THE BUSINESS ROUNDTABLE

CLOSING THE TECHNOLOGY GAP IN THE DEVELOPING WORLD

A Practical Strategy to Address Global Climate Change

ENVIRONMENT, TECHNOLOGY & THE ECONOMY TASK FORCE

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A PRACTICAL STRATEGY TO ADDRESS GLOBAL CLIMATE CHANGE

A White Paper from

THE BUSINESS ROUNDTABLE

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Executive Summary

The Business Roundtable (BRT) views global climate change as an important and complex issue with significant potential environmental, energy supply and economic implications. BRT agrees with the overwhelming number of analyses[1] that conclude maintaining economic growth while avoiding, reducing, or sequestering greenhouse gases will require the widespread use of innovative new technologies. Development and global deployment of new, highly efficient technologies that minimize carbon emissions and maximize carbon capture promise to be the most effective long-term response to concerns about global climate change.[2]

The process of broadly applying new technologies has been called technology transfer, but we believe that "technology diffusion" is a more appropriate term. Technology transfer implies that the shift of responsibility for the technology from the innovator to the user occurs at a single, definable moment, akin to the transfer of property. This is a misleading image. Effective application of new technology requires a collaborative effort between the supplier or investor and the user. As the collaboration proceeds, the user becomes more knowledgeable about the new technology and accepts more responsibility, but it is often hard to define when this happens, even in retrospect. Hence, our preference for the term "technology diffusion."

Achieving the goal of global technology diffusion is a three-step process. First, the technologies must be developed. Second, they must demonstrate commercial viability, and third, they must be broadly applied in both developed and developing countries.

Previous BRT reports focused on policies to accelerate the development and demonstration of advanced technology. This report examines barriers to technology diffusion, using case studies of BRT member companies to illustrate how these barriers have been overcome in innovative ways. The report also presents several recommendations for increasing technology diffusion and maximizing its benefits to infrastructure.

The seven case studies cover the diffusion of technology under a wide range of circumstances. The barriers encountered include a general lack of appropriate skills or knowledge, the higher initial cost of advanced technologies and corruption, which has a negative impact on all aspects of economic development including the introduction of new technologies.

Here is a summary of the case studies:

Pfizer
Energy–Efficient Plant Operations

Pfizer, a pharmaceutical manufacturer, has successfully transferred energy-efficient plant technology to its facilities in Asia, but only after working to educate both suppliers and plant personnel.

United Technologies
Cultural Sensitivity

United Technologies has been successful in transferring energy audit know-how, both between divisions in the U.S. and to its operations in China. For this case, the "enabling environment" consisted of sensitivity to the needs of the local affiliate and a willingness to tailor programs to accommodate those needs.

1 See, for example, Weyant, J. P., 2000: "An introduction to the economics of climate change policy." Pg. 45, published by the Pew Center on Global Climate Change. In discussing economic modeling studies of climate change policies, Weyant concludes: "The more flexibility the model includes in the choice of technologies, retirement of old equipment and introduction of new technologies, the lower the economic impacts of emissions reductions."

2 BRT Policy Statement (see Appendix I).

The Home Depot
Promoting Sustainable Forestry

To promote the use of sustainable biomass, The Home Depot instituted a wood purchasing policy that focused on achieving sustainable forestry. Because Home Depot does not own any forests, implementing this policy required evaluation and education of its suppliers.

ITT Flygt
Energy Savings vs. Initial Cost

As is often the case with advanced technology, the initial cost of ITT Flygt's high-efficiency pumps is greater than the initial cost of lower-efficiency competitors. This case study explains how the company has made the case that life cycle energy savings more than compensate for the higher initial cost.

DaimlerChrysler
Innovative Financial Structure

Poor air quality is a major problem in the megacities of the developing world. In Sao Paulo, Brazil, DaimlerChrysler has successfully marketed its natural gas-fueled buses, which have lower emissions of both local pollutants and carbon dioxide than standard diesel buses. To overcome the barrier of higher costs, the company worked with the local bus operator to create special bus routes, employ a more efficient refueling system and negotiate a longer-than-normal contract term.

Shell/Eskom
Solar-Based Rural Electrification

Access to affordable, reliable electric power is one of the key requirements for the alleviation of poverty, the primary goal of developing nations. Shell and its joint venture partner Eskom, the South African electric utility, have overcome infrastructure and economic barriers to deliver solar-based electric power in rural areas. They install a complete system — solar cells, wiring, electric lighting and power points for appliances — in users' homes. The companies also have implemented a program that allows users to rent the system or pay for it on an installment basis, rather than incurring the full cost upfront.

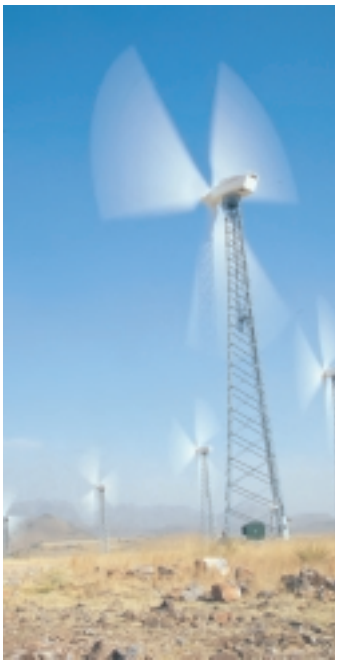
ExxonMobil
Ensuring Economic Benefit

ExxonMobil, through its subsidiary Esso Chad, is leading a consortium that is developing an oil field project in the Central African country of Chad. To ensure that the benefits of this development reach the citizens of Chad, the Chadian government, with the assistance of the World Bank, has developed a revenue management plan. In addition, ExxonMobil has taken steps to help local communities benefit from the project.

The substantial foreign direct investment by BRT member companies can provide focal points for the diffusion of advanced and cost-effective technologies. However, broad diffusion of many of these technologies depends on their being adopted by small- and medium-sized enterprises in developing nations. These enterprises can adopt new technology only if they have access to the capital resources necessary to invest in the new technology. At present, these enterprises often have very limited access to capital markets because they operate outside a formal system

of property rights. Establishing clear title to the property that poor and middle class people own in developing countries would make this property available for use as collateral for loans and thus greatly increase economic development.

The private sector must take a leadership role and partner with the public sector in proposing innovative deployment and financing mechanisms to make projects that avoid, reduce, or sequester greenhouse gases economically attractive. The BRT believes that the right policies and efforts can catalyze much larger public-private undertakings and close the global technology gap. A critical goal of these efforts should be to make it easier for companies from the U.S. to engage in joint ventures and other cooperative research, development and demonstration and technology deployment efforts in the developing world.



Better coordination of public and private investments could be helpful in promoting international technology diffusion, but additional national or international financial incentives may be required. Any international financial incentives should be geography neutral. International lending agencies supported by the U.S. should encourage the diffusion of these technologies.

Based on the experience of BRT member companies, and a review of international efforts to enhance the diffusion of advanced technologies, the BRT makes five recommendations:

Recommendation 1: Examine Regulatory Barriers

Governments of all nations should examine their regulations to ensure that they are not creating unnecessary barriers to the diffusion of technologies that avoid, reduce or sequester greenhouse gases. The U.S. should encourage discussion of these barriers in all international and bilateral forums.

Recommendation 2: Eliminate Corruption

Governments of all nations should continue their efforts to eliminate corruption, recognizing the negative impacts that corrupt practices have on all aspects of economic development, including efforts to avoid, reduce or sequester greenhouse gases. The U.S. government has long been a leader in these efforts, with its enforcement of the Foreign Corrupt Practices Act and its support for both the Organization for Economic Co-operation and Development Convention on Combating Bribery of Foreign Public Officials and the Inter-American Convention Against Corruption. The BRT fully supports these efforts.

Recommendation 3: Demonstrate Technology Benefits

The U.S. and other nations should redirect the focus of international technology transfer activities from broad technology awareness efforts to actual demonstrations of the technology using examples from developing nations, wherever possible. The most effective agents of technology diffusion are

entrepreneurs and plant personnel who have benefited from using that technology.

Recommendation 4: Address Higher Initial Costs

The U.S. and other developed nations should share innovative approaches, based on actual experience, for addressing the higher initial and/or operating costs of many technologies that avoid, reduce or sequester greenhouse gases. Use of advanced technology often involves higher initial and/or operating costs. In some cases the technology provides operating savings that compensate for its higher initial costs, while in other cases the net present value of the total cost of the technology will be higher, often due to the small scale on which it is applied. The U.S. should encourage the creation of forums in which technology suppliers, technology users, financiers, and developing nation government officials can discuss ways of financing the higher costs of advanced technology.

Recommendation 5: Establish Clear Title and Property Rights

The U.S. and other developed nation governments should encourage, and where possible, support efforts in developing nations to create clear title and property rights to land and other assets in their countries that are currently undocumented. While foreign direct investment is a powerful tool for initiating technology diffusion, many small- and medium-sized enterprises do not have access to capital markets because their assets are undocumented. Property systems in developing nations have to be upgraded and made to reflect the realities of actual ownership.

Introduction

Most analyses[3] conclude that maintaining economic growth while avoiding, reducing, or sequestering greenhouse gases will require the widespread use of innovative new technologies. The Business Roundtable (BRT) agrees, and in their policy statement (Appendix I) said:

> The development and global deployment of new, highly efficient technologies that minimize carbon emissions and maximize carbon capture promise to be the most effective long-term response to concerns about global climate change.

This policy position builds on the BRT's ongoing efforts to accelerate the development, commercialization and global diffusion of technology to avoid, reduce, or sequester greenhouse gases.

In its July, 1999 report titled, *The Role of Technology in Responding to Concerns about Global Climate Change*, the BRT stated:

> In a preliminary review of the role of new and emerging technologies for addressing climate change, The Business Roundtable finds great promise and truly exciting opportunities. In every sector of the economy, the long-term prospect for new and emerging technologies holds the potential for greater productivity, safety, convenience, and energy and carbon efficiency.

In its April, 2001 report: *Unleashing Innovation: The Right Approach to Global Climate Change*, the BRT identified 38 near-term opportunities in the U.S. for accelerating the development, commercialization, and global dissemination of advanced technologies by removing barriers created by existing regulatory, tax and trade policies.

Unleashing Innovation also identified the lack of infrastructure as a major barrier to energy-related investment in developing countries. The infrastructure necessary to support the investment includes: financial, legal, regulatory and market institutions; physical infrastructure such as communications and transportation capacity; and the technical and managerial skills needed to assess, implement and maintain advanced climate-related technologies.

Solving environmental problems with high-quality science and technology is also one of the four broad aspects of *Blueprint 2001: Drafting Enviromental Policy for the Future* (February 2001), the BRT's recommendations to senior government officials and Congress. As part of this focus, the BRT calls for policies that will ensure effective diffusion of new technologies, particularly in the developing world.

Achieving the goal of global technology diffusion is a three-step process. First, the technologies must be developed; second, they must be demonstrated to be commercially viable; and third, they must be broadly applied in both developed and developing countries. This report examines some of the barriers to the third step of the technology process, the diffusion of technology, especially to developing nations.

The term technology usually conjures up an image of sophisticated computer and communications equipment, bioengineering, or fuel cell vehicles. However, the technology needed to avoid, reduce, or sequester

3 Weyant, Pg. 45.

greenhouse gases covers a much broader scope. It includes "low tech" equipment, such as improved insulation; sequestration approaches, such as reforestation projects; and a broad range of know-how, such as energy-efficiency audits that can often produce large gains at low cost in developing nations. This report will include a full range of technologies, from high-tech devices through simple know-how.

The process of broadly applying new technologies has been called technology transfer, but we believe that "technology diffusion" is a more appropriate term. Technology transfer implies that the shift of responsibility for the technology from the innovator to the user occurs at a single, definable moment, akin to the transfer of property. This is a misleading image. Effective application of new technology requires a collaborative effort between the supplier or investor and the user. As the collaboration proceeds, the user becomes more knowledgeable about the new technology and accepts more responsibility, but it is often hard to define when this happens, even in retrospect. Hence, our preference for the term "technology diffusion."

Effective application of new technology requires a collaborative effort between the supplier or investor and the user.

Technology diffusion also creates the image of technology spreading from a central focal point. This is a useful image, since in many cases the early adopters of a new technology demonstrate its benefits to others, who subsequently adopt the technology and assist in its further spread. Some technology is highly proprietary and the innovator retains control over its application through much of the technology diffusion process. Other technology, particularly know-how, is inherently non-proprietary, and can have multiple innovators and centers for diffusion.

No single model exists for technology diffusion. Indeed, flexible approaches are needed to maximize the benefits of the full range of advanced and new technologies. The diffusion of advanced technologies can provide benefits in addition to the reduction of greenhouse gas emissions. While appropriate skills and infrastructure are needed before advanced technology can be implemented in developing countries, the widespread application of new technology leads to the development of additional skills and infrastructure. In developing countries, these new skills and infrastructure can be a catalyst for broader economic and social advances.

The importance of technology in addressing climate change is well recognized, and a variety of international mechanisms have been developed to promote the diffusion of technologies that avoid, reduce, or sequester greenhouse gases. Appendix II provides a discussion of the performance of these mechanisms.

This report examines barriers to technology diffusion, using case studies of BRT member companies to illustrate how these barriers have been overcome in innovative ways. The report also presents several recommendations for increasing technology diffusion and maximizing its benefits to infrastructure.

Barriers to Technology Diffusion

The summary of the international mechanisms for promoting the diffusion of climate change technology in Appendix II indicates that these mechanisms have not had, and are not likely to have, a noticeable impact on the rate of technology diffusion, because they focused on written descriptions of technology needs, on the creation of databases and on government-to-government interactions. They have not promoted the direct interaction between technology suppliers and users that is critical to technology diffusion.

The written word, whether on paper or on the Internet, is a poor medium for transferring technology. Written descriptions can make potential users aware of the existence and potential benefits of a technology. But users of technology, like consumers in general, are usually skeptical about technology claims. Demonstrations, preferably in actual operations, are far better for selling new technology than written descriptions.

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Testimonials from actual users carry more weight than manufacturers' claims, which is why early adopters who are willing to talk about their experience with a technology are so important to technology diffusion.

Convincing users of the value of a new technology is necessary, but not sufficient, to achieve technology diffusion. New technology typically requires new installation and operating procedures. Anyone who has bought a new computer or home appliance will appreciate the difficulty that the user of a new technology faces. There are far too many cases in which new technology is purchased, then either not put into operation or operated at less than its full capacity because the user does not have the technical skills to apply it correctly.

The best way to successfully diffuse technology is for the suppliers and users to engage in a collaborative effort. This approach is viable with large-scale processing equipment, such as new electric power generation facilities, but obviously impractical with smaller scale technology such as improved household insulation. For such smaller scale technology, the manufacturer or distributor should provide sufficient demonstration and technical support to ensure that users can realize the full benefits.

Broad diffusion of technology will occur only if governments of developing nations provide an "enabling environment." There are two critical aspects to an enabling environment: The first is an environment which is attractive to foreign direct investment and the second is an environment which helps the creation of local capital for investment.

Enabling Foreign Investment

■ Overcoming Regulatory Barriers

The diffusion of low greenhouse gas emission technology to developing nations faces both regulatory and non-regulatory barriers. There is growing literature on regulatory barriers, which was well summarized in the *Intergovernmental Panel on Climate Changes Special Report on Technology Transfer.*[4] Among other recommendations, the *Special Report* called for:

- **Reforming legal systems.** Uncertain, slow and expensive enforcement of contracts by national courts or international arbitration and insecure property rights can discourage investment

- **Reforming administrative law.** Reducing regulatory risk and ensuring that public regulation is accessible to stakeholders and subject to independent review can encourage greater investment

- **Protecting intellectual property rights and licenses.** Protections should foster innovation and avoid misapplication, which may impede diffusion of environmentally sound technologies (ESTs)

- **Encouraging financial reforms.** Competitive and open national capital markets and international capital flows support foreign direct investment. Governments can expand financial lending for ESTs through regulation that allows the design of specialized credit instruments, capital pools and energy service companies. In addition, project approval procedures and public procurements requirements should be simple and transparent

- **Reducing corruption.** Using legislation, enhancing transparency and increasing participation by civil society to reduce corruption in conformity with international conventions

These recommendations, which were approved by over 100 nations at an IPCC Plenary meeting, appear supportive of BRT recommendations.

■ Overcoming Non-Regulatory Barriers

Many of the barriers to the diffusion of technology in developing countries are less easily categorized. Some of these barriers, and the innovative ways in which they can be overcome, are discussed in the BRT member company case studies presented below.

■ Case Study 1: Pfizer

Energy-Efficient Plant Operations

All manufacturing operations have the potential to reduce their direct or indirect greenhouse gas emissions by using energy-efficient technology in their plants. A wide variety of such technology is available in the industrialized world, but transferring it to manufacturing facilities in developing nations requires careful education of both suppliers and plant personnel.

Pfizer, a pharmaceutical manufacturer, has successfully transferred energy-efficient plant technology to its facilities in Asia, but only after working with suppliers to ensure that they

4 Metz, B., et al, eds; "Methodological and Technological Issues in Technology Transfer" (Cambridge University Press, 2000, Pg. 5-6).

understood the specification changes that were required and providing training to their plant personnel.

In China and Thailand, initial attempts to obtain energy-efficient lighting, such as T8 lamps with electronic ballasts and compact fluorescent lamps, were unsuccessful because the products being requested were new in these countries and poorly understood.

Pfizer was able to obtain the equipment it requested only after a series of negotiations that educated the vendors about state-of-the-art lighting equipment. While this resulted in project delays, Pfizer ultimately obtained the efficient lighting equipment it specified. In the process, the company built expertise among the vendors involved, who are now available to help apply energy-efficient lighting elsewhere in their region.

Pfizer had a similar experience when it attempted to install a state-of-the-art chilled water system in Thailand. This system derives its efficiency, in part, from use of automated variable speed controllers on the circulating pumps. Thai vendors were unfamiliar with automated, variable speed controllers, and initially attempted to design the system with manual controllers. Pfizer educated local vendors on the use of variable speed controllers, obtained the desired equipment for its plant and also built capacity among its vendors in the use of this technology.

Plant personnel must also be educated on the use of energy-efficient technology. Pfizer provided Energy Star computer equipment, which will automatically shut down after a fixed period of idling time, to its facilities in Indonesia, India and China. The company later discovered that plant personnel did not realize they had to activate this energy-saving feature. Equipment users had to be notified and trained in the use of this energy-efficient equipment.

Education on the features and advantages of energy-efficient technology was the key to creation of an enabling environment in each of these examples.

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Case Study 2: United Technologies

Cultural Sensitivity

Manufacturing equipment will not perform at optimum energy efficiency unless it is properly designed, operated and maintained. To ensure that plant personnel are given the best advice possible on the proper operation and maintenance of their existing equipment — as well as investment opportunities to further improve performance — many companies have instituted energy audits. These audits examine opportunities for reducing energy use and lowering greenhouse gas emissions through a combination of design modifications, operating procedure changes and improved maintenance.

United Technologies has been successful in transferring energy audit know-how, both between divisions in the U.S. and to its operations in China. Achieving this success required cultural sensitivity.

United Technologies' training program was tailored to the needs of its Chinese affiliate. All

training materials were translated into Chinese, and simultaneous translation was provided for training sessions. Wherever possible, the company used consultants and internal staff who had already worked at the local facility and could speak confidently about the local situation. Training sessions were not presented as a one-time event, but as the beginning of an ongoing dialogue on energy conservation.

Between formal meetings, representatives of the units involved formed a committee to communicate needs and concerns. To the extent possible, the company representatives are kept constant so that faces become familiar and the dialogue is ongoing. Senior management support is demonstrated by the participation of regional managers and general plant management. United Technologies' efforts are expected to pay off in terms of reduced normalized energy use and greenhouse gas emissions from its Chinese operations, but final documentation of the level of reduction is still being developed. The program also includes water conservation measures that have resulted in significant reductions in water usage at a number of plants. Chinese facilities are receiving information about best practices and a forum has been established for cross-divisional information exchange.

For this case, the enabling environment consisted of a sensitivity to the needs of the local affiliate and a willingness to tailor programs to accommodate those needs.

Case Study 3: The Home Depot

Promoting Sustainable Forestry

Use of biomass to substitute for other raw materials has the potential to reduce greenhouse gas emissions. But this potential can only be achieved if the use of biomass is sustainable, i.e., the harvested biomass is replanted, and care is taken to minimize the methane and nitrous oxide emissions that can accompany biomass production.

In 1999, to promote the use of sustainable biomass, The Home Depot instituted a wood purchasing policy that focused on achieving sustainable forestry. Because The Home Depot does not own any forests, implementing this policy required evaluation and education of its suppliers.

The Home Depot realizes that forest conditions and harvesting practices vary greatly among the different regions of the world from which it purchases wood products. The company cannot develop a single approach to wood procurement. It reviews forest assessments provided by governmental, intergovernmental and environmental organizations, including the U.S. Forestry Service, National Ministers of Forests, the UN Food and Agriculture Organization (FAO), World Wildlife Fund, Global Forest Watch and others.

Some of the forest issues that lead to unsustainable forest are illegal logging, harvest areas that are not reseeded (either naturally or planted) and the harvesting of forests that are near extinction (endangered regions). There are other social, economic and political issues that have impacts on forests on a local level. These issues must be solved in a collaborative manner with local stakeholders.

The Home Depot also works with suppliers to improve their practices. To promote sustainable forestry in Indonesia, The Home Depot first met with groups such as the FAO and the Rainforest Alliance to determine what

was needed for sustainable forestry in that country. The company then held many meetings with their Indonesian vendor to discuss how sustainable forestry practices could be implemented to meet The Home Depot's policy goals and to ensure that Indonesian wood products had wide acceptance. As a result of these meetings, the vendor is now developing a sustainable forestry program to meet the Forest Stewardship Council and LEI certification requirements.[5] This process could be accelerated greatly if the Indonesian government, which owns the forests, was prepared to assist through satellite imagery and pre-establish recognized sustainable forestry practices that are presently used in some developed countries.

There are other social, economic and political issues that have impacts on forests on a local level. These issues must be solved in a collaborative manner with local stakeholders.

Case Study 4: ITT Flygt

Energy Savings vs. Initial Cost

ITT Flygt, an affiliate of ITT Industries, manufactures high efficiency pumps for use in water and wastewater systems. Since many developing nations are investing in such systems, Flygt is actively marketing its pumps to public utilities in these countries. As is often the case with advanced technology, the initial cost of Flygt's pumps is higher than the initial cost of lower efficiency competitors. However, the savings in energy that Flygt's pumps provide over their lifetime more than compensates for their higher initial cost. These energy savings also translate into lower greenhouse gas emissions.

Purchasing decisions for Flygt's equipment are complicated by the complex structure of decision-making that frequently exists in public works projects. The enduser is a public utility that typically will hire consultants for advice on equipment purchases and contractors to install the equipment. Both the consultants and contractors have incentives to minimize construction costs and choose the lowest initial cost equipment, without consideration of future energy costs or greenhouse gas emissions.

Flygt uses two techniques to compare products with different cost and emission profiles. First, life cycle costing, which compares products on the basis of the sum of their initial cost, operating and maintenance costs, and disposal or recycling costs; and second, life cycle assessment, which compares products on the basis of the sum of the direct emissions generated in their manufacture, use and disposal. While these techniques are increasingly used in developed nations, they are often not used in developing nations.

Local acceptance of life cycle costing and life cycle assessment would overcome the barriers Flygt has encountered in marketing its products and create an enabling environment for the use of similar high efficiency, but higher initial cost, technology.

Case Study 5: DaimlerChrysler

Innovative Financial Structure

Poor air quality is a major problem in the megacities of the developing world. Vehicles are a significant source of emissions in many of these cities, with the use of two-cycle engine motor scooters and older, poorly maintained cars exacerbating the problem. Low-emission

5 LEI stands for Lembaga Ekolable Indonesia, and is an Indonesian environmental certification group.

mass transit is often suggested as a method for reducing these emissions, but the introduction of this technology faces many barriers. DaimlerChrysler's experience in Brazil with natural gas-fueled buses, which have lower emissions of both local pollutants and carbon dioxide than standard diesel buses, demonstrates both the barriers encountered and some of the innovative strategies that can be used to overcome these barriers.

Mercedes-Benz do Brasil, DaimlerChrysler's Brazilian affiliate, began producing natural gas-fueled buses in 1987. Initial experience with these buses was poor, due to the low quality of the available natural gas. In 1992, the quality of the natural gas improved, as did the performance of the buses.

Mercedes-Benz do Brasil developed a new generation natural gas engine in 1993 which was available for export to Germany, Australia and several countries in Asia. This was followed in 1997 with a new bus chassis, designed for the improved engine, which resulted in a bus with the same reliability as diesel buses and better durability. DaimlerChrysler is now working with the UN Development Programme (UNDP) and the World Bank's Global Environment Facility (GEF) to demonstrate fuel cell buses in Latin America.

While existing natural gas bus technology has lower emissions than its diesel counterpart and fuel cell buses promise even lower emissions in the future, only a relatively small number of natural gas buses are in use in Latin America. The major barrier is cost. The buses are about a third more expensive to buy than diesel buses and have higher maintenance costs because of the small scale on which parts are manufactured.

DaimlerChrysler worked with the city of Sao Paulo, GATUSA (a local bus operator) and Shell (the natural gas supplier) in an innovative program to compensate for the higher capital and operating costs of natural gas-fueled buses. GATUSA's garage was equipped with a modern compressor system that cut refueling time to five minutes, and allowed enough natural gas to be carried on each bus for a full day's operation. The low-emission buses run on special routes that have a high concentration of customers, helping to recover the higher initial equipment costs. To keep ridership high and recover costs faster, unlicensed bus operators are prevented from operating on the special routes. Finally, GATUSA was given a twenty-year contract, longer than normal, to operate over these routes, again providing assistance in recovering the higher cost of the bus technology.

The special bus routes and longer contract period do not have a monetary cost to the city of Sao Paulo, but they do create the enabling environment that allows the local bus operator to use DaimlerChrysler's lower emissions, but higher cost technology.

Case Study 6: Shell/Eskom

Solar-Based Rural Electrification

Access to affordable, reliable electric power is one of the key requirements for the alleviation

of poverty, the primary goal of developing nations. At present, 2 billion of the world's poorest people do not have access to electric power and large numbers of them live in rural areas where extension of the conventional electric power grid is currently too expensive for either public or private utilities. Solar power offers an attractive alternative in many developing nations, but it, too, is expensive. Residents of these poor, rural areas cannot afford the initial cost of the system. In addition, the infrastructure necessary to install and maintain these systems is often lacking.

Shell and its joint-venture partner Eskom, the South African electric utility, have developed an innovative program to overcome these barriers and deliver solar-based electric power in rural South Africa. They install a complete system — solar cells, wiring, electric lighting and power points for appliances — in users' homes. A unique feature of the system is that it requires a magnetic card to operate. This card allows the user to use the system for 30 days, after which a new card must be purchased. This approach allows users of the system to rent the system or, as may be the case for other projects, pay for it on an installment basis, rather than paying for it upfront. The magnetic card also acts as a deterrent to theft, since the system will not work without the card.

This approach allows users of the system to rent the system or, as may be the case for other projects, pay for it on an installment basis, rather than paying for it upfront.

Shell/Eskom also built the infrastructure necessary to install and maintain the system. They trained 220 installers, who also provide maintenance support, if needed, and established a network of 230 local merchants who sell the magnetic cards. Training of these people builds capacity in the local area and should provide additional benefits in the future. The project was initiated in 1999, with the goal of installing 50,000 units. By March of 2000, some 6,000 units had been installed, and the project was so successful, the South African government decided to use it as a model for a broader program. Officials are currently in the final stages of deciding on the details of a program to subsidize the installation of 250,000 solar-based electricity systems in five areas of South Africa. The government's goal is electrification of the entire country in the next 10 years, with 1.5 million homes being supplied from renewable resources, including solar.

Case Study 7: ExxonMobil

Ensuring Economic Benefit

In the fight to encourage economic growth and alleviate poverty, developing countries can take proactive steps to ensure the most beneficial use of their resources. Important steps include developing required infrastructure as well as providing critical improvements in health care delivery systems and education facilities. Combined, these actions will encourage future investment in other sectors of the economy.

ExxonMobil, through its subsidiary Esso Chad, is leading a consortium that is developing an oil field project in Chad, in Central Africa. The project will generate between $2.5 billion to $5 billion in royalty and tax revenues for the Chad government over the life of the oil field.

To ensure the benefits reach the citizens of Chad, the Chadian government has developed a revenue management plan with the assistance of the World Bank. This plan, which has been enacted into law, defines the use of project revenues: over 70 percent must be used to fund health, education, infrastructure and agriculture projects; 10 percent must be placed in savings for future generations; and 5 percent used for development projects in the oil field area. An independent oversight committee including NGO participants and other members of civil society will review spending. The World Bank, which has provided funds for Chad's equity participation in the project, will monitor the use of the revenues. This process should ensure that the revenues from the project are used for the benefit of the people of Chad.

In addition, ExxonMobil has taken steps to ensure that local communities benefit from the project. ExxonMobil is committed to preferentially hiring qualified citizens of Chad and Cameroon (a pipeline from the oil field will pass through Cameroon), especially from nearby villages, as construction proceeds in the oil field area. At the end of 2001, 85 percent of the 10,000 construction workers were Chadian or Cameroonian nationals.

In addition, to ensure that Chadians will be qualified to hold the skilled jobs that will be created once the oil field project is operational, ExxonMobil is undertaking several initiatives. One of these is the establishment of a training center in Chad where dozens of Chadians are given training in English and petroleum industry skills before being sent abroad for more advanced training.

ExxonMobil is also committed to purchasing goods and services from the local economy when and where that is possible. Business development seminars have been held to build capacity among local businesses to meet project needs. The project's training and business development efforts have a broader infrastructure-building value to both Chad and Cameroon.

Enabling Local Capital Formation

While foreign direct investment by BRT member companies can provide the focal points for the diffusion of environmentally sound technologies, broad diffusion of many of these technologies depends on their being adopted by small- and medium-sized enterprises in developing nations. These enterprises can adopt new technology only if they have access to the capital resources necessary to invest in the new technology. At present their access to these capital resources is limited, for reasons that are often not well understood.

Hernando de Soto persuasively argues in his book *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else*,[6] that the poor and middle class in developing countries, the people who are most likely to start the small enterprises that will be necessary for the broadest diffusion of environmentally sound technologies, have surprisingly large financial resources.

But they hold these resources in defective forms: houses built on land whose ownership rights are not adequately recorded; unincorporated businesses with undefined liability; and industries located where financiers and investors cannot see them. Because rights to these possessions cannot be adequately documented, these assets cannot be readily turned into capital, cannot be traded outside of narrow local circles where people know and trust each other, cannot be used as collateral for a loan and cannot be used as a share against investment. In contrast to this situation, de Soto points out that the single most important source of capital for new businesses in the U.S. is a mortgage on the entrepreneur's house.

The solution that de Soto proposes is the careful documentation of property rights in developing nations that accept the claims of the current occupants and developers. This will be a tedious and time-consuming process, as it was in the developed world — it took a century of legislation and judicial rulings for the U.S. to develop its current property rights system. But the development of such a system is a critical component of "the rule of law" that is necessary for a market-based economy to thrive. It is only in such a system that the technology diffusion needed to limit greenhouse gas emissions in developing nations can occur.

A brief summary of these arguments appeared in an article titled "The Poor Man's Capitalist" in the July 1, 2001 issue of *The New York Times Magazine*,[7] where de Soto estimates that even in Haiti, one of the poorest countries in the world, the poor have "$5.2 billion in dead capital … four times greater than the assets of Haiti's 123 largest private formal enterprises, 11 times greater than the deposits in Haitian banks, and 158 times the value of all direct foreign investment in the country up to 1995."

6 Hernando de Soto, "The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else" (Basic Books, 2000).
7 Miller, M., "The Poor Man's Capitalist" (*The New York Times Magazine*, July 1, 2001, Pg. 44-47).

Recommendations

The private sector must take a leadership role and partner with the public sector in proposing viable and innovative deployment and financing schemes to make advanced technology projects that avoid, reduce, or sequester greenhouse gases economically attractive. The BRT believes that the right policies and efforts can catalyze much larger public-private undertakings and close the growing global technology gap. A critical goal of these efforts should be to make it easier for companies from the U.S. and other developed nations to engage in cooperative research, development and demonstration; joint venture; and technology deployment efforts in the developing world.

Better coordination of public and private investments could be helpful in promoting international technology diffusion, but additional financial incentives may be required, including mechanisms for reducing the "first-cost" disadvantage that some low greenhouse gas emissions technologies face. The role of international lending agencies could be developed further to encourage the diffusion of these technologies.

The case studies presented above show that BRT member companies can be the focal points for technology diffusion in developing nations, but only when they overcome significant barriers. These barriers fall into four general categories: (1) regulatory barriers; (2) barriers due to lack of appropriate education and training; (3) financial barriers and (4) corrupt practices. Governments can do many things to minimize these barriers. Many of the required actions are not directly involved with the technology process but deal with more general economic conditions, including the elimination of corruption and the recognition of property rights. The benefits of these steps are far broader than the encouragement of advanced technologies.

Recommendation 1: Examine Regulatory Barriers

Governments of all nations should examine their regulations to ensure that they are not creating unnecessary barriers to the diffusion of technologies that avoid, reduce or sequester greenhouse gases. The U.S. should encourage discussion of these barriers in all international and bilateral forums.

Recommendation 2: Eliminate Corruption

Governments of all nations should continue their efforts to eliminate corruption, recognizing the negative impacts that corrupt practices have on all aspects of economic development — including efforts to avoid, reduce or sequester greenhouse gases. The U.S. government has long been a leader in these efforts, with its enforcement of the Foreign Corrupt Practices Act and its support for both the Organization for Economic Co-operation and Development (OECD) Convention on Combating Bribery of Foreign Public Officials and the Inter-American Convention Against Corruption. The BRT fully supports the U.S. government in these efforts.

Recommendation 3: Demonstrate Technology Benefits

The U.S. and other developed nation governments should redirect the focus of international technology transfer activities from broad technology awareness efforts to actual demonstrations of the technology, using examples from developing nations wherever possible. The most effective agents of

technology diffusion are entrepreneurs and plant personnel who have benefited from using that technology. Their claims for the benefits of the technology will be more credible than the claims of vendors, and they can answer questions about the difficulties involved in using the technology with more authority than can vendors. While it may be difficult for multilateral organizations such as the OECD's Climate Technology Initiative (CTI) to address the details of specific technology diffusion projects, efforts should be made to move past technology awareness discussions into the specifics of technology implementation. The U.S. is a leader in the CTI and should advocate this as a direction for future training seminars. The U.S. should advocate similar approaches in other international programs on technology diffusion and adopt them in its bilateral climate technology programs.

Recommendation 4: Address Higher Initial Costs

The U.S. and other developed nation governments should share innovative approaches, based on actual experience, for addressing the higher initial and/or operating costs of many technologies that avoid, reduce or sequester greenhouse gases. As indicated in the case studies, the use of advanced technology often involves higher initial and/or operating costs. In some cases the technology provides operating savings that compensate for its higher initial costs, and overall savings can be shown calculating the net present value of the initial, operating, maintenance and decommissioning costs. In other cases, the net present value of the total cost of the technology will be higher, often due to the small scale on which it is applied. In these cases, innovative approaches must be used to provide incentives for the use of the technology. Monetary subsidies are the simplest approach, but their use creates market distortions and political problems and should be avoided. Non-monetary incentives, such as those created to encourage the use of natural gas fueled-buses in Brazil, are more desirable. The U.S. should encourage the creation of forums in which technology suppliers, technology users, financiers and developing nation government officials can discuss ways of financing the higher costs of advanced technology.

Recommendation 5: Establish Clear Title and Property Rights

The U.S. and other developed nation governments should encourage, and where possible, support efforts in developing nations to create clear title and property rights to the land and other assets in their countries that are currently undocumented. While foreign direct investment is a powerful tool for initiating technology diffusion, it cannot do the whole job. Small- and medium- sized enterprises must be involved in the final stages of technology diffusion, and they can do this only if they have access to capital markets. Currently many small- and medium-sized enterprises in the developing world do not have this access because their assets are undocumented. Property systems in developing nations have to be upgraded and made to reflect the realities of actual ownership.

Appendix I

The Business Roundtable Global Climate Change Position

The Business Roundtable views global climate change as an important and complex issue with significant potential environmental, energy supply and economic implications. The development and global deployment of new, highly efficient technologies that minimize carbon emissions and maximize carbon capture promise to be the most effective long-term response to concerns about global climate change. We support actions to implement a U.S. climate change technology strategy that would involve all nations and are committed to playing a key role in its success.

Technology

The development and global deployment of new, highly efficient technologies that minimize carbon emissions and maximize removal of carbon from the atmosphere is the most effective long-term response to concerns about global climate change. Successful development, commercialization, and global dissemination of new technologies will require a shared public-private sector commitment. Industry alone cannot assume the financial risk necessary to develop and commercialize technologies on a global scale. The Roundtable believes that key elements for a climate change research and development investment strategy should include:

- **Increasing the level of energy research and development funding commensurate with the challenge:** Energy R&D funding suffers from declining investment, poor coordination across sectors and insufficient focus on technologies that address climate change challenges. These hurdles must be overcome if the United States and the world are to reduce greenhouse gas emissions. Indeed, energy R&D is less than 1 percent of the value of energy products, far less than the 3 percent for other industries. Public and private sector energy R&D funding should be increased, better coordinated and targeted toward developing revolutionary new technologies that are more efficient and reduce, avoid, or capture greenhouse gas emissions.

- **Increasing technology deployment:** There are valuable emerging and commercially available advanced technologies that could reduce emissions of greenhouse gases today. Increased efforts are needed to deploy these beneficial technologies for application in domestic and international markets, as well as to develop and commercialize technologies to conserve energy and/or to capture and sequester emissions of greenhouse gases.

- **Market incentives:** Federal technology policy initiatives must take into account the central role of the private sector in commercializing and deploying new and emerging technologies. Governments can most effectively promote the development of advanced energy and environmental technologies through policies that provide effective market-driven incentives for research, commercialization, investment and the global deployment of new technologies. We recognize that climate change impacts all nations and that solutions must be of a global nature. One key element of any such efforts will be to maintain and expand trade linkages among nations and facilitate the free flow of private capital through foreign direct investment, the primary vehicle for global technology diffusion.

Economy

Development and deployment of technology

requires a sound economy, both at home and abroad. Only strong, free market economies can produce the kind of technological advancement needed to meet the challenge of climate change.

United States regulatory, tax and trade laws make important contributions to a cleaner and healthier environment. They facilitate an effectively functioning economy and an efficient global trading order. However, too often the implementation of these laws and policies unintentionally increases risks and uncertainty, which can discourage innovation and raise costs.

In our paper *Unleashing Innovation: The Right Approach to Global Climate Change* we identify instances where regulatory policy, tax, and trade laws inadvertently suppressed research, innovation, and the global dissemination of advanced technologies. We support solutions that drive rapid innovation, while improving environmental performance.

We recognize that investments made to address one environmental concern, such as climate change, may not be used simultaneously to address other safety, health and environmental needs. To maximize resources, actions to address climate change should make good economic sense today, while at the same time improving the quality of life for tomorrow.

Summary

The Business Roundtable is committed to preserving and protecting the environment. We are committed also to the fundamental concept of sustainability – the achievement of economic growth, superior environmental performance and rising living standards for a growing world population. We believe the development, commercialization, and global diffusion of advanced energy-efficient and environmental technologies are the most cost-effective and enduring responses to concerns about climate change.

The best approach to the climate change challenge consists of promoting and fostering technological advancement, and eliminating barriers to technology development and diffusion. The BRT member companies support a climate change policy response that:

- supports principles of sustainability that lead to an improved environmental protection system;
- eliminates regulatory, tax and trade impediments to the development and global deployment of new highly efficient technologies that minimize carbon emissions and maximize carbon capture;
- recognizes the important role of terrestrial and ocean sinks and supports policies that encourage the use of sequestration in agriculture and forestry;
- institutes economically sensible measures that accelerate the deployment of newer more efficient, lower-emitting and renewable technologies;
- increases research, development and deployment of beneficial energy and climate change technologies;
- strengthens our national commitment to basic and applied R&D in the physical sciences;
- fosters development of innovative public-private partnerships that accelerate the

commercialization of advanced technologies;

- accelerates research into remaining uncertainties in climate change science; and

- fosters research into adaptation technologies as well as preventive technologies, so that society is better prepared for climate changes that may occur, regardless of cause.

Our goals are a cleaner, safer, and healthier world with economic growth and a higher standard of living for all. We are committed to constructive participation with all stakeholders in the evolutionary process of environmental protection. Ultimately, it will be industry that provides much of the innovation and capital to develop, commercialize and deploy the technologies needed to enable societies around the world to meet their economic development aspirations in a sustainable manner.

September 2001

Appendix II
International Mechanisms for Promoting the Diffusion of Advanced Technology

All of the international bodies concerned with climate change have activities related to technology diffusion. A brief summary of these activities follows.

UN Framework Convention on Climate Change (UNFCCC)

The importance of technology in addressing concerns about global climate change and the capacity-building benefits that it can provide are recognized in the UNFCCC. Article 4.5 of the Convention reads:

> The developed country Parties and other developed Parties included in Annex II [the countries that were members of the OECD in 1990] shall take all practical steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.

Article 4.7 of the UNFCCC makes developing country Party fulfillment of their commitments under the Convention contingent on their receiving financial aid and technology transfer, and Article 4.9 reiterates the Article 4.5 commitment in terms of the least developed countries. The UNFCCC's Annex II Party commitments on technology transfer were reiterated in the Kyoto Protocol, and the Buenos Aires Plan of Action adopted in 1998 contained 20 issues or questions related to technology diffusion.

Technology transfer has been on the agenda of every UN climate change negotiating session since 1995, and the Parties to the Convention have charged the UNFCCC Secretariat with a variety of survey activities. These activities have generated large volumes of paper, and the Secretariat's latest effort is a technology transfer Web site, which was unveiled at COP-7[8] in November, 2001.

COP-7 also adopted a framework for meaningful and effective actions to enhance technology transfer and established a twenty-member expert group on technology transfer. The framework is a comprehensive statement of what is needed to ensure that developing countries obtain and implement environmental technology. It acknowledges the role of the private sector and the obligation of developing nations to provide an enabling environment, but is little different from similar statements made over the years by other UN agencies. The expert group is to meet twice a year to promote technology transfer. The COP will review its activities in five years.

It is far from clear that these efforts have increased or will increase technology diffusion.

Except for industry participation in a roundtable discussion of technology diffusion at COP-3, industry's role in these discussions has been minimal. The UNFCCC process still sees technology diffusion as a function of governments or international institutions, and

8 All countries that have ratified the UNFCCC are member of the Conference of Parties (COP) to the UNFCCC that normally meets once a year to approve all actions taken under the Convention. COP meetings are numbered consecutively. COP-1 was held in 1995, COP-2 in 1996, etc.

the need for collaborative efforts between technology providers and technology users has yet to be recognized.

Intergovernmental Panel on Climate Change (IPCC)

The IPCC's activity on technology diffusion was the publication in 2000 of a Special Report titled, *Methodological and Technological Issues in Technology Transfer*[9] (SRTT). The SRTT, which was developed in response to a request from the UNFCCC COP's Subsidiary Body of Scientific and Technological Advice (SBSTA), first looked at the framework under which technology transfer occurs, then at the opportunities for technology transfer in seven economic sectors, public health and coastal protection. Finally, the report presented 30 case studies of successful technology transfer in developing nations.

The SRTT gives greater emphasis to the role of the private sector in technology transfer than is generally acknowledged in UNFCCC discussions, but the private sector is still seen as only one of many stakeholders, not as the primary driver of technology transfer. The report concludes that increasing the flow and improving the quality of technology transfer will require capacity building, an enabling environment, and improved mechanisms in developing countries. Under the heading of capacity building, the IPCC sees a need for: improved human capacity, e.g., more technical, business, managerial, and regulatory skills; improved organizational capacity, e.g., improved support services such as legal and financial firms; and better information assessment and monitoring capacity, e.g., better use of the private sources of technology that are proliferating as the result of the Internet, the activities of consultants, etc.

A long list of measures is presented under creation of an enabling environment, including reforming legal systems to ensure that contracts can be quickly and inexpensively enforced, protecting intellectual property rights, and encouraging financial reforms that open capital markets. Improved mechanisms include: development of "national systems of innovation" that include strengthening scientific and technical education; targeted capacity building in support of climate-related projects; development of technology assessment capabilities; and use of official development assistance (foreign aid) and funding from the Global Environment Facility and multilateral banks to implement environmentally sound technology.

There is much in the SRTT that the BRT supports, particularly the call for creation of an enabling environment that would allow more transfer of environmentally sound technologies by the private sector. The IPCC presented the SRTT in June, 2000, but there was little discussion of the report or its implications.

Global Environment Facility (GEF)

The GEF is the financial mechanism of the UNFCCC, and is used to disperse technology diffusion funding from Annex II countries to developing nations. These funds are in addition to bilateral foreign aid. In assessing the GEF's activities, the IPCC Special Report concluded:

> Compared with the magnitude of the technology transfer challenge, these [GEF's] efforts are of modest scale, even when added to the contributions from bilateral development assistance. The GEF currently targets incremental, one-time investments in mitigation projects that test and demonstrate a variety of financing and

9 Metz, B., et al., eds.

> institutional models for promoting technology diffusion, thus contributing to a host country's ability to understand, absorb and diffuse technologies. GEF also supports capacity building for adaptation.[10]

GEF's Web page (http://www.undp.org/gef/portf/climate.htm) lists 50 projects that appear to include a technology diffusion component, but most of these projects are either still in the planning stage or in early stages of implementation. No evaluation of GEF's effectiveness at promoting technology diffusion will be possible for several more years.

Climate Technology Initiative (CTI)

The CTI was launched by 23 OECD countries and the EU at COP-1 as part of the fulfillment of their UNFCCC commitment to promote the transfer of environmentally sound technologies and know-how. The CTI carries out this mission through three types of activities: (1) building capacity through hands-on regional training courses; (2) identifying technology needs; and (3) supporting research and development. The first of these activities should promote technology diffusion.

A discussion is underway in the CTI as to how far it should go in actually encouraging specific technology diffusion projects. A major concern is that, as a multilateral program, it cannot be seen as favoring technology from one country over that from another. It is likely the CTI will continue its general technology awareness efforts, depending on developed and developing country participants, to follow-up on their own ideas generated by CTI presentations.

10 Ibid., Pg. 7.

The Business Roundtable is an association of chief executive officers of leading corporations with a combined workforce of more than 10 million employees in the United States and $3.5 trillion in revenues. The chief executives are committed to advocating public policies that foster vigorous economic growth and a dynamic global economy.

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