Hoffman)

12. In addition to rising future demand for energy, two other long-term important trends have emerged: The first is a shift—welcome on health grounds—away from biomass and toward electricity as an energy source. The second is the rising importance of natural gas, particularly in electrical power generation. (Victor)

13. There is a real risk of irreparable damage to the estuaries of Texas. If we destroy the natural system, we will not have sustainability. (Blackburn)

14. The world water situation is critical, with up to 80 percent of the world's population lacking access to reliable water systems. Pollution control efforts are highly skewed towards developed countries, with 85 percent of control activities serving only 18 percent of the population. Traditional centralized water systems are not affordable to two-thirds of the world's population. (Dangard)

15. Companies, governments, financial markets, and academia all have important and complementary roles to play. It is imperative to train a new generation of leaders in sustainable development. Education is a vital part of the Shell Center for Sustainability's mission. Business cannot succeed in a society that fails. (Stigson)

## Policy Impacts

Malcolm Gillis, president of Rice University, opened the conference by stressing the need for market-based solutions to environmental degradation. "Sustainable development," he declared, "seeks to make conservation the handmaiden of development." While noting that there is no universally agreed definition of the concept, he suggested that sustain-


able development could best be described as a path that maximizes the long-term net benefits to humankind. Sustainable development does not mean limiting growth but developing sensibly.

Gillis focused on the importance of "getting the prices right" and explained the environmental degradation and outright depletion that comes from persistently undervaluing natural resources and environmental services. Underpricing in such areas as water, grazing, forestry, energy, and agriculture, Gillis pointed out, inevitably leads to overuse and degradation. While some of this undervaluation occurs because of market failures now well-documented by economists, much is attributable to policy failures, notably the pervasiveness of counterproductive governmental subsidies.

In one notable example, Gillis explained that the Brazilian government's heavy subsidies to ranching destroyed rainforest occupations that provided more jobs than the subsidized ranching operation. Nevertheless, the government made deforestation as cheap as possible. "Although a typical subsidized investment yielded a loss to the economy equivalent to 55 percent of the initial investment," Gillis explained, "heavy subsidies allowed private ranchers to earn a positive return equivalent to 250 percent of their investment, while the forest was relentlessly destroyed."

Gillis also emphasized the role that poverty itself can play in damaging the environment. He cited the emergence of "shifted cultivators" in Africa and Asia—landless, mostly urban people driven to migrate to the forest by economic need—with tragic consequence for the environment.

When thinking of sustainable development, Gillis suggested, it is critical to remember the role of nonenvironmental policies in such areas as taxation, industrial policy, credit, and agriculture. Too narrow a focus on environmental policy could lead to unintended—and potentially disastrous—consequences.



*"Sustainable development seeks to make conservation the handmaiden of development while protecting the interests of future generations. In sensible sustainable development, preservation is valued not for its own sake, but for what it can do for the welfare of present and future generations"*

—Dr. Malcolm Gillis  
President, Rice University

## Energy and Climate Change

In his remarks welcoming the opening of the Shell Center, Sir Philip Watts, chairman of the Royal Dutch/Shell Group, stressed the importance of collaboration in reducing the threat of climate change. “Business has a role to build bridges,” the senior executive emphasized, explaining that Shell was committed to doing its part through reducing its own greenhouse gas emissions, helping its customers to do so, and working with others to advance practical solutions. The company has reduced its greenhouse gas emissions by 10 percent over 1990 levels. Despite anticipated growth in its business, Shell is pledged to keep them at least five percent below 1990 levels in 2010.

Looking forward, Watts suggested that there were two key factors in meeting growing world demand for energy: resource availability and innovation. Shell believes that energy resource constraints are unlikely until 2025 or even after, and Watts noted that research and development in new energy technologies are going forward rapidly.

Watts emphasized the critical role of the private sector in addressing the challenge of climate change in a world of increasing demand for energy. “Business is a part of the solution,” he said, “not the problem.” He noted the importance of the World Business Council for Sustainable Development (WBCSD) in coordinating efforts in such areas as developing new transportation technologies and increasing eco-efficiency in the delivery of goods and services. Watts acknowledged the central role of governments—individually and in concert—in helping business play its part by creating “stable, market-based frameworks that encourage and enable innovation.” He stressed, however, that all concerned—public and private sector alike—need to focus on taking practical action today rather than getting bogged down in the details of extreme long-range planning.

*“Energy developments have always depended on innovation, as businesses respond to challenges and opportunities. This creativity has certainly not diminished. More resources are being applied to research, made more effective by modern communications and computing. I believe we are entering a particularly innovative period in energy technology.”*

—Sir Philip Watts  
Chairman of the Committee  
of Managing Directors,  
The Royal Dutch/Shell Group

*“Addressing global climate change will require the combined effort of all nations over the course of this century as well as major advances in the underlying science. We need what I would call a Revolution in Energy Affairs—that is the development and deployment of newer and cleaner energy technologies that will help us address climate change.”*

—Dr. Paula Dobriansky  
Undersecretary of State for Global Affairs  
U.S. Department of State

## The View from the United States

Paula Dobriansky, U.S. undersecretary of state for global affairs, concurred with earlier speakers that economic growth could be “the solution to climate change, not the cause of it,” noting that new technology and enhanced energy efficiency that comes along with economic development brings a reduction in emissions.

The focus of governmental action, she emphasized, must be on achieving tangible results, not just publishing new international agreements. The U.S. diplomat spoke of the need for result-oriented programs. She noted that development of new, cleaner energy technologies is a pivotal aspect of climate change policy and that trade policy could be an engine for public-private partnerships that institute good governance processes.

The undersecretary said that the Bush administration’s approach had three basic elements: to slow the growth of greenhouse gas emissions, to work with other nations to develop an effective global response, and to pursue assertively new technologies and better science. She highlighted recent initiatives in support of these goals. They included a national goal of reducing greenhouse gas intensity by 18 percent over the next 10 years and a voluntary public-private program—Climate Vision 12—to reduce emissions. She also described a series of administration “action-oriented” climate change dialogues with 14 nations and regional entities. These, she stressed, did not conflict with the spirit of the Kyoto Protocol but would, in fact, supplement it.

In explaining that the Bush administration had already begun new programs designed to help the U.S. meet climate change goals, Dobriansky detailed measures—including support for carbon sequestration research, hydrogen fuel development, and fusion power generation—aimed at fostering scientific and technological innovation. The president’s new

budget, Dobriansky said, includes tax credits that support use of alternative energy sources, such as solar heating systems for residences, hybrid and fuel cell vehicles, and energy produced from landfill gas.

Throughout her remarks, Dobriansky stressed both the importance of public-private partnerships and the vital role of technology in creating what she described as the promise of a “revolution in energy affairs” that would benefit developed and less-developed countries alike. She said that the United States—whose research and development on climate equals the rest of the world combined—will play a decisive role in fostering that revolution.

## The View from Europe

European politics has adopted a more integrated approach to sustainability than its American and Asian counterparts. European political platforms integrate sustainability goals directly into their ideology and socioeconomic programs in a more holistic manner. But much work needs to be done to eliminate inconsistencies created by special interest groups and industries whose needs are at odds with overall globally oriented sustainability goals.

Guy Hascoet, former French minister of state for social policy, noted that the last 10 years have witnessed a growing awareness of private sector responsibility in such areas as the environment, treatment of women and minorities, and exploitation of children.

Drawing on the European tradition of the “social economy,” Hascoet stressed that sustainable development must begin with the immediate need to provide such basics as education, healthcare, and access to water. But he also mentioned broader goals as well, including democracy, human rights, and North-South dialogue. Indeed, Hascoet described sustainability as an “evolutionary political program.” “Sustainable development,” he declared, “is the only strategy of peace.” Hascoet was on occasion critical of developed countries in their approach to sustainable development. He noted that agricultural protection in wealthy countries cost less-developed economies up to 60 billion dollars a year in lost exports. Hascoet pointed out the hypocrisy of doing so even as rich countries criticized poorer ones for their lack of commitment to free market principles.

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for Social Economy

*“There is a linkage now between environmental markets, commodity markets, and financial markets.”*

—Dr. Richard Sandor  
Chairman and CEO,  
Environmental Financial Products, LLC

## A Look at Workable Market Solutions

New markets can play a key role in pricing environmental goods and preventing the kind of market failures and resulting environmental degradation seen around the world, according to Richard Sandor, chairman and CEO of the Chicago Climate Exchange (CCX). Sandor noted that the Chicago Climate Exchange is a first but potentially important step in creating a market mechanism to set prices for greenhouse gas emissions. The CCX—a voluntary cap-and-trade program for reducing and trading these emissions—is a pilot market for emissions sources, farm and forest carbon sinks, offset projects, and liquidity providers in North America; it will also facilitate participation by offset providers in Brazil.

Sandor stressed that firms agreed to voluntary cuts in emissions under the CCX formula for sound business reasons: such a pledge increased stockholder value by promoting competitive advantage through potential trading profits as well as protecting companies against possible litigation and shareholder activism. The CCX already has roughly 15 members, producing about 250 million metric tons of carbon dioxide annually; and discussions are under way with more than 80 other companies. Trading is expected to begin in 2003.

Putting the development of a climate change exchange in a historical context, Sandor described a process of evolution that led to the creation of markets in such varied commodities as wheat, collateralized mortgage obligations, and sulfur dioxide emissions allowances. He said that the market in greenhouse gas emissions had already met most of the preconditions for a private-sector commodity trading market. The CCX was an attempt to move this process forward by creating proof that sustainability and superior stock performance were compatible. “There is a linkage now,” Sandor declared, “between environmental markets, commodity markets, and financial markets.”

In another example of market-based solutions, Hiroyuki Watanabe, senior managing director of Toyota Motor Corporation, discussed how his company is matching the business of meeting the growing demand for automobiles with the



goal of “sustainable mobility.” He pointed to Toyota’s participation in the WBCSD’s mobility project as an expression of his company’s commitment to promotion of broad-based economic growth and the elimination of the mobility divide between rich and poor, but in a manner that protects rather than harms the environment.

Watanabe, who is responsible for Toyota’s development of hybrid and fuel cell systems, noted that improving sustainable mobility in a world of rising demand must mean a broad-based approach that includes modifying conventional engines, both gasoline and diesel, and introducing new vehicles, first hybrid and then fuel cell.

Watanabe stressed that technological efforts must not be limited to vehicular efficiency, but on every step of an automobile’s production chain. “The efficiency of pumping, refining, and transporting energy or well-to-tank efficiency and vehicle efficiency or tank-to-wheel efficiency,” Watanabe said, “must be put together as well-to-wheel efficiency, which must be the subject of our discussions.” Watanabe noted that while the fuel cell hydrogen vehicle (FCHV) reduced vehicular CO2 emissions to zero, it faced major hurdles in terms of environmental externalities, cost, and support infrastructure. Not least, producing the fuel cell itself created CO2. Once this CO2 was factored in, the current FCHV held little or no advantage over hybrid vehicles in terms of greenhouse gas emissions. Mr. Watanabe noted that despite the fascination with hydrogen vehicles, Toyota considers a diesel engine with a particulate and NOx reduction catalyst as an equally important environmental step forward.

*“Technological efforts must not be limited to vehicular efficiency, but on every step of an automobile’s production chain. The efficiency of pumping, refining, and transporting energy or well-to-tank efficiency and vehicle efficiency or tank-to-wheel efficiency”*

—Mr. Hiroyuki Watanabe  
Senior Managing Director,  
Toyota Motor Corporation

## Power of Public–Private Partnerships

Public-private partnerships will play a critical role in the development of more sustainable economic development strategies. While governments can and do intervene to influence environmental decision-making, protection, and performance through regulation, taxation, and subsidy, the private sector also has a huge role to play. Industry is increasingly

emphasizing that sustainable business practices will be more profitable and ensure the companies’ long-term future.

Many corporations have begun to seek out public-private partnerships that promote consultation among local stakeholders, conservationists, governments, and industry, such as resource developers. These cooperative ventures, which bring together many concerned parties to put together and monitor resource development plans are emerging as a new avenue to promote sustainable development in such areas as real estate development, oil and gas exploitation and water-industry privatization.

The Smithsonian Institute has been a leader in bringing together various groups into public-private partnerships to foster biodiversity. Francisco Dallmeier, director of monitoring and assessment for the institute’s Biodiversity Program, told the conference that biodiversity has an immense value but it is often misunderstood. Some of that value, in areas such as tourism or fisheries, is easily quantifiable. But much of the value of biodiversity is difficult to price with any accuracy, such as its role in climate modification or drought/flood control, or impossible to measure, such as its part in religious or other cultural traditions.

The Smithsonian’s public-private partnership with Royal Dutch Shell Group at the Gambia Complex project may serve as a model for future such projects, according to Dallmeier. The Smithsonian also has been a leading member of the Energy and Biodiversity Initiative (EBI), a consortium of energy companies and conservation organizations, which are committed to creating tools and guidelines for integrating biodiversity more closely into oil and gas development. The EBI’s goal is to foster a set of best practices that will shape the approach of energy companies to development in some of the most environmentally sensitive regions in the world.

*“The Energy and Biodiversity Initiative’s goal is foster a set of best practices that will shape the approach of energy companies to development in some of the most environmentally sensitive regions in the world.”*

—Dr. Francisco Dallmeier  
Director, Monitoring and Assessment  
of Biodiversity Program  
National Zoological Park Conservation and  
Research Center, Smithsonian Institute

## The Specific Challenges of Sustainable Energy Supply, Clean Air, and Protection of Water

### Air

Efforts to improve air quality will require the integration of a bewildering array of regulatory, legislative, and private initiatives, according to Hank Habicht, CEO of Global Environment and Technology Foundation. “Success,” he declared, “will require new institutional relationships” that recognize the imperative of public-private partnerships and market-based systems.

Any effective approach, Habicht argued, would have to recognize the close convergence of energy supply and clean air policy by identifying and promoting co-benefits. There remain huge inefficiencies in the American and—indeed, world—power generation system. Regulation should be examined in terms of encouraging innovation. It should also recognize the importance of capital cycles and asset lives. Efforts like the administration’s “Clear Skies” initiative should be applauded for attempting to create a simple, stable set of rules for businesses.

Habicht discussed important efforts to achieve the integration he said is central to success. They include airshed based public-private partnerships, a National Commission on Energy Policy, and the Energy Future Coalition. He concluded by saying that Houston and the Shell Center could play a vital role in advancing a clean air agenda that recognizes the complexity and urgency of the issues involved.

In his presentation, Kyriacos Zygourakis, chair of Rice University’s chemical engineering department, focused on the role of technology in achieving cleaner air. He began by developing a theoretical framework for examining the issue. The environmental burden, Zygourakis explained, could be defined as the product of population, affluence, and technology. “Given rising population and increasing affluence

*“We are at a unique time to align environmental, market, international and RD+D forces to focus on systems approaches to clean air. Success will focus on airshed-based public-private partnerships and market-based systems.”*

—Mr. Hank Habicht  
Chief Executive,  
Global Environment Technology Foundation

*“Given rising population and increasing affluence, particularly in developing countries, environmental burdens will become unsustainable without new or dramatically improved technologies. In the case of air pollution over the next 50 years, to completely offset effects of population growth, new or improved technologies must reduce emissions by 98 to 99 percent.”*

—Dr. Kyriacos Zygourakis  
Chair, Chemical Engineering Department,  
Rice University

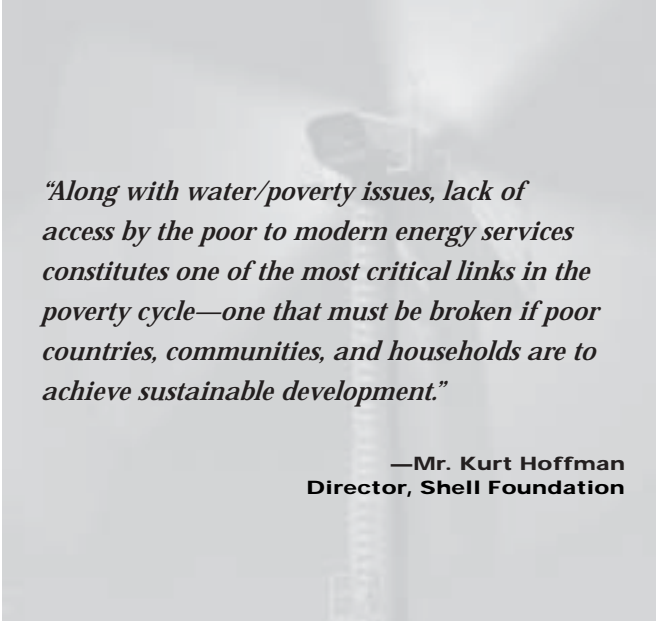
particularly in developing countries, environmental burdens will become unsustainable without new or dramatically improved technologies. In the case of air pollution over the next 50 years, to completely offset effects of population growth, new or improved technologies must reduce emissions by 98 to 99 percent.”

This, Zygourakis admitted, was a daunting challenge. But he pointed out the amazing success of the catalytic converter, which has succeeded in reducing cumulative emissions of CO, HC, and NO<sub>x</sub> in the average automobile by 95 percent or more over the course of 35 years. Achieving such a gain with greenhouse gas emissions, however, would be difficult without a dramatic change in engine systems or a significant move away from fossil fuels.

Zygourakis concluded by stressing that the role of technological change, as he saw it, was to expand the realm of possible solutions. This can be done either through maximizing the use of existing products and processes or by introducing new, more sustainable ones. Innovative, eco-efficient processes are clearly required if we are to achieve sustainability in air quality. But maximizing the efficiency and scope of existing technologies must also play a critical short- to medium-term role.

### Energy

Over 1.6 billion individuals, one quarter of the world population, have no access to electricity. In the absence of dramatic, concerted international initiatives to change this reality, 1.4 billion people will still lack electricity and basic energy services by 2030, according to the International Energy Agency. Four out of five people without electricity services live in rural areas of the developing world, mainly in South Asia and sub-Saharan Africa. Some 2.4 billion



*“Along with water/poverty issues, lack of access by the poor to modern energy services constitutes one of the most critical links in the poverty cycle—one that must be broken if poor countries, communities, and households are to achieve sustainable development.”*

—Mr. Kurt Hoffman  
Director, Shell Foundation

people rely on traditional biomass—wood, agricultural residues, and dung—for cooking and heating. Again, without significant policy changes, that number will increase to 2.6 billion by 2030.

“Lack of access by the poor to modern energy services constitutes one of the most critical links in the poverty cycle,” according to Kurt Hoffman, director of the Shell Foundation. “This must be broken if poor countries, communities, and households are to achieve sustainable development.” The stark reality of the 1.6 billion people who lack access or cannot afford electricity, he said, must shape any discussion of energy and sustainable development. Hoffman eloquently spoke of the hundreds of millions of children struggling to study by smoky kerosene lanterns, and of the farmers and small enterprises who are denied access to the enormous productive power of modern energy services such as refrigeration, shaft power for processing, transport fuel, etc. But he added that the “most tragic but little known health dimension of the energy/poverty problem” was one that needed more emphasis and study in the policy community. “There are hundreds of millions of households relying on traditional forms of biomass. This is a major cause of deforestation. However the part of the story that is not so well known is that millions of these same women, and their young children, about 2 million in fact, die prematurely every year from respiratory infections due to the exposure to indoor air pollution—or the inhalation of particulate emissions from cooking indoors over smoky fires and stoves burning traditional biomass fuels.” He went on: “Acute respiratory disease constitutes the third largest cause of death in women and children under five in developing countries—and by this measure alone probably accounts for 30 to 40 percent of the 13,000 children’s deaths occurring every day from environment-related dangers and disease.

Hoffman noted the important role public-private partnerships can play in moving the poor up the energy ladder to cleaner fuels. Still, Hoffman noted that there was a danger in narrowing the choices too selectively for delivering energy to the world’s poor. While acknowledging the longer-term importance of renewable energy, he suggested that too many resources had been focused on renewable technologies that the rural poor simply cannot afford. Instead, the least advantaged should be extended the full menu of affordable modern fuels that can be delivered by market mechanisms. “If markets are to work even in rural areas to help bring about a robust and sensible allocation of resources to energy access solutions, and if those solutions are to become cost-effective, viable, and durable over the long term, then the full menu of energy choice alternatives including fossil fuels, traditional and modern renewables, etc. have to be available and competing on real cost terms.”

Hoffman also said that existing public-private partnerships have shown the damage that can be done when parties fail to craft market-development policies that successfully develop markets. Many international donors and host governments, he noted, have supported renewable energy in the less-developed world through direct or indirect subsidies. Such an approach undercuts long-term economic viability and the development of effective energy markets. Cost subsidies and energy services give-aways undermine market development and create a problem of how to maintain public funding. Once the aid funding for these programs runs dry, the communities that they served are left with no lasting improvement in access to clean and affordable energy supplies.

Hoffman also noted that too often public aid programs to foster enterprise creation have been hampered by: a) inordinately long start-up periods, and b) insufficient enterprise scale to ensure commercial viability. Last, Hoffman criticized what he called the “stamp collector approach” to market development, with a plethora of demonstration projects that add little to the energy requirements of the world’s energy poor. “No attention is given in the project design to the task of how you create individual businesses capable of operating at the scale required to supply their solutions to mass markets,” Hoffman noted. He added that the private sector should be called on to provide expertise in creating markets, assessing risk, initiating methods for starting up businesses and showing how to scale up a supply chain.

On these public-private partnerships, Hoffman asserted that: 1) projects need to be designed to accomplish specific goals after which there is an exit route, 2) that there should be some selectivity and strategy involving in choosing partners, 3) that each partner should perform the functions that it does best, and 4) that if subsidies are going to be deployed, they should be done in a manner that “either sets in train a process whereby the subsidies will themselves disappear in a fixed period of time, or use them to promote operational performance addressing pro-poor goals.” He noted that while public money can be used to lower the risk for direct involvement of local capital, that local capital should operate the interventions on a “for-profit basis so they are incentivized to make them work.”

Looking at the question of sustainable development and energy choices in broad historical terms, David G. Victor, director of Stanford University's Program on Energy and Sustainable Development, questioned the notion that rising per capita income globally could be achieved without a rapid increase in energy demand. Declared Victor: "It is totally implausible that we are talking about any kind of energy system that does not imagine much larger consumption of energy." Victor noted that economic data shows a direct correlation between rising per capita income and rising commercial energy use per capita. Similarly, as per capita income grows, the percentage of traditional biomass as the total of primary energy use shrinks.

In addition to rising future demand for energy, Victor identified two other important, long-term trends. The first was a shift—welcome on health grounds—away from biomass and toward electricity as an energy source. The second was the rising importance of natural gas, particularly in electrical power generation. Although energy use has risen dramatically in the industrial world over the past few decades, Victor noted that it was coupled with a declining carbon intensity in advanced economies like the United States, a development attributable to the shift away from biomass and coal to structural shifts within developed economies themselves.

"While noting the importance of private-public cooperation, Victor warned that it was possible to place too much emphasis on the idea of public-private partnership." One of the most dramatic transformations in energy use in recent years—the spread of electrical power to hundreds of millions of Chinese—had little or nothing to do with public-private partnership, but was attributable to the decentralization of authority within China and rising disposable income due to robust growth.

*"Partnerships are important to create a new organization of the industrial economy that will a 'social contract' involving access to energy, environmental protection, and employment, as well as further innovation."*

—Dr. David G. Victor  
Director, Stanford University Program  
on Energy and Sustainable Development

*"The world water situation is nothing less than gruesome, with up to 80 percent of the world's population lacking access to reliable water systems. Moreover, pollution control efforts are highly skewed toward developed countries, with 85 percent of control activities serving only 18 percent of the population."*

—Dr. Alain Dangeard  
Chairman and CEO,  
M.E.E. Development


## Water

James Blackburn, chair of the Galveston Bay Conservation and Preservation Association, explained that the Texas legal system reflects little or no recognition of the relationship between surface and underground water.

In economic terms, Blackburn said, water is both mispriced and underpriced. Plans to provide water to San Antonio, Texas, are a stark case in point. The "liquid gold rush" to provide the city with its future water supply includes plans to divert river water and tap groundwater. Such approaches do not factor in the true costs of supplying water. A plan to use water from the Guadalupe River, for instance, does not factor in the immense potential damage that could be done to its estuary, San Antonio Bay. The damage will not only be direct, in terms of lowered commercial and recreational fishing revenue, it would also be reflected in diminishing the sort of ecosystem benefits mentioned earlier by Dallmeier.

According to Blackburn, other options to supply water to San Antonio—notably desalination—would become viable were the full-cycle costs of the various current plans actually applied. As it is, there is a real risk of irreparable damage to the estuaries of Texas. "If we destroy the natural system," Blackburn concluded, "we will not have sustainability."

Shifting from the local example in Texas to a global perspective, Alain Dangeard, chairman and CEO of M.E.E. Development, described a world water situation that was nothing less than "gruesome," with up to 80 percent of the world's population lacking access to reliable water systems. Moreover, pollution control efforts are highly skewed toward developed countries, with 85 percent of control activities serving only 18 percent of the population. Like other speakers, he stressed the importance of affordability.



*“Sustainable development is about using our knowledge in a way that protects the natural system as we accommodate human settlement patterns.”*

—Mr. James Blackburn  
Chair, Galveston Bay Conservation and  
Preservation Association

“Traditional centralized water system systems,” Dangeard said, “are not affordable to two-thirds of the world’s population.”

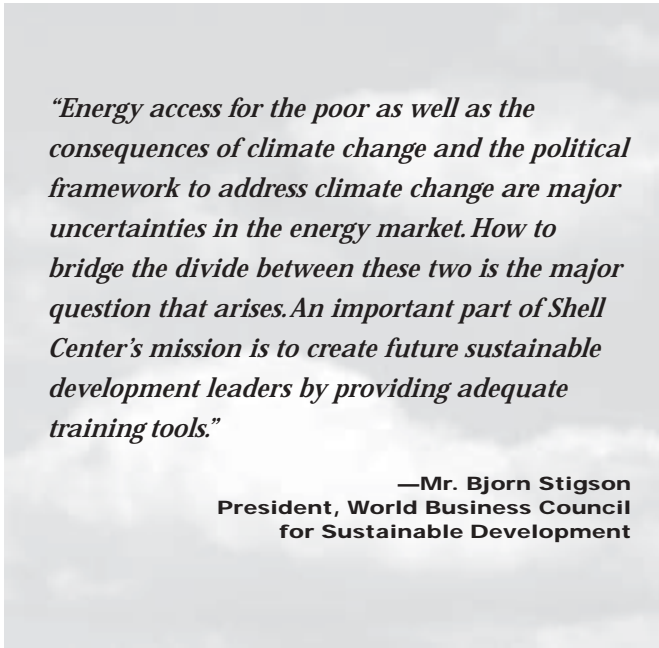
While acknowledging the needs of the very poor, Dangeard reminded the audience of the hundreds of million members of the new middle class who lived in such places as China and India. They represent a key—and often overlooked—market for reasonably priced water supply and treatment systems. To address their needs would require a broad-based approach, which would span expanded research, enterprise creation, institutional reform, and innovative financing. Waste treatment and transportation were key areas of concern: It is vitally important that treatment occur as close as possible to use in order to minimize costs.

Dangeard declared that the United States—particularly the Western states—represent a huge potential source of expertise on a whole range of issues related to water. He saw independent institutions like the Shell Center as invaluable resources in developing what he called a critical element in addressing the world’s need for water: business plans that capture the full complexity of the issues involved.

## Conclusion

In the closing address, Bjorn Stigson, president of the WBCSD, emphasized that the world is seeing a growing participation of business and industry in defining norms and principles of sustainable development. Business is now an equal partner with government and civil society in promoting sustainability, Stigson noted. Stigson described the WBCSD as an effort by leading companies to pool their resources in support of sustainable development. A notable achievement in this regard is the WBCSD’s project on mobility, which is designed to “fill in the goals of there is a strong business case for sustainable development, most notably the proven track record of eco-efficiency, which he defined as “creating more value with less impact.”

In his conclusion, Stigson described in broad strokes the complex approach that will be required if sustainable development is to be attained. Companies, governments, financial markets, and academia all have important and complementary roles to play. He stressed the imperative of training a new generation of leaders in sustainable development and described education as a vital part of the Shell Center’s mission. Summarizing his remarks, Stigson declared, “business cannot succeed in a society that fails.”



*“Energy access for the poor as well as the consequences of climate change and the political framework to address climate change are major uncertainties in the energy market. How to bridge the divide between these two is the major question that arises. An important part of Shell Center’s mission is to create future sustainable development leaders by providing adequate training tools.”*

—Mr. Bjorn Stigson  
President, World Business Council  
for Sustainable Development

## Workshop Reports

### Air and Urban Sustainability Workshop

The air and urban sustainability workshop focused on areas in which the Shell Center might make its greatest contribution to sustainability. The suggestions focused on effecting change in culture and in science and technology that would address a convergence of social, economic, and environmental issues. The panelists felt that the Shell Center for Sustainability should foster and facilitate dialogues on technological and cultural changes needed to achieve sustainability.

#### *Culture and Urban Changes*

Many participants felt that achievement of sustainability in an urban context will be a cultural challenge, not a technological one. For cities like Houston to continue to grow and prosper, traditional business concerns must be brought into harmony with quality-of-life concerns of urban citizens. Basic questions about air quality, flood control, and traffic congestion are among the many serious problems that must be addressed in the urban context. The panel also discussed the value and importance of addressing sustainability issues for the entire shared air shed between Mexico and the U.S. and creating a vision for a common structure across regions and borders. The Shell Center could contribute to knowledge of how industrial and other sources of emissions interact and how they affect air sheds. Some suggested that the Shell Center could address such questions as how do Houstonians see themselves in the natural system? How do they respect the natural landscape? What is the relationship between the natural and urban system? How can Houston better develop and use its natural bayou system to complement the urban system rather than colliding with it.

#### *Technology*

Other panelists emphasized the need for scientific and technological advancements, which could *also* make a contribution to effecting a change in cultural attitudes toward sustainable development. New technologies, or new ways of applying technologies, have the potential to resolve some of past political stumbling blocks. Panelists suggested that the Shell Center might work on the following areas:

#### *Industrial complexes*

- Examine how emissions from an industrial complex interact with emissions from other sources.
- Work on capturing, storing, sequestering and transporting CO<sub>2</sub> so as to reduce the CO<sub>2</sub> footprint of the industrial complex.
- Determine what constitutes a sustainable petrochemical complex in Houston.

- Focus on changing the culture at a petrochemical complex to reduce emissions.
- Design processes so as to achieve zero emissions.
- Determine the processes that can improve plant operations and reduce emissions levels.

#### *Emissions analysis*

- Analyze the air shed as a whole to achieve more effective emissions control.
- Develop a better understanding of the overall environmental impacts. As one panelist stated: "We are in effect, hooked together in one big reactor and we don't fully understand how this reactor operates." To improve that understanding, a major challenge is the development of an improved model for ozone formation.
- Develop systems to see if the data coming out of petrochemical plant conforms to what is regulated in the ambient air quality system.
- Research and rank emissions by level of threat to human health and the environment.
- Better understand the dynamics of ozone formation.

#### *Communications*

- Help communities and individuals better understand air quality issues.
- Educate industry on how to improve their integrated environmental and economic performance.
- Develop, with the Houston Advanced Research Center (HARC), clear indicators of sustainability for Houston.
- Ensure that the actual emissions and data conform to the reported data.
- Provide the technical information and resources to support community action programs.
- Develop urban sustainability measures.
- Build areas of trust between industry and communities.
- Work on federal exemptions, such as foreign vessels that are not fully regulated under environmental laws.

### Energy Workshop: Sustainable Choices among Alternative Fuels and Emerging Technologies

Among the most important technical challenges facing the world in the 21st century is providing clean, affordable energy whose supply is sustainable and universally available. Lack of access by the poor to modern energy services constitutes one of the most critical links in the poverty cycle in Africa, Asia, and Latin America.

Despite great advances in oil and gas drilling techniques and progress in renewable fuels, more than a quarter of the world's population has no access to electricity today, and two-fifths are forced to rely mainly on traditional biomass—fire wood and animal waste—for their basic cooking and heating needs. Indoor air pollution from this traditional energy source is responsible for the premature death of more than 2 million women and children a year worldwide from respiratory infections, according to the World Health Organization. Without a major technological breakthrough,

well over 1 billion people will still be without modern electricity in 2030, energy specialists calculate.

World primary energy demand is projected to grow by 23 percent from 2000 to 2010 and by 46 percent to 2020. It is unlikely that rising per capita income globally could be achieved without a rapid increase in energy demand. Ronald Soligo, professor of economics at Rice University suggested at the opening of the discussion that to be successful, strategies for sustainable fuel choices should focus on the transportation sector, which is expected to be a tremendous energy-use growth sector. He added that switching energy sources is easier than cutting total energy use in terms of limiting environmental impacts. Energy efficiency is embedded in capital that is only replaced gradually and that new technologies affect energy use and emissions with variable lag times ranging from 10 to 80 years, and Soligo argued that a variety of approaches will be vital, including energy efficiency and renewables, but that natural gas is a substantially cleaner fuel than coal or oil and can serve an important role as a transition fuel. Soligo showed data demonstrating that developing countries will account for an increasing share of emissions. This means that countries that have not yet committed to key infrastructure have the opportunity to opt for cleaner alternatives. However, given the magnitude of the environmental and supply challenges, breakthrough technologies are needed.

The need for the international community to press on with fundamental research and development on enhanced energy technology was a major finding of the energy workshop group. Questions were raised whether conservation, price signals, changing capital stocks, and natural innovation would be enough to meet the rising energy needs without direct and forceful interventions by governments. Public policy debate will have to cover who pays for research and commercialization of technology improvements in the energy area. Among the areas of controversy are the proper role for government and the private sector in the research and development process, how to remove barriers to commercialization of promising technology innovation and the collaboration and responsibilities of the industrialized world versus the developing world in the process.

In drafting effective strategies to shape cleaner and more sustainable fuel choices, policy makers must develop an accurate picture of the driving forces that affect fuel use and how those forces come together and interact with each other, according to the experts in the energy workshop. The energy workshop group felt the three most important factors influencing fuel choices at present are: 1) availability and price, 2) policy (regulation), and 3) technology. Market prices do not at present fully take into account environmental externalities, and that is a key problem to sustainable development on both the global and national scale.

The workshop group concluded that the U.S. should take the lead in developing and transferring new energy technologies because of its market size. A policy priority in this challenge will be to focus on how to get new technologies by the so-called "Valley of Death" between development and commercialization. Smart licensing and regulatory

policy for technology development will be critical to this process.

Public perceptions and market pricing do not currently reflect the true environmental impact of available fuel choices properly. Greater understanding of life cycle analysis needs to come into the public domain to enhance public awareness of the true costs and risks of various fuels. The workshop concluded that carbon and other environmental considerations should be more important factors in analyzing fuel choices and suggested that the Shell Center should play a role in improving access to transparent and accurate data about the environmental costs and risks of various fuels to enhance policy-making in the energy area.

## Water Sustainability Workshop

The integrity of supplies of potable water is being damaged by over-use, by widespread quality degradation through interaction with industrial, agricultural, and urban end-users, and by climatic conditions—both natural and man-made—that impact its geographical distribution.

While sustainable, clean water supply is a global issue, the world's developed nations—including the United States, European countries, and Japan—have an important role to play in developing the new technologies needed to assure water needs and to mitigate the ongoing widespread water cycle deterioration. Direct participation of industries, financial, and educational institutions of the more-developed nations are essential to reversing this deterioration.

These and other water supply sustainability issues were among discussion topics at the water sustainability workshop. Scientists, business people, officials of both governmental and nongovernmental organizations, policy specialists, educators, students, members of private stakeholders' groups, and the concerned public attended.

Participants shared water supply and quality improvement data and discussed opportunities available in both developed and developing nations to promote innovative solutions to global water challenges. Participants also shared lessons already learned from past efforts in their individual fields of expertise.

Opening the workshop, Dr. Alain Dangeard, chairman and chief executive officer of M.M.E. Development S.A., a Paris-based mineral resources, water, environmental, and development company, said that ambitious global goals and principles set out in previous international water conferences must be matched with regional and local enterprise and market-based solutions. He noted that about 85 percent of the market for so-called "eco-industries," which were created to meet the challenge of water-supply sustainability and wastewater management, is located in industrialized countries. Though this market is estimated at between U.S. \$500-\$550 billion, of which about 75 percent involves the water and waste sectors, the industrialized countries account for only about 18 percent of the world's population. "Indeed, the core of the business is not focused on the areas where the need is greatest," he said.

Centralized systems, the predominant model supported by the investment community, has meant concentration on highly capital-intensive projects and large operations with high economic, social, and environmental costs that are not affordable throughout most of the developing world.

“There is a potentially large market for alternative systems alongside the present segment occupied by traditional approaches,” Dangeard noted, adding that demonstration projects can be designed for specific scenarios, with private industry and host governments both financing and monitoring the short-term effects on water supply and the long-term effects on safety, health, and the environment.

Roughly two-thirds of the world’s population will reside on or near the sea coasts, creating an opportunity to tap desalination techniques to provide much greater volumes of potable water. Additionally, wastewater treatment and membrane technologies will continue to improve for application in both industrial and domestic water re-use scenarios, giving some relief to the already stiff demand placed on surface and underground fresh water resources. In Europe, in fact, restoration of groundwater quality is becoming the main thrust of technology efforts.

The political aspect of both public and private water supply initiatives is highly important to overall sustainable development, said James Blackburn, a Houston-based environmental attorney who is chairman of the Galveston Bay Conservation and Preservation Association. Blackburn stressed the need for all stakeholders—including those whose interests lie downstream from such initiatives—to be included in the political process that creates and approves them. Participants agreed that there is a need to establish the true value of water, since the political nature of government takes the “lowest cost to voters” approach to creating new water supply sources and environmental protection. Regulators often address industrial water needs, Blackburn asserted, without substantial input from all affected stakeholders such as downstream players like the fishing industry or local communities.

Roger Hulbert, senior assistant director of water quality and production for the City of Houston’s Public Works Department, agreed that technological solutions were available but noted that even in the U.S. “the public’s perceptions about water supply will have to change before they will accept the technology and its higher costs.” Hulbert also remarked that water conservation is an integral part of solving water supply sustainability.

Jim Orr of United Communities for Health, an Austin, Texas, faith-based organization, added that there is a vital need for governments, corporations and educational and health institutions to apply inexpensive, subsistence-level water supply technologies to remote areas of the world. Private-sector partnerships with government and other stakeholders in advancing sustainable development is one means to achieve that, participants felt. In fact, corporate-sector voluntary initiatives are important because they allow private companies to interact with state and federal regulators in a less adversarial atmosphere, building better relationships for the resolution of conflicting interests.

The energy industry is a key player in the water production business by dint of the co-production of huge volumes of subsurface brines along with conventional oil and gas production. A key factor in utilizing produced water profitably is changing the mindset and behavior of the corporate sector, which previously thought of produced water as a waste product. Carlos Guimaraes, vice president of Dow Chemical Company’s environmental operations business, also agreed that the midstream and downstream sectors of the energy industry are becoming more conscious of the profitable use of wastewater.

Opportunities are increasing because confidence is improving that near-total wastewater filtration of solids, as well as microbial agents, has become attainable, according to Mark Thompson of Advanced Membrane Systems in Newport News, Virginia. Such improvements in wastewater treatment technologies offer unlimited possibilities for developing nations of the world to treat not only wastewater but also water drawn from surface and subsurface freshwater sources.

The workshop concluded that there is a pressing need to establish a value for water in a world where most people consider it a “free” resource. Moreover, re-education is needed so that businesses and the public understand that improving water-quality economic sense is essential, particularly since water use affects the business and environmental cycles, as well as the life cycle. Mark Wiesner, director of the Environmental and Energy Systems Institute at Rice University and professor of environmental engineering, noted that the diverse efforts to improve water quality could be one of the most important assets of overall sustainable development, particularly if technical solutions to potable water supply challenges in various parts of the world can be transferred to others. In particular, water recycling—either naturally through aquifers or artificially through filtering and chemical treatment including desalination—offers distinct advantages but will require involvement at the primary educational level to create a public knowledge base on which to move forward.



## Shell Center on Sustainability Inaugural Conference Speaker/Moderator Biographies

### David T. Allen, *Chair, Texas Council on Environmental Technology*

Dr. David T. Allen is the Reese Professor of Chemical Engineering and the director of the Center for Energy and Environmental Resources at the University of Texas at Austin. He also serves as chair of the Texas Council on Environmental Technology. Dr. Allen's research interests lie in environmental reaction engineering, particularly issues related to air quality and pollution prevention. Dr. Allen is the author of four books and more than 100 papers in these areas. The National Science Foundation, the AT&T Foundation, and the American Institute of Chemical Engineers have recognized the quality of his research.

### James Blackburn, *Chair, Galveston Bay Conservation and Preservation Association*

Mr. James Blackburn is an environmental attorney with a M.S. in environmental science from Rice University. He has been practicing environmental law in Houston for 30 years and teaches in the Department of Civil and Environmental Engineering at Rice. Mr. Blackburn is an environmental activist, chair of the Galveston Bay Conservation and Preservation Association, and a member of the board of the Matagorda Bay Foundation. He received the National Wildlife Federation's Conservation Achievement Award in the legal/legislative category in 2001. His *Book of Texas Bays* is forthcoming from Texas A&M Press in winter 2003.

### Francisco Dallmeier, *Director, Monitoring and Assessment of Biodiversity Program National Zoological Park Conservation and Research Center, Smithsonian Institute*

Dr. Francisco Dallmeier, a conservation biologist with oversight in 23 countries, heads up the Smithsonian Institution/Monitoring and Assessment of Biodiversity Program (SI/MAB). A Smithsonian scientist and educator since 1986, Dr. Dallmeier is involved in multiple aspects of biodiversity conservation, especially those that link conservation and development. He has coordinated more than 60 international research and training programs in developing countries and has served as an advisor to various national and international committees. He has written publications that outline new approaches to conservation based on adaptive management techniques. SI/MAB successfully tested one such approach when it helped establish a partnership between Shell Oil Company developers and scientists in Peru's Urubamba Basin.

### Alain Dangeard, *Chairman and CEO, M.E.E. Development*

Dr. Alain Dangeard is CEO of MEED (Matières Premières. Eau. Environnement. Développement), a consulting firm specializing in environmental, minerals, and water economics. MEED focuses on the design and initiation, at the precompetitive stage, of significant water and environmental demonstration projects in India, the Mediterranean, the Middle East, and Central Asia. Dr. Dangeard is external advisor of EUROMINES (European Association of Mining Industries) and a member of the European Union work group on sustainable development in the minerals industries. He began his career as a diplomat and subsequently took over responsibilities in several environment-related companies, predominately the French Bureau of Mines (BRGM) and the French National Agency for Recycling and Waste Disposal (ANRED).

### Paula Dobriansky, *U.S. Under Secretary of State for Global Affairs*

Dr. Paula J. Dobriansky, U.S. Under Secretary of State for Global Affairs, is responsible for foreign policy issues, including democracy, human rights, labor, counter-narcotics and law enforcement, refugee and humanitarian relief matters, and environmental/scientific issues. Previously, she served as senior vice president and director of the Washington office of the Council on Foreign Relations. Other government appointments have included associate director for policy and programs at the United States Information Agency, deputy assistant secretary of state for human rights and humanitarian affairs, deputy head of the U.S. delegation to the 1990 Copenhagen Conference on Security and Cooperation in Europe (CSCE), advisor to the U.S. delegation to the 1985 UN Decade for Women Conference, and director of European and Soviet affairs at the National Security Council at the White House.

### Matthew Fraser, *Assistant Professor, Civil and Environmental Engineering, Rice University*

Dr. Matthew Fraser is an assistant professor in the civil and environmental engineering department at Rice University and is Rice's first air-quality researcher. Dr. Fraser received his B.S. degree with university honors in chemical engineering from Carnegie Mellon University and his Ph.D. degree in environmental engineering science with a minor in geology and planetary science from California Institute of Technology. He is the co-principal investigator of a \$3.65-million EPA grant together with Dr. David Allen of the University of Texas-Austin, studying atmospheric fine particles in Houston.

Malcolm Gillis, *President, Rice University*

Dr. Malcolm Gillis received his B.A. and M.A. degrees from the University of Florida and his Ph.D. from the University of Illinois. He began his academic career at Duke University, followed by a 15-year tenure at Harvard. He returned to Duke in 1984 as professor of economics and of public policy. In July 1990, he became vice provost for academic affairs at Duke University. In July 1993, he became the sixth president of Rice University. Until assuming leadership roles in university administration, he was a frequent consultant to the U.S. Treasury Department, Canadian Ministry of Finance, World Bank, and the governments of Colombia, Ecuador, Bolivia, and Indonesia. He has published more than 70 articles and is author, co-author, or editor of eight books.

Hank Habicht, *Chief Executive, Global Environment Technology Foundation*

Mr. Hank Habicht has been president and chief executive officer of Global Environment and Technology Foundation since 1998. Mr. Habicht was senior vice president with Safety-Kleen Corporation. From 1989 to 1993, he served as deputy administrator for the U.S. Environmental Protection Agency (EPA). He also served as assistant attorney general of the U.S. Department of Justice under the Reagan administration, where he directed the environment and natural resources division. Since 1998, Mr. Habicht has been the president of the Global Environment Technology Foundation.

Guy Hascoet, *Former French Minister of State for Social Economy*

Mr. Guy Hascoet served as French minister of state for social economy from March 2000 until May 2002. Previously, he served as a member of the National Assembly Manufacturing and Trade Committee and vice chairman of the Study Group on Rivers and Navigable Waterways. He was a member of the National Council for Departmental and Communal Public Services, vice chairman of the Nord-de-Calais Regional Council, and deputy for Les Verts National Assembly. Mr. Hascoet received his degree in environmental engineering from the University of Tours.

Kurt Hoffman, *Director, Shell Foundation*

Mr. Kurt Hoffman is director of the Shell Foundation. He joined Shell Oil Company in 1997 to design and develop the Shell Foundation, which was established formally as a UK grant-making charity in June 2000 with a mission to promote sustainable development worldwide. Previously, Mr. Hoffman enjoyed a 20-year career as a development professional, serving as senior staff member and adviser to numerous development agencies, private foundations, and international corporations. He has also served as senior fellow and reader in development studies at the science policy research unit, University of Sussex, United Kingdom, from 1976 to 1987.

Christian Holmes, *Executive Director, Shell Center for Sustainability and Environmental and Energy Systems Institute, Rice University*

Mr. Christian Holmes serves as executive director of both the Rice University Shell Center for Sustainability and the Rice Environmental and Energy Systems Institute. He has held a number of senior executive positions in business and government in the energy, environmental, and international economic development sectors, including vice president for environment, safety, and health at Tenneco Energy; chief financial and administrative officer of the U.S. Environmental Protection Agency; director of the U.S. Trade and Development Agency (TDA); executive director of the President's Task Force on International Private Enterprise; and principal deputy assistant secretary of state for refugee programs.

Amy Myers Jaffe, *Wilson Fellow for Energy Studies, James A. Baker III Institute for Public Policy Associate Director, Environmental and Energy Systems Institute*

Ms. Amy Myers Jaffe is associate director of the Rice University Energy Program and Wallace Wilson Fellow for Energy Studies at the James A. Baker III Institute for Public Policy of Rice University. Prior to joining the Baker Institute, Ms. Jaffe, a Princeton graduate in Arabic studies, was the senior economist and Middle East analyst for *Petroleum Intelligence Weekly*, a respected oil journal. Ms. Jaffe is a widely quoted expert on energy issues and has written for a variety of publications including the *New York Times*, *Dow Jones International*, the *Asian Wall Street Journal*, and the *Mideast Report*.

Nancy Kete, *Senior Fellow and Co-director of the EMBARQ Center for Transport and Environment, World Resources Institute*

Dr. Nancy Kete is senior fellow in the climate, energy, and pollution program at the World Resources Institute and co-director of the EMBARQ Center for Transport and the Environment. Dr. Kete previously served as deputy director of the Office of Atmospheric Programs for the U.S. Environmental Protection Agency. She has been responsible for the development and analysis of domestic and international climate change policy options as well as for voluntary energy efficiency and other greenhouse gas mitigation programs. Other experience includes serving as senior policy analyst in the Office of Air and Radiation and science advisor for environmental affairs at the U.S. Mission to the Organization for Economic Cooperation and Development in Paris.

Alberto Mendoza Dominguez, *Assistant Professor, Chemical Engineering,  
Instituto Tecnológico y de Estudios Superiores de Monterrey*

Dr. Alberto Mendoza Dominguez is assistant professor of chemical engineering at the Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), Mexico, where he also holds a joint position as head of the Air Quality Laboratory with the Center for Environmental Quality. Dr. Mendoza has a Ph.D. in Environmental Engineering from the Georgia Institute of Technology and an M.S. in environmental engineering and B.S. in chemical engineering from ITESM. He has participated in numerous air quality studies, including SAMI (Southern Appalachian Mountain Initiative), SCISSAP (Southern Center for the Integrated Study of Secondary Air Pollutants), and a Mexico-U.S. border air quality effort examining transboundary air pollution.

Richard Sandor, *Chairman and CEO, Chicago Climate Exchange*

Dr. Richard L. Sandor is chairman and CEO of the Chicago Climate Exchange, a self-regulatory exchange that administers a voluntary greenhouse gas reduction and trading program for North America. He is a research professor at the Kellogg Graduate School of Management at Northwestern University. Previously, he served as vice president and chief economist of the Chicago Board of Trade, where he earned the reputation of being the principal architect of the interest-rate futures market now traded worldwide. Dr. Sandor was honored by the City of Chicago and the Chicago Board of Trade for his contribution to the creation of financial futures. In August 2002, Dr. Sandor was chosen by *Time* magazine as one of its "Heroes for the Planet" for his work as founder of the Chicago Climate Exchange.

Bjorn Stigson, *President, World Business Council for Sustainable Development*

Mr. Bjorn Stigson is president of the World Business Council for Sustainable Development. He began his career as a financial analyst with the Swedish Kockums Group and later worked for welding equipment suppliers ESAB in positions responsible for finance, operations, and marketing. In 1983, he became president and CEO of the Fläkt Group, the world leader in environmental control technology. Following the acquisition of Fläkt by ABB in 1991, he became executive vice president and a member of ABB Asea Brown Boveri's Executive Management Group. In 1995, he was appointed president of the World Business Council for Sustainable Development (WBCSD) in Geneva, a coalition of some 150 leading international corporations. Mr. Stigson is presently a member of advisory councils to, among others, Unilever, OECD, and the government of China. He is also a member of the newly established board of GRI (Global Recruiting Initiative) and the IRGC (International Risk Governance Council).

Rahul Tongia, *Research Engineer, Department of Engineering and Public Policy,  
Carnegie Mellon University*

Dr. Tongia's research explores issues of infrastructure in emerging economies. Using quantitative policy and decision analysis, he has focused on the energy and telecom domains. His work also deals with broader policy issues such as security, international collaboration (especially U.S.-India), and technology and analysis transfer. Part of his research involves developing models for identifying current technology and policy environments, examining the role of public and private intervention, and exploring technology options for telecom infrastructure. Dr. Tongia holds a B.S. in electrical engineering from Brown University and a Ph.D. in engineering and public policy from Carnegie Mellon University.

David G. Victor, *Director, Stanford University Program on Energy and Sustainable Development*

Dr. David Victor is director of the Program on Energy and Sustainable Development at Stanford University, which focuses on economic and environmental consequences of energy consumption. His initial studies examined the development of the North American and global natural gas markets and the reform of electric power markets. Other research has analyzed how the availability of modern energy services can affect the process of economic growth in the world's poorest regions. Previously, Dr. Victor directed the science and technology program at the Council on Foreign Relations in New York. He holds a Ph.D. in political science from the Massachusetts Institute of Technology and a B.A. in history and science from Harvard University.

Hiroyuki Watanabe, *Senior Managing Director, Toyota Motor Corporation*

Mr. Hiroyuki Watanabe, senior managing director of the Toyota Motor Corporation, joined Toyota in 1967. Named to the board of directors in 1996, he directed Toyota's worldwide operations in after-sales service, supply parts, and conversion and accessory and was responsible for Toyota's Future Project Division. Appointed managing director in 1999, Mr. Watanabe's responsibilities shifted to environmental affairs, product management, and development of Toyota's fuel cell systems. He also oversees the Virtual Venture Company, a Toyota internal organization set up in 1997 for planning and commercializing activities designed to provide new products and services for young consumers. In 2001, he assumed the position of senior managing director.

Sir Philip Watts, *Chairman of the Committee of Managing Directors, The Royal Dutch/Shell Group of Companies*

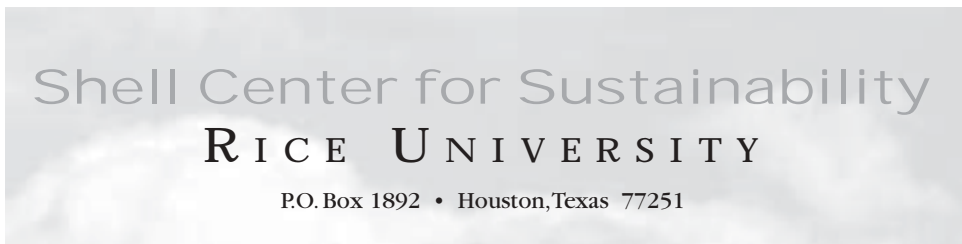
Sir Philip Watts is chairman of Shell Transport and Trading Company and of the Committee of Managing Directors of Royal Dutch/Shell. He has served as chairman and managing director of the Shell Petroleum Development Company of Nigeria; regional coordinator for Europe; and director of planning, environment, and external affairs for Shell International in London. He also is chairman of the World Business Council for Sustainable Development and of the UK chapter of the International Chamber of Commerce. In January 2003, Mr. Watts was knighted both for services to British business and in recognition of his role in the WBCSD.

Mark R. Wiesner, *Director, Environmental and Energy Systems Institute, Rice University*

Dr. Mark Wiesner is the director of the Environmental and Energy Systems Institute at Rice University, where he also holds appointments as professor in the Departments of Civil and Environmental Engineering and Chemical Engineering. Dr. Wiesner's research pioneered the application of membrane processes to environmental separations and water treatment and recently initiated an examination of the fate and transport of nanomaterials in the environment. Before joining the Rice University faculty in 1988, he worked in research and development with the Lyonnaise des Eaux, Le Pecq, France, and was a principal engineer with the environmental consulting firm of Malcolm Pirnie, Inc., White Plains, New York.

Kyriacos Zygourakis, *Chair, Chemical Engineering Department, Rice University*

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