# The New Business Climate

A **Guide** to Lower Carbon Emissions and Better Business Performance

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**By Rocky Mountain Institute**

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**Recommendations** (blue/gold boxes)

The "recommendations" are brief insights, or "punch lines," revealed by the authors' experience with the study, analysis, and design of carbon management strategies. We hope that the recommendations will help the reader summarize and organize the information presented in this document, and to "peek" ahead in order to prioritize which sections to read more or less thoroughly.

**Examples** (yellow/grey boxes)



**Figures**



**Tables**

# Executive Summary

Global climate change and the potential costs of $CO_2$ emission limits can impose risks to business performance and asset values. On the other hand, these concerns also present new business opportunities for proactive companies and institutions.

Profitable "no-regrets" energy efficiency improvements are widely available today, and longer-term investments in clean energy technology will be increasingly attractive in a carbon-constrained world. Meanwhile, flexible regulation and careful use of the emerging carbon markets can help manage costs. These and other opportunities can be captured by responding to the challenge of climate change in a way that stimulates innovation and improves business practices.

Consensus is emerging among scientists that the global climate is warming and that most of the observed change is due to the increase in greenhouse gas (GHG) concentrations caused by fossil fuel combustion and other human activity.

Although the risks of global climate change have not been accepted as requiring immediate action at the national political level, some U.S. states such as California, Massachusetts, and Oregon already limit some GHG emissions. Also, emission limits and carbon taxes are being instituted in Europe, based on the expected ratification of the Kyoto Protocol.

For both private businesses and public institutions, the stakes are high in trying to determine the best strategy for responding to global climate change and the policy measures that are being put into place. While some firms may choose to ignore or resist any sort of emission regulations, others accept the eventuality of GHG limits and are working to influence the regulatory structure to their benefit.

These firms understand that the *status quo* is not risk free because emission limits, higher energy costs, and market volatility could hurt business performance and lower asset values of carbon-intensive plants and equipment. They also understand that there is a significant risk in treating future energy costs and related emission control costs as a predictable, unavoidable expense.

Their goal therefore is to implement risk mitigation strategies *at low cost or at a profit* and to help create emission regulations that are as flexible as possible regarding when, where, and with which technologies reductions are achieved.

To reach this goal, firms and industries need to demonstrate that they can realize significant reductions when allowed to choose their own strategies, even under voluntary programs. Flexible solutions can be achieved *via* emission trading and other market-based mechanisms, which will reduce the cost of compliance with future emission limits.

***There is a significant risk in treating future energy costs and related emission control costs as a predictable, unavoidable expense.***

Thus, proactive "early action" to reduce emissions demonstrates that flexible regulation can be effective. This helps to *influence the future regulatory structure in favor of flexible, market-based regulations.* It is important to document any "early action" on emission reductions, which ensures that the reductions are credited against future emission limits, and to communicate about climate-related actions to employees, investors, and the public.

If firms want to undertake early actions, or at least prepare to participate in the carbon market in the future, they can take the following short-term measures:

- Develop an emission accounting, measurement and tracking system,
- Begin to implement "no-regrets" reduction measures, and
- Position themselves relative to the emerging carbon markets.

Companies and institutions can benefit from the development of an emission accounting, measurement, and tracking process. Such a system requires a detailed energy audit and metering study, which provides the basis for emission accounting and can employ one of several generic protocols now available.

With an emission accounting and tracking system in place, firms can establish emission reduction targets, identify reduction measures, and demonstrate progress achieved. Accounting and tracking systems are a way to educate staff on the risks and options related to climate change, and to gain an advantage over the competition. Firms that use a tracking system to report emission reductions achieved in an official carbon registry ensure they are given credit under future emission regulations.

Emission reduction targets can be an absolute amount or an index based on such parameters as production, sales or value added, facility occupancy, or weather. Larger companies can establish an internal GHG emission trading program to help meet their target. In any case, the least-cost strategy is to implement all emission reduction measures that cost less than the internal or external price of carbon offsets. Consider buying external offsets before they are needed. The best way to do this might be to buy call options for the future period.

Cost-effective "no-regrets" demand-side energy-efficiency measures can be found wherever energy is used in buildings, factories, and vehicles. Improving energy efficiency often provides sufficient cost savings to justify their implementation on an economic basis alone.

***Cost-effective "no-regrets" demand-side energy-efficiency measures can be found wherever energy is used in buildings, factories, and vehicles.***

Energy cost savings and other benefits should be treated as returns on capital investment, subject to an appropriate hurdle rate, rather than a simple payback criterion. Incorrect use of the latter is often a barrier to profitable efficiency projects. To capture the efficiency potential, a business should identify and implement available cost-effective energy efficiency measures in buildings, industrial production, and vehicles. This can be done in an opportunistic way, which minimizes the costs of emission reductions, by building aggressive energy-efficiency improvements into routine upgrades or expansions of facilities and equipment. In addition, use energy efficiency improvements to capture additional economic and quality benefits, such as down-sized cooling equipment, better thermal comfort, and higher quality lighting that improves the working environment.

***Companies and institutions should plan for carbon trading to become part of the procurement process for energy services.***

In the longer term, binding emission limits will be increasingly likely. Preparing for and responding to eventual GHG emission limits will involve substantial investments in:

- Buying (and possibly selling) carbon offsets and "green power" certificates,
- Implementing advanced technologies, and
- Reorienting company strategy toward new processes, products, and services.

***Smart firms will use the challenge of global climate change to stimulate innovation and improve business practices.***

The Kyoto Protocol provides for three "flexibility mechanisms": emission trading between Annex I (industrialized) countries, "joint implementation" (JI) carbon offsets within Annex I, and the clean development mechanism (CDM), which involves carbon offsets in developing countries. Recently, specific rules for these mechanisms have been negotiated. Although the United States supports the idea of emission trading and carbon offsets, its rejection of reduction targets means that only firms with operations in the EU and other participant countries will use the carbon market for near-term compliance.

Nevertheless, companies and institutions should plan for carbon trading to become part of the procurement process for energy services, either in the form of green power certificates or carbon offsets. First priority should be on Kyoto compliance for operations in participant countries. Other types of carbon offsets, or verified emission reductions (VERs), can be used to meet any domestic regulations, or to accumulate inexpensive credits to meet post-Kyoto international limits later when prices are likely to increase.

An incremental energy technology strategy would continue to capture available no-regrets efficiency opportunities, purchase green power, and otherwise offset the GHG emissions associated with energy use. A more ambitious approach can improve a firm's competitive position while minimizing climate-related risks through radical resource efficiency, which seeks 75–90 percent efficiency improvements. Examples of such performance can be found in building energy systems, industrial motor systems, etc.

This approach is profitable when designers "tunnel through the cost barrier" to where larger savings begin to cost less than smaller savings, and efficiency improvements at the end use are multiplied upstream in the energy conversion chain. Achieving such performance requires the application of whole-systems thinking early in the design process, in order to provide the end-use service at minimum cost, optimizing the system rather than sub-optimizing its components in isolation.

On the energy supply side, distributed generation (DG) based on small turbines or fuel cells can provide premium-reliability power and heat for space, water, and process heating or absorption or desiccant cooling. These technologies reduce GHG emissions compared to central power generation and separate heat production. Solar photovoltaic power can reduce emissions still further.

Just as whole-systems thinking and end-use, least-cost design can improve performance of a firm's facilities, these concepts can be applied to the products and services that a firm designs, produces, and sells. New markets will emerge for products that combine advanced energy technology with services such as financing, carbon offsets, and green power or ancillary services tailored to improving performance while reducing GHG emissions.

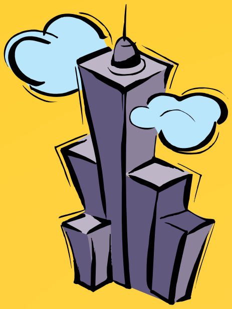
Smart firms will use the challenge of global climate change to stimulate innovation and improve business practices that help reconcile environmental and business performance goals. Once people step beyond the boundaries of incremental, zero-sum thinking they can create a culture supportive of creativity and learning. Such a learning organization will empower its people to effect innovative change as part of the everyday working culture. Learning organizations are better at improving quality, serving customers, and responding to changes such as GHG emission limits. A learning organization committed to addressing climate change can be a more fun, energizing place to work, and this employee motivation can create a competitive marketplace advantage.

***A firm's competitive position can improve while minimizing climate-related risks through radical resource efficiency.***

# Introduction: A Pop Quiz

**In 1997, at the Third Conference of the Parties (COP 3) to the 1992 U.N. Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan, international negotiators arrived at the first quantitative commitments to reduce emissions of greenhouse gases (GHGs) including carbon dioxide ($CO_2$), beginning in 2008.**

**The Kyoto Protocol commits all industrialized-country Parties to the UNFCCC, the so-called Annex I countries, to legally binding targets to limit or reduce six main GHGs by an aggregate seven percent. The U.S. government signed the Kyoto Protocol but to date has refused to ratify it.**



## What is your company's strategy on the Kyoto Protocol?

A. Ignore the agreement as lip service to environmentalists that will never be enforced?

B. Mount an intense lobbying effort to convince Congress to not ratify the agreement?

C. Corner the nascent market in carbon emission credits to offset your firm's emissions?

D. Identify low-cost emission reduction options and explore ways to limit the risk of future limits?

E. Begin to invest massive resources in shifting technology to non-fossil energy sources?

*"Companies composed of highly skilled and trained people can't live in denial of mounting evidence gathered by hundreds of the most reputable scientists in the world."*

*Sir John Browne, Chairman of British Petroleum, speech at Stanford University, 11 March 2002*

**Answering this question could involve the commitment of a significant share of your company's or institution's labor and financial resources over the next decade. The implications of that answer, right or wrong, could involve the continued growth and success of the organization, or perhaps its complete demise. The right answer is not yet clear, and it is probably not the same for every organization that addresses the question.**

**This guidebook will illustrate the important components of the scientific, economic, and political debate that has emerged in the last ten years over the threat of global warming and climate change, caused mainly by the increasing global emissions of $CO_2$ from fossil fuel burning. As the range of answers to our quiz suggests, the meaning of this debate, and an organization's response to it, depend strongly on one's knowledge of the impacts of climate change and the risks, costs, and opportunities they create. In this quiz, "None of the above" is not an option.**

**For both private businesses and public institutions, the stakes are high in trying to determine the best strategy for responding to the potential threat of global climate change and the policy measures that may result from the emerging realization of this threat. This document contains the information you need to help you gain a basic understanding of climate science, climate policy, and the strategic options available for reducing $CO_2$ emissions and positioning your business to thrive in a carbon-constrained world. Specific recommendations for climate action follow most sections of this document. Also, detailed case studies describe actions taken on climate change by several well-known companies.**

# Part I: A Guide to Lower Carbon Emissions and Better Business Performance

*"We need to make plain the inevitability of the climate impact predicted at the lower end of the IPCC scenarios, but begin to take action to ensure that the outcome remains at the lower end… we need to address our own emissions, work on developing energy choices which help our customers meet theirs, and establish GHG [trading] systems."*

*Mark Moody-Stuart, Shell International, "Energy for Sustainable Development," Conference on Health, Safety and the Environment in Oil and Gas Exploration and Development, Kuala Lumpur, 20 March 2002*

## Part IA: Motivations for Corporate/Institutional Action on Climate Change

Although global climate change is a long-term issue that is unlikely to affect the next quarterly report, there are numerous reasons to consider action on this issue now. These motivating factors involve cost reduction, risk mitigation, market positioning, and communications to a variety of internal and external audiences.

### Reduce costs and improve profitability

The most powerful and universal reason to take action on climate change is that it can reduce costs. The key strategy for cost-effective emission reductions is to improve energy and resource efficiency. This strategy relies on advanced technology, which is becoming more plentiful, to replace fossil fuels, which are being depleted and converted to carbon dioxide ($CO_2$) that is accumulating in the atmosphere and influencing the global climate.

Most $CO_2$ emissions result from the use of fossil fuels, which cost money. Saving fuel and electricity therefore saves money while reducing emissions. Although energy costs typically represent a small fraction of total operating costs, saving energy provides cost savings that drop straight to the bottom line on the firm's income statement.

Aggressive emission reductions could be very expensive if implemented within a short period of time. However, it is possible to reduce costs dramatically by building aggressive energy efficiency improvements into routine upgrades of facilities and equipment. This opportunistic approach to energy and emission savings saves money, smoothes the pattern of investments over time, and allows cost savings from earlier measures to help pay for later measures. The key to such a strategy is to start soon.

A wide range of reduction measures has the potential to be cost effective. These are described in more detail later under

**Recommendation**

*Minimize costs of emission reductions by building aggressive energy efficiency improvements into routine upgrades of facilities and equipment.*

Strategies for Action on Climate Change (Part IC). For example, energy cost savings from energy efficiency and other measures can provide an attractive rate of return while reducing emissions. Most facilities have at least some such "no-regrets" opportunities that can be exploited in the near term. Other cost-effective "no-regrets" measures can be designed into new and upgraded facilities and equipment in the future, using the opportunistic strategy suggested above.

**Risk management, hedging against uncertainty**

Risk mitigation is the primary goal of a climate strategy in industries that are potential "losers." If profits depend on sales of fossil fuels or carbon-intensive products, GHG limits could be a threat to the bottom line, or at least to the top line.

Thus, some of these firms are studying how they can reduce or offset the emissions associated with their purchasing decisions, their operational activities or their products sold. Emission reductions can be achieved

### Potential "winning" and "losing" industries

In the United States, there is a wide chasm between the environmental community and most of industry regarding the need to take action on climate change. Environmentalists favor commitments to reduce emissions and distrust the use of "flexibility mechanisms." Industry, on the other hand, resists regulation and favors the use of market-mechanisms to implement any commitments that are made. In the aftermath of the Kyoto Protocol, various domestic interest groups began to formulate positions that would initiate some progress toward the Kyoto commitments, while acknowledging that there is little chance that the Senate would ratify the Kyoto Protocol.

The positions of domestic industry groups can be broadly categorized along a spectrum—with opposition to a new regulatory burden at one end and interest (albeit cautious) in a set of potential new business opportunities at the opposite end. In other words, industries tend to view the prospect of GHG emission limits according to whether they see themselves as potential "winners" or "losers."

The potential "losers" are relatively easy to identify: they are the large fossil-fuel producers and users, in particular the coal and petroleum industries. They represent a powerful opponent to any form of emission limits, with few exceptions (notably British Petroleum and Royal Dutch Shell). Other industries, such as U.S. electric utilities, most of which rely heavily on coal-fired generation, also oppose the prospect of heavy-handed regulation. However, some such companies are showing increasing interest in "flexibility mechanisms," with the hope that emission limits could be made less painful by using economic mechanisms rather than a rigid regulatory regime.

The potential "winners" are a diverse group. The few pure beneficiaries of emission limits, such as renewable energy companies, are generally so small that they represent relatively little economic or political clout at present. Others, such as diversified technology companies, have both potential liabilities in their present carbon emissions and potential assets in technologies that could help reduce future emissions. Their potential as "winners" lies partly in their ability to reduce their own emissions and partly in their potential to capture new markets in the relevant technologies. Yet others, such as engineering and environmental consulting firms, have the opportunity to assist companies with liabilities to reduce their emissions.

in energy-intensive industries by, for example, buying "green power" from renewable sources, improving plant energy efficiency, and offsetting the emissions of products—even registering such products as "climate neutral" (Part IC).

These firms participate in industry groups on the climate issue, such as the now-defunct Global Climate Coalition (GCC) and the International Climate Change Partnership (ICCP), which is still active. They are also entering into new business ventures and corporate alliances to facilitate the transition to low-carbon operation and to diversify into low-carbon technology areas. Some examples of such alliances include:

- The Pew Center on Global Climate Change assembled the Business Environmental Leadership Council (BELC), which includes ABB, Alcoa, DuPont, IBM, Intel, Shell, and others, and encourages companies to take voluntary actions to reduce emissions. BELC members have developed reduction targets and believe that taking initiative can show government how to create climate change policies that work for business.[1]

*ENERGY STAR labeled appliances, electronics, and office equipment cost less to operate than than their standard counterparts while simultaneously working to reduce energy consumption, which translates to a cleaner environment.*

*Jeremy Heiman photo*

- General Motors, British Petroleum (BP), Monsanto and the World Resources Institute created an affiliation called "Safe Climate, Sound Business" to address climate change through emission reductions, carbon sequestration and support for climate research.
- World Wildlife Fund (WWF) established the Climate Savers Program to work with selected companies, including IBM, Johnson & Johnson, Polaroid, Nike, Lafarge, and the Collins Companies, to develop business plans for reducing GHG emissions.
- The Climate Neutral Network (CNN) is an alliance of companies and other organizations committed to bringing Climate Neutral products (those that have little or no net GHG emissions) to market. Members reduce GHG emissions by first reducing energy use in their facilities, and then investing in external energy reductions to achieve a net zero climate impact. Members include BP Amoco, Chevron, Interface Inc., Nike, The Saunders Hotel Group, Philips Lighting, and Sunoco.
- The U.S. Department of Energy (DoE) and the electric utility industry have formed a partnership to reduce, avoid, or sequester greenhouse gases. The utilities that have made agreements with the DoE represent 71 percent of 1990 electric generation and utility carbon emissions, with the potential to reduce carbon emissions by over 47 million metric tons of carbon equivalent (mtC).

- More than 3,000 organizations are involved in the U.S. Environmental Protection Agency's (EPA) Energy Star Program. These participants—including corporations, small businesses, hospitals, schools and universities, and non-profits—are using Energy Star to improve the energy efficiency of their buildings and certify energy efficient products.

A risk mitigation strategy can involve a study of options and analysis of internal business practices. It might also include "early action" to reduce emissions, which is discussed below. At a minimum, it is prudent for a company or institution to evaluate its options, using an internal energy and emission audit, which can be used to develop an emission inventory (of past emissions), tracking system (of present emissions), and baseline projection (of future emissions) (Part IC).

More sophisticated risk management tools include carbon market hedging. If future emission regulations could require expensive reductions, this risk can be mitigated by buying carbon offsets at a lower cost. The risk that offset prices will increase sharply when GHG limits become binding can be reduced by buying offsets sooner and cheaper. Another option is to buy call options on future carbon offsets (Part IC).

### Competitive advantage *via* early action

In addition to energy cost savings, implementing energy efficiency and other emission-reduction measures can improve a firm's competitive position, making it less vulnerable to future energy-price fluctuations or emission limits. While some firms resist the idea of any new GHG emission charges or regulations, others consider such measures inevitable in the medium to long run.

Business scholar Michael Porter observes that "the adversarial process locks companies into static thinking and systematically pushes industry estimates of the costs of regulation upward," and that "static thinking causes companies to fight environmental standards that actually could enhance their competitiveness." Indeed, such static thinking seems to motivate much of the resistance to GHG emission limits and leads to predictions that even modest emission reductions would impose unbearable costs. However, initial industry claims of the costs of pending regulations have consistently turned out to be exaggerated, and companies that find innovative compliance strategies gain competitive advantage.[2]

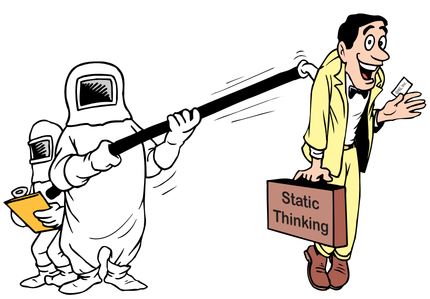
***Static thinking causes companies to fight environmental standards that could actually enhance their competitiveness.***

From this perspective, there is a clear business advantage in being among the first to develop and deploy low-carbon technologies. Dependence on continued weak emission standards may be a risky, if not obsolete, long-term strategy if it assures that a firm will be the last, not the first, to penetrate important future markets.

**Recommendation**

*Don't wait for competitors to deploy low-carbon technologies.*

Emission reductions implemented in advance of binding regulations are known as "early action" in the policy arena. The policy issue is that firms that voluntarily reduce emissions are concerned that they will be penalized if later regulatory emission limits are based on their *reduced* emission levels, rather than their *original emissions before the reductions*, as has happened in the past with conventional air pollution regulation. There are numerous proposals for early-action legislation, and widespread agreement that it is needed, but no specific rules have been implemented to date.




One approach that some firms, notably BP, are taking to "early action" is establishment of an internal carbon trading regime. Internal trading is appropriate for a large company, especially one with operations in several countries. It allows a firm to learn about carbon trading, to identify and implement the lowest-cost reduction measures, and to make such measures profitable for the business units that implement them. These units are the "sellers" of carbon offsets to "buyers" in other business units within the company. BP recently announced that their internal carbon trading program enabled them to *reduce emissions ten percent between 1990 and 2002, eight years ahead of their 2010 goal, at a negative net cost* to the company, *i.e.*, a profit.[3] See Part III for a more detailed case study on BP. Shell also has launched an internal GHG trading system.

## The Chicago Climate Exchange℠

The first voluntary U.S. pilot program for reduction and trading of all GHGs has been created in Chicago. The Chicago Climate Exchange℠, administered by Environmental Financial Products, LLC and funded by the Joyce Foundation, will be first based in seven Midwestern states, and later expanded to include national and international sources.

The Exchange features phased-in commitments, starting with a target of two percent below 1999 levels during 2002 and one percent per year thereafter. Credits will be given for domestic and foreign emissions offset projects such as methane destruction, solar and wind energy projects, and certain carbon sinks. Commitments and trading by participants are scheduled for 2003, expanding to include international participants by 2004.

Corporate participants in the design phase of the project include: DuPont, Ford, ST Microelectronics, Waste Management Inc., International Paper, Mead Corp., Alliant Energy, American Electric Power, BP, Calpine, Cinergy, DTE, Exelon, and PG&E.

Offset providers include Growmark, Iowa Farm Bureau Federation, National Council of Farmer Cooperatives, The Nature Conservancy, Ducks Unlimited, Pronatura Noreste, and Agriliance.

### Develop new products, new markets

A primary goal of potential "winners" is to capture market share in the technology areas that will be favored under GHG emission limits. These technologies that will be in greater demand in a carbon-constrained world include the following:

- Renewable energy sources: wind, solar, biomass, hydro, geothermal
- Natural gas conversions from coal and oil-fired systems
- Fuel cells for vehicles and power generation
- Energy-efficient equipment, vehicles, building systems, and industrial processes
- Methane recovery measures for landfills, water treatment plants, etc.
- Certain forestry and agricultural practices that increase carbon storage
- Energy and land use monitoring systems and services

Many of these technologies are commercially available but not widely used today (*e.g.*, wind turbines, natural gas, and energy-efficiency technologies), while others are still in development (*e.g.*, fuel cells, some solar technologies). As the prospect of GHG emission limits becomes more immediate, the "winners" will gain incentive to be more aggressive in identifying and developing the technology areas where they expect to have an advantage in a carbon-constrained market. Strategies for investing in these areas are covered later in Part IC.

***Even if the United States does not join the EU in limiting emissions, the European markets represent major export targets for U.S. firms that are strong enough to overcome the local competition.***

Meanwhile, the EU has ratified the Kyoto Protocol and most of the European countries have already begun to impose GHG emission limits or carbon taxes. In response, their industries are working to capture early markets for these technologies, and this European competition will strengthen. Even if the United States does not join the EU in limiting emissions, these markets represent major export targets for U.S. firms that are strong enough to overcome the local competition. Moreover, if U.S. firms do not engage this competition early, they risk being disadvantaged when the United States limits emissions in the future.

*PowerGuard™ modular photovoltaic roof tiles, by PowerLight, coordinate easily with the building's existing electrical network. Installation does not require penetration of the roof, and the tiles add insulation and protect the roof.*

*Photo courtesy PowerLight*

One business alliance whose members are more likely to be "winners" is the CEO Coalition to Advance Sustainable Technology, a group of senior business leaders from mostly technology firms that is focused on how business can promote new technologies that advance sustainable development. The growing coalition of companies, which includes Intel, Gillette, CH2M Hill, Northeast Utilities, Public Service Electric & Gas of New Jersey, Clean Air Action Corp., and Stonyfield Farm Yogurt, Inc., advocates an early action crediting system to reward companies for GHG reductions in their operations.

*Ponnequin Wind Farm, built and operated by Public Service of Colorado. Each turbine can generate 700,000 watts of energy. Wind power worldwide is increasing by over one gigawatt per year and has become competitive with fossil fuels as an energy source.*


CH2M Hill is a large environmental engineering and construction firm that is pursuing competitive advantage using low-carbon technology in both its own operations and, more importantly, in the projects that it carries out for clients. The firm designed a high-efficiency building for its new corporate headquarters in Denver, and it buys "green power" for its major facilities in Denver and the Pacific Northwest.[4]

As part of its growing business in client energy management, CH2M Hill provides energy-efficient building design, retrofits and commissioning services, waste heat recovery, industrial process optimization, and water reclamation systems. Also, the firm is increasing its activity in development and design of renewable energy sources, including wind energy, small hydroelectric, solar thermal, solar electric, and biogas from landfills and digestion of animal waste, wastewater treatment sludge, and food waste.

These new and growing business ventures provide CH2M Hill with new markets for their products and services. At the same time, they provide clients with opportunities to reduce their GHG emissions by investing in technologies that pay for themselves through energy savings or revenues from energy sales.

New business opportunities are not restricted to the "winners." Even carbon-intensive firms can improve their competitive position by reducing their emissions per unit of product sold. They can make their products "carbon neutral," indicating zero net emissions, by buying sufficient carbon offsets. For example, Interface Corp. made their institutional floor-covering product one of the world's first certified carbon-neutral products, based on certification by the Climate Neutral Network (CNN).[5]

**Internal education, preparation for future action**

Another motivation for "early action" to reduce emissions is the self-education gained from the direct experience in developing and improving energy technology and facility operating practices. Even if emission reductions or offset purchases are not required today, it is worthwhile to develop an understanding of the available options. Firms that are unprepared run the risk of an accelerated timetable for emission constraints due to climate-related surprises, which are entirely possible. Such surprises could lead to strict mandatory emission limits and potentially high costs of last-minute compliance.

Early experience with emission reductions provides an opportunity to test, evaluate, and improve the technologies and operating practices now available. If the reductions turn out to be as cost-effective as RMI research suggests, further reductions may be justified by their economic performance alone. Moreover, experience with buying carbon offsets will make it easier to use emission trading if and when deeper reductions are mandated.

**Regulatory positioning *via* voluntary market activity**

The decision whether to take immediate action on a carbon strategy also depends on the perceived benefit in terms of regulatory positioning. By initiating "early action," in advance of any mandatory reduction measures, some organizations hope to demonstrate the "win-win" advantages of relying on "flexibility mechanisms," such as carbon offsets and emission trading in place of the traditional command-and-control approach to environmental regulation. Thus, most early movers want to keep policy makers informed about their activities and progress in order to influence future policy.

Some industries, particularly the electric utilities, have had difficult and costly experiences with command-and-control regulations of air pollution emissions. Consequently, they realize that market-based mechanisms would

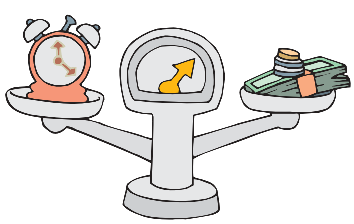
*This 1.0 kW proton exchange membrane (PEM) fuel cell uses solar hydrogen to run the Telonicher Marine Lab air compressor in Trinidad, California when the sun is not shining. Electricity from photovoltaic panels runs the air compressor when the sun is shining.*

Photo courtesy U.S. Department of Energy

***While some firms may choose to resist any sort of emission limits or regulations, others accept the eventuality of GHG limits and are working to influence the regulatory structure to their benefit.***

make the process of emission control less painful, if it is indeed inevitable. While some firms may choose to resist any sort of emission limits or regulations, others accept the eventuality of GHG limits and are working to influence the regulatory structure to their benefit.

Their goal is emission regulations that are as flexible as possible with regard to when, where, and with which technologies reductions are achieved. This requires clear goals and sufficient time to achieve them. The needed flexibility can be achieved *via* emission trading and other market-based mechanisms, which will reduce the cost of compliance with future emission limits. To achieve this goal, industry needs to demonstrate that it can accomplish significant reductions when allowed to choose its own strategy, even under voluntary programs. Thus, "early action" provides the benefit of positive regulatory positioning.



### Employee morale and buy-in

A proactive stance on climate change can also be a positive influence on employees. This is a cost-effective way for a company to demonstrate its social responsibility, which can boost the morale of employees and improve employee retention. Employees tend to be ahead of management in recognizing opportunities to improve environmental performance and being motivated to take action. According to Mark Moody-Stuart, former Chairman of the Royal/Dutch Shell Group of companies, "I know the impact on the motivation of our own people of our efforts to apply sustainability in our day to day business… is a vital ingredient in attracting and retaining the talent we need."[6]

It is important to share information on climate change and related corporate action to employees, in order to inform them of positive steps taken and the anticipated benefits, to gain internal buy-in for the proposed measures, and to solicit new ideas to improve and expand the climate-related activities. All the Pew Center's BELC firms that were studied reported that they communicated internally to employees about their emission targets.[7]

**Recommendation**

*Use "early action" on climate change mitigation to demonstrate the benefit of flexible, market-based regulations, and document emission reductions to ensure they are credited against future emission limits.*

### Investment community and public relations

As explained above, climate change is a source of both potential business opportunities and significant risks to business performance. Therefore, it is necessary to inform the investment community about these risks and opportunities. If this information is not provided to investors, they may begin to speculate on their own. To the extent that a firm is prepared to respond to new opportunities and manage the risks of a carbon-constrained future, such plans should be shared with the investment community, which should treat this information as good news. For example, a proactive emission reduction program could make a company's shares more attractive to socially responsible investment funds.

Finally, an important aspect of most emission-reduction measures is the opportunity to promote the firm's public image, since most of the relevant measures, from energy efficiency to tropical reforestation, have local environmental benefits in addition to GHG reductions. Therefore, communication about climate change and climate-related actions should be part of a firm's public communication efforts in general.

Public relations were clearly a primary objective of many of the earliest carbon offset transactions completed between 1988 and 1997, before the Kyoto Protocol was negotiated. During that time, the market value of carbon would not otherwise have supported such investments. However, by taking a proactive approach to offsetting their GHG emissions, companies such as AES Corp., PacifiCorp and others could demonstrate their environmental commitments to the public and policy makers as well.

**Recommendation**

*Communication about climate-related actions should be part of a firm's communication efforts to employees, investors and the public.*

***Climate change is a source of both potential business opportunities and significant risks to business performance.***

## Part IB: Potential Effects on Business Performance

*Compact fluorescent bulbs last about seven times longer than conventional incandescent bulbs, resulting in lower maintenance costs. They produce the same illumination with one-fourth the energy cost.*

*Norm Clasen photo*

Some of the motivations for corporate action on climate, such as internal education and communication with regulators, investors, and the public, are difficult to evaluate in terms of their effect on business performance. These objectives are ones on which businesses routinely spend significant time and money; however, their impact is generally difficult to measure.

The other motivating factors can lead more directly to increased revenues or reduced costs and risks, which can more readily be measured. Although most of the potential impacts of climate change are expected to be rather far in the future, at least from the perspective of business planning, some of the benefits of "early action" can be realized soon enough to figure into short-term business planning. Below, we identify in general terms the types of incremental revenues, costs and risks that can be expected from action (or non-action) on climate change.

### Energy investments: operating cost savings *vs.* capital investments

Most carbon emissions result from energy conversion and use. The most direct impacts of energy-related emission reduction measures are their direct investment costs and the resulting savings in purchased fuel, electricity, and other operating costs. These measures are described in more detail in Part IC.

Revenues: Direct operating cost savings from reduced fuel and electricity use, lower electric peak demand charges, and possibly reduced emission charges or permit purchases. Other cost savings can result from improved process control, reducing equipment wear and maintenance costs, and down-sized equipment for heating, cooling, and circulation of air, water and working fluids. Energy-efficient lighting and appliances can also reduce maintenance costs, and anecdotal evidence suggests that improved lighting and thermal comfort from efficient design can improve employee productivity and retention.[8]

Costs: Low-carbon energy technology that improves end-use efficiency or uses cleaner energy sources generally requires an additional investment compared to conventional technology. This cost premium can be minimized, and sometimes eliminated, by timing emission reducing investments to coincide with planned facility upgrades or equipment replacements. These costs are typically treated as capital investments, which draw on a separate budget from the operating budget, where the savings are logged. This separation of the two budgets, which may be controlled by different people or departments, can create barriers to the implementation of even highly cost-effective energy measures. This and other barriers are discussed in more detail under Barriers to Capturing Profitable Emission-Saving Opportunities (p. 46).

**Recommendation**

*Use energy efficiency improvements to capture additional benefits, such as down-sized cooling equipment, better thermal comfort, and higher quality lighting that improves the working environment.*

Risks: The risks related to emission reduction measures generally involve technology cost and performance, energy prices, and emission regulations. If the cost of clean energy technology turns out to be higher than expected, or its performance less than expected, its economic performance will be reduced. On the other hand, such technology reduces the need for purchased fuel and electricity, which can reduce the risks of energy prices steadily increasing or just continuing their recent volatility.

### New products and markets: revenue potential *vs.* opportunity costs

Many firms, especially those likely to be "winners," can realize new business opportunities or create new products in anticipation of carbon emission limits. These opportunities, described in more detail in Part IC, must be compared to others that could be pursued instead in order to determine their opportunity costs.

Revenues: There is potential to generate incremental sales from introducing a new product (*e.g.*, carbon-neutral flooring), entering a new market (*e.g.*, fuel cell cogeneration), or increasing market share by improving competitive position (*e.g.*, by minimizing energy costs). These new opportunities can be comparable to or larger than the firm's existing market.

Costs: The cost, in terms of time and money, of realizing new business opportunities or creating new products for a carbon-constrained world must be evaluated in terms of the other opportunities that would be foregone, *i.e.*, the opportunity cost. Does the development of a new product justify shifting one's budget allocation away from increased marketing of an existing product? As in the case of direct energy- or emission-saving investments, the opportunity cost can be reduced by integrating the development of a low-carbon product with ongoing new product development.

Risks: Introducing a new product or entering a new market is inherently risky. If such initiatives are motivated by their potential advantages in a carbon-constrained world, there is a risk that emission limits will be delayed or avoided. On the other hand, the prospect of climate-related surprises and accelerated emission limits makes the status quo more risky and increases the potential benefit of low-carbon products.

***The prospect of climate-related surprises and accelerated emission limits makes the status quo more risky and increases the potential benefit of low-carbon products.***

**Recommendation**

*Consider the potential to introduce new products, enter new markets, or increase market share in anticipation of carbon emission limits.*

***Improved lighting and thermal comfort from efficient design can improve employee productivity and retention.***

## Asset values *vs.* potential liabilities

Accelerating the development and deployment of low-carbon technologies may require a shift in corporate resources compared to the "business-as-usual" direction. This could be accompanied by a shift in the value or at least the perception of some types of assets.

*Revenues:* Equipment, processes, intellectual property, even land that is useful for low-carbon technologies could become more valuable. Because energy-efficient, low-carbon technology will be more competitive in a carbon-constrained world, assets related to the production and delivery of these technologies will increase in value. The intellectual property needed to develop climate-friendly products and services will also appreciate. Land that can accommodate carbon sequestration or wind turbines could also gain value.

*Costs:* Emission-intensive assets, such as inefficient coal-fired boilers, could lose value, as they would become more expensive to operate and less competitive in a carbon-constrained world. This relationship, however, is complex and will be highly sensitive to the type of emission-control policy regime that is eventually chosen. For example, to the extent that historical emissions are used as the baseline to allocate emission allowances, ownership of carbon-intensive equipment would provide a large "grandfathered" emission allowance. This allowance could potentially be used to cover increased capacity from new, cleaner equipment while operating the dirty equipment only enough to retain the allowances, making the dirty equipment valuable. Some "early action" policy proposals allow for this rather perverse type of incentive, but it would be risky to depend on such incentives becoming law.

*Risks:* Asset values that are based on carbon-intensive plants and equipment, or on the delivery of products that generate high levels of emissions, will be increasingly at risk in a carbon-constrained world. Technical improvements in such equipment and products would mitigate this risk, as would diversification away from such lines of business. In the short term, however, pursuing an aggressive emission reduction target may carry a risk to shareholders, due to the uncertainty of future government policy. This risk, however, can be managed by adequately justifying planned reduction measures in terms of their potential financial returns and new business opportunities.

***Asset values that are based on carbon-intensive plants and equipment, or on the delivery of products that generate high levels of emissions, will be increasingly at risk.***

**Recommendation**

*Don't treat the status quo as risk free. Emission limits, higher energy costs and market volatility could hurt business performance and lower asset values of carbon-intensive plants and equipment.*

### Risks of early action *vs.* no action

To summarize, emission reduction measures generally involve energy efficiency or supply technologies that are more expensive than the conventional technology they replace. The return on this incremental investment comes in the form of energy cost savings, as well as emission reductions. Many energy-efficiency improvements should be clearly cost-effective. There are, however, risks involved in pursuing aggressive emission reduction goals. These risks include higher-than-expected costs, disappointing technical performance, and the possibility that concern about global climate change will diminish, reducing the value of emission reductions.

The uncertainty associated with innovative energy-efficiency or supply technologies can make these measures appear relatively risky compared to the status quo. However, it is important to note that there are significant risks associated with the status quo as well. These risks include the following:

- Risk of accelerated GHG emission limits, due to climate-related surprises, which lead to mandatory emission limits and high costs of last-minute compliance.
- Risk of increasing energy costs, market volatility, and possible shortages, apart from climate change and GHG emissions, from continued reliance on energy-inefficient, fossil-fueled energy systems.
- Risks to the security and reliability of energy supplies, or even shortages, due to the centralized and vulnerable nature of conventional energy supply infrastructure.

Treating future energy costs and related emission control costs as an unavoidable expense is a significant risk. Energy price volatility could lead to severe cost increases. Stringent emission controls could further increase energy costs, impose substantial emission control costs, or both. If, but most likely when, risks of climate change are recognized in U.S. policy, additional costs and constraints could be imposed. The alternative options, energy efficiency and low-carbon energy sources, can mitigate these risks and provide greater certainty in managing energy-related costs.

Energy-efficiency measures pay for themselves over time, many of them quickly and profitably, assuming stable energy prices. An equally important benefit is that energy efficiency keeps overall operating costs relatively stable even if market prices or emission constraints cause energy costs to escalate. Use of cleaner, more efficient sources of energy has similar benefits. Distributed cogeneration of heat and power minimizes exposure to power price volatility and provides the option to sell into electricity markets. Renewable sources have no fuel cost and are invulnerable to price volatility.

***Energy efficiency keeps overall operating costs relatively stable even if market prices or emission constraints cause energy costs to escalate.***

## Part IC: Strategies for Action on Climate Change

The corporate or institutional strategy for addressing potential GHG emission limits depends to some extent on whether one is more likely to be a "winner" or a "loser," but it also depends on one's assessment as to if and when binding emission limits will actually be imposed. Even if one does not expect such limits for many years, there are a number of measures that can reduce exposure to GHG liabilities and capture compensating benefits in addition to emission savings from "no-regrets" activities.

If firms want to undertake "early actions," or at least prepare to participate in the carbon market in the future, there are a number of measures they can take. Short-term measures to understand include:

- The potential carbon markets,
- Their own starting position,
- Their potential to implement "no-regrets" reduction measures, and
- The resulting risks and opportunities in the carbon markets.

*Carbon trading markets are now operating in several cities. As greenhouse gas emission restrictions are imposed, they could become as active as this stock trading floor. In the meantime, businesses should prepare for carbon trading to become part of the procurement process for energy services, either in the form of green power certificates or carbon offsets.*

In addition, long-term options include:

- Buying carbon offsets,
- Implementing new technologies, and
- Reorienting company strategy toward new processes, products and services.

Each of these options should be identified, evaluated and tested today with an eye toward the future and the possibility of emission limits.

### Short-term action to reduce costs and risks

Short-term actions, in advance of binding emission limits, should emphasize self-education and the reduction of future risks and liabilities at minimum costs. This effort could involve an evaluation of present emissions, future trajectories and reduction options, as well as positioning to participate in future carbon trading.

Companies find that simply measuring their emissions can stimulate ideas for reductions, and a cost analysis of potential reduction measures provides useful information that can help improve productivity. Of course, cost-effective "no-regrets" reduction measures, such as energy-efficiency improvements, should be undertaken as soon as they appear.

***Audit/inventory/baseline/track and educate***

The first step in introducing a corporate carbon strategy is to evaluate present emissions and establish a system for tracking emissions. Business research indicates that better process measurement alone can lead to innovation and productivity improvement.[9] This observation was confirmed by case studies of the companies in the Pew Center's BELC, which concluded that emission data alone generates ideas for improvement, while the existence of reduction targets drives profitable innovation to improve performance.[10]

Because most GHG emissions result from energy conversion and use, a detailed *energy audit and metering study* is essential to begin reducing the energy consumption and resulting emissions from a firm's buildings, production processes, and transport systems. The facility audit will provide the basis for emission accounting and make it possible to identify potential cost-effective reduction measures, some of which can usually be implemented immediately.

A company or institution can develop its own *framework for emission accounting* and tracking, or it can use one of several generic protocols that are now available. For example, the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) have developed a tool that allows businesses to uniformly report their emissions of GHGs using the Greenhouse Gas Protocol.[11] Developed over a three-year period by a partnership of 350 representatives from businesses, non-profits, and governments, the GHG Protocol enables businesses to account and report information on GHGs in a way that is consistent with financial reporting standards.

Based on the results of detailed facility audits and more general company-wide analyses, a firm can construct a historical record or *quantitative model of its emissions.* In order to measure improvement and isolate external influences, emissions should be indexed to such parameters as production, sales or value added, facility occupancy, weather, etc. This makes it possible to demonstrate the *baseline* level of emissions and to identify reduction measures that have already been taken. For example, if production increases by 25 percent with no change in energy use or emissions, then emissions have actually been reduced by 20 percent (25/125) compared to baseline emissions without any improvement. Other variables, such as weather and occupancy influences on commercial building energy use, can be tracked using computer simulation models.

*A detailed energy audit makes it possible to identify potential cost-effective energy reduction measures and to calculate energy savings, cost savings, and emission reductions.*

The direct measurements needed to determine overall emission levels and to update the emission model should be made on a continuous, or at least periodic, basis. *The emission measurement system and model constitute an emission accounting and tracking system.* This system provides an internally consistent way to measure emission reductions from measures taken in the future.

### Recommendation

*Develop an emission accounting and tracking system to establish the metrics for setting an emission reduction target and identifying cost-effective emission reduction investments. Such a system requires a detailed energy audit and metering study to provide the basis for emission accounting, which can be based on one of several generic protocols now available.*

Using the firm's emission model, which could be as simple as the ratio of emissions to product sold, to update baseline emissions, allows one to track the measured emissions, compare them to the updated baseline, and calculate the resulting energy savings, emission reductions, and their dollar value.

Emission reductions, and carbon offsets based on such reductions, can only be quantified as *differences* that must be measured relative to a *baseline*. Table 1 characterizes the comparisons that are needed to assess the performance of energy projects and the quantities that need to be measured, depending on the type of project.

**Table 1: Performance comparisons and measurements required for monitoring and verification of carbon offsets from emission reductions in energy projects**[12]

| **Energy technology** | **Comparison (between baseline and project case)** | **Required measurements** |
|---|---|---|
| Renewable (solar, wind, hydro, geo) energy supply | Baseline: fossil fuel supply<br>Project: renewable energy system (generally electric) | Baseline: carbon fuel intensity<br>Project: energy supplied |
| Biomass energy conversion | Baseline: fossil fuel supply<br>Project: biomass production and conversion to fuel/electricity | Baseline: carbon fuel intensity<br>Project: energy supplied and net terrestrial carbon storage |
| Fuel-switching (supply-side) | Baseline: fossil fuel supply<br>Project: cleaner fuel supply (coal to natural gas, for example) | Baseline: carbon fuel intensity<br>Project: energy supplied and change in carbon intensity |
| Fuel-switching (demand-side) | Baseline: fuel or electric energy end-use<br>Project: change between fuels or between fuel and electricity | Baseline: carbon fuel intensity<br>Project: energy use, change in efficiency and carbon intensity |
| Energy-efficiency measures (EEM) | Baseline: fuel or electric energy end-use<br>Project: more efficient end-use technology | Baseline: energy end-use and carbon fuel intensity<br>Project: change in energy use |

Once the capability to measure and track emissions is in place, a company can consider establishing an emission reduction target. For example, 30 companies in the Pew Center's BELC set some type of target, some of which are shown in Table 2. Such targets can have several forms:

- Targets can apply to purchases, to internal operations, or to products sold.
- Targets can apply to GHG emissions or to energy use.
- Targets can apply to absolute quantities or be indexed per unit of product or revenue.
- Targets can apply to a fixed end goal or annual rate of improvement.

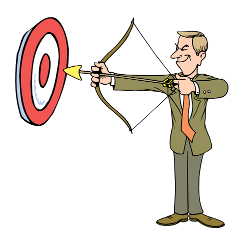
The emission accounting and tracking system is a fundamental piece of a corporate carbon strategy. It establishes the metrics for setting and achieving an emission reduction target, and it provides essential information needed to begin making cost-effective energy-saving and emission-reducing investments. This system also provides a basis for internal education and communication about the strategy for, and progress of, an emission reduction program. Finally, this information can readily be packaged for external communications to investors, government, and the public.

**Recommendation**

*Consider establishing an emission reduction target, which can be an absolute amount or an index based on such parameters as production, sales or value added, facility occupancy, or weather.*

**Table 2: GHG emission reduction targets by selected companies**

| Company | Emission reduction target |
|---|---|
| ABB | 1% per year between 1998 and 2005 |
| Alcoa | 25% below 1990 levels by 2010 |
| BP Amoco | 10% below 1990 levels by 2010 |
| Dow Chemical | Energy use 20% below 2000 by 2005 |
| DuPont | 65% below 1990 levels by 2010 |
| Eastman Kodak | 15% below 2000 levels by 2004 |
| IBM | 4% per year |
| Intel Corp. | PFC emissions 10% below 1995 by 2001 |
| Johnson & Johnson | 7% below 1990 levels by 2010 |
| Shell Oil | 10% below 1990 levels by 2002 |
| ST Microelectronics | Energy use per dollar of production 5% per year |
| Toyota | 10% below 1990 levels by 2010 |
| TransAlta Corp. | 1990 levels by 2000 |



### *"No-regrets" energy efficiency measures*

Energy-efficiency improvements, cogeneration projects, and fuel switching are some of the measures that often are cost-effective investments and also reduce GHG emissions. Such measures can also improve a firm's competitive position, making it less vulnerable to future energy-price fluctuations or emission limits. Another "no-regrets" benefit of early action is that the company learns how to implement such projects effectively and has the opportunity to test, evaluate and improve the technologies and practices being used, before the stakes get higher and a robust carbon trading market emerges.

*Several different fuel cell technologies exist, and all generate electricity using hydrogen and oxygen, producing only water. They can be scaled in size to fit almost any application.*

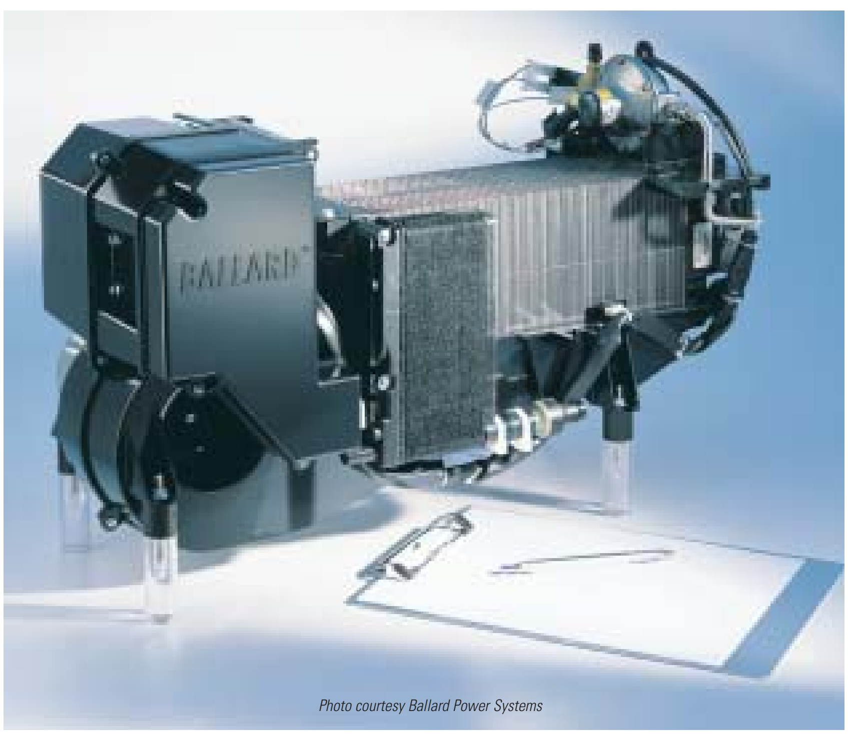



*Photo courtesy Ballard Power Systems*

The full range of energy measures could include the following types of actions:

- Energy efficiency: supply or demand-side.
- Fuel switching: supply or demand-side.
- Renewable energy sources: central or distributed

Energy efficiency can be implemented in either the energy supply system or on the demand side. Supply-side efficiency measures include hardware efficiency in boilers, pumps, and turbines, reduced losses from electricity or steam distribution, as well as cogeneration of heat and electric power. Advanced supply technologies such as fuel cells can deliver power at very high efficiency.

Demand-side efficiency measures can be found wherever energy is used in buildings, factories and vehicles. For many businesses, the most plentiful opportunities are in buildings. Improvements to the building skin (walls, roofs, windows, etc.) can improve space-heating efficiency. Lighting, water heating, air-conditioning, refrigeration, and even computer equipment can be improved in efficiency. Some building energy efficiency measures can be installed as retrofits to existing buildings or equipment, while other measures are best implemented when new facilities, major renovations, or equipment replacements are needed.

Other end-use efficiency measures can be found in transport vehicles, water supply and treatment facilities, and industrial production. In process industries, large quantities of fuel are used for process heating, presenting opportunities for heat recovery and cogeneration. In nearly all industries, the largest use of electric energy is in motors to run pumps, fans, compressors and other machinery, all of which can be more efficient.

Fuel switching can also be applied on either the supply side or the demand side of the energy network. Supply-side fuel switching would involve, for example, changing a power station's fuel supply from coal to natural gas, which emits less $CO_2$. Demand-side fuel switching could involve switching from heating oil to district steam, or from electricity to natural gas. The emission benefits of a measure depend on the relative efficiencies of each energy carrier.

Renewable energy sources can be central or distributed resources. Central renewable sources include traditional hydroelectric plants and modern wind farms. Distributed renewable sources can include rooftop photovoltaic (PV) modules or biomass-fueled cogeneration systems.

Energy-efficiency improvements and certain supply-side measures, such as boiler replace-

## Monitoring and verification protocols

Energy efficiency projects may need detailed protocols for monitoring and verification (M&V). Accurate M&V makes it possible to convert the energy savings to a bankable quantity, for example to satisfy a performance contract or to sell as a carbon offset. The principal issue is the net energy savings compared to the baseline energy use. A relatively detailed approach to monitoring requires measuring equipment-usage and energy-service levels to compare baseline and actual energy use in a dynamic way.

U.S. Department of Energy's (DoE) International Performance Measurement and Verification Protocol (IPMVP), first published in 1996 and recently updated, is well suited for M&V of efficiency projects in most facilities.[13] The IPMVP is intended to introduce procedures that allow buyers, sellers, and financiers of energy projects to quantify project performance and energy savings, and allocate various risks associated with achieving energy cost savings to either the buyer or seller of the energy or emission savings. Additionally, the IPMVP can provide the basis for structuring performance contracts for energy-efficiency projects. Most of the elements of the IPMVP framework are analogous to the M&V needs of a carbon offset project.

IPMVP is targeted toward the verification and tracking of energy savings for typical energy projects carried out in single commercial buildings or facilities. However, of the IPMVP's four options for developing M&V protocols, Option B *(Savings Verification, End-Use Retrofits—Measured Capacity, Measured Consumption Approach)* is most suitable to an industrial project. The IPMVP's simpler Option A *(Savings Verification, End-Use Retrofits—Measured Capacity, Stipulated Consumption Approach)* can be applied to relatively static parameters in order to reduce monitoring cost.

For each site or project, the baseline and project energy use can be estimated using a combination of metering, billing analysis, engineering calculations and/or computer simulations. Definitions of site-specific M&V plans should include consideration of accuracy requirements and the importance of *relating monitoring costs and accuracy to the value of the energy savings.* Typical building end-use monitoring, based on a statistical sample of similar end-use functions (for example, fluorescent lighting), tends to cost on the order of $0.1/ft$^2$ ($1/m$^2$), while more detailed monitoring required for building diagnostics and commissioning tends to cost on the order of $0.2/ft$^2$ ($2/m$^2$).[14]

**Table 3: Relationship of simple payback time to (before-tax) return on investment**

| Simple payback time: / Project Life | 1 year | 2 years | 3 years | 4 years | 5 years | 6 years | 7 years | 8 years |
|---|---|---|---|---|---|---|---|---|
| **5 years** | 100% | 41% | 20% | 8% | | | | |
| **10 years** | 100% | 49% | 31% | 21% | 15% | 11% | 7% | 4% |
| **15 years** | 100% | 50% | 33% | 24% | 18% | 14% | 11% | 9% |
| **20 years** | 100% | 50% | 33% | 25% | 19% | 16% | 13% | 11% |

ment and conversion to cogeneration, can be implemented opportunistically, taking advantage of the need to upgrade facilities or replace equipment as an opportunity to install efficient replacement technology. The net cost of the efficiency measures is only the incremental cost of the efficient technology compared to the conventional technology that would have been installed anyway, which is far less than the entire cost of retrofitting a facility with efficient equipment.

*In industry, 75 percent of electricity is used in motor systems, and pumping fluids is the most common use of motors. Pumping systems account for nearly 20 percent of the world's electrical energy demand and up to 50 percent of energy use in certain industrial operations.*

*Photo courtesy U.S. Department of Energy*

Another advantage of this opportunistic strategy is that energy-efficiency improvements, if included in the design of new or replacement systems, allow equipment such as boilers, pumps, or air-conditioning components to be down-sized, reducing their capital costs to near the original equipment cost or below.

"No-regrets" energy efficiency measures often pay for themselves in two to four years, and sometimes in less than one year. The value of energy savings, however, is typically underestimated. As shown in Table 3, a measure with a four-year payback provides a 21 percent before-tax return over ten years; a two-year payback measure provides a 49 percent before-tax return. Considering

## Recommendation

*Implement all cost-effective energy efficiency measures in buildings, industrial production systems, and vehicles, in an opportunistic way. Consider energy cost savings and other benefits as returns on capital investment, and apply an appropriate hurdle rate, rather than a simple payback criterion.*

the low risk involved in such investments, energy efficiency is one of the soundest financial strategies a firm can choose. STMicroelectronics is one technology firm that is pursuing a carbon emission reduction goal, namely zero net emissions by 2010.[15] ST has cut energy use per chip by 60 percent in their Singapore fabrication facility with a payback of about one year. ST has identified technical improvements that will reduce emissions by 98 percent *via* higher yields, larger wafers, more energy-efficient production, combined heat and power using natural gas, and use of renewable energy.[18] The ST zero-emission goal also includes offsetting their remaining 2010 emissions by investing in carbon sequestration from tropical forestry projects.

***Energy-efficiency improvements allow equipment to be down-sized, reducing capital costs to near the original equipment cost or below.***

## Carbon offsets and the carbon market

An emission offset is a reduction, in excess of any mandatory requirements, which can be sold to other emitters, who credit the reduction as an offset against their own emission limit or reduction commitment. Emission offsets are a useful instrument of environmental policy because it is impossible to regulate emissions without, on one hand, imposing high costs on certain emitters, and on the other hand, omitting some sources of reductions altogether. The ability to trade offsets creates a win-win opportunity for an emitter to avoid high reduction costs by buying offsets from another who can profit by reducing the same quantity of emissions at lower cost. Offsets can be exchanged within a company or externally.

To date, most emission offset trading has addressed conventional pollutants such as $SO_2$ and $NO_X$. Because GHG emissions can cause climate change regardless of where they are emitted, and because developing countries are not expected to assume emission limits in the near term, carbon offsets should be tradable internationally. This is the goal of the Kyoto Protocol's Joint Implementation and Clean Development Mechanism provisions.

The existing carbon markets involve mostly sporadic individual bilateral trades between emitters and developers of reduction measures. Other initiatives that could lead to more developed global markets are just beginning operation. These include the Prototype Carbon Fund (PCF) of the World Bank, the Dutch Emission Reduction Unit Procurement Tender (ERUPT), and national trading programs in Canada, Denmark, and the U.K.

Also, numerous local initiatives have created demand for carbon offsets. The most ambitious such program to date is the Oregon Climate Trust (OCT) in Oregon, where developers of new power stations are required to offset some of their GHG emissions. Offsets can be obtained by direct investment, by purchases on the open market, or by funding the OCT, which uses the money to contract for carbon offsets.[16]

The World Bank PCF analyzed most of the carbon offset transactions conducted in the past five years and reported a cost range of \$0.60–3.00/ton-$CO_2$ (\$2.50–12.00/mtC). The offering price from the PCF itself appears to be around \$5/ton-$CO_2$ (\$20/mtC) for high-quality offsets that are expected to comply with Kyoto Protocol requirements. Recent transactions that are intended for compliance purposes include the Dutch ERUPT offset program and the U.K. and Danish internal trading programs. These programs report a cost range of \$4–8/ton-$CO_2$ (\$15–33/mtC).[17]

***The least-cost strategy will be to implement all reductions that are less expensive than the market price of offsets, and to buy offsets for the remaining reductions to meet the target.***


### *Internal carbon trade, project registries, and market hedging*

Today, a corporate carbon strategy must balance future risks against present costs. Efforts to manage the risks imposed by a carbon-constrained future, including direct emission reductions, should be screened and prioritized to achieve minimum cost. A least-cost strategy will capture profitable "no-regrets" opportunities and will limit the amount of today's dollars spent to mitigate tomorrow's risk of emission limits. The cheapest reductions might be internal reductions from energy technology in a firm's own facilities, or carbon offsets purchased from an external source. Either way, carbon trading is an efficient mechanism to reduce costs by capturing the least-cost reduction options.

A large company or institution with multiple locations or types of facilities can benefit from an internal carbon trading program. BP and Shell are using an *internal emission trading program* to minimize the cost of achieving their emission reduction goal. In 1997, BP's CEO Sir John Browne announced a goal of ten percent reductions from 1990 to 2010. Compliance with this target was written into the contract of each business unit leader, based on an internal allocation of emission allowances to each business unit in the company. (See Part III for a more detailed case study on BP.)

To implement its trading system, BP conducted a company-wide inventory of present emissions and created a system to measure and verify future emissions and reductions. Each business unit then had to determine the cost of reducing emissions to meet their assigned target. Those with low reduction costs are encouraged to make deeper reductions and sell surplus allowances to business units with higher costs. In March 2002, Browne announced that the 2010 reduction goal had already been reached, and that the net cost was negative, *i.e.*, that cumulative savings would surpass total costs.[19] The trading program is also beneficial in stimulating innovation, educating staff on efficiency and environmental performance, and generating data on company operations and costs.

Firms that implement reduction measures should consider reporting these actions and the results in an official carbon registry. Several legislative proposals are under consideration that would establish a national registry for GHG reduction actions, and state-level registries are being set up in California and elsewhere. The advantage of reporting to a carbon registry is that it documents "early action" reductions, making it more likely that such reductions will receive credit under a future emission cap or other reduction policy. The only registry that is fully active now (early 2002) is the U.S. Department of Energy's 1605b program, a voluntary GHG registration process.[20]
The other carbon trading option, and probably the only one for smaller firms, is to buy carbon offsets from the external market. Given a future emission reduction target, the least-cost strategy will be to implement all reductions that are less expensive than the market price of offsets, and to buy offsets for the remaining reductions to meet the target. The first step is to evaluate the nascent carbon offset market to identify which project types, locations and technolo-

gies are capable of providing reliable offsets, have a high probability of being certified and verified, and what costs are reasonable for such offsets.

Because of the time value of money, it is tempting to delay any purchases of offsets until very close to the time when they are needed. However, there are several reasons why it might be less expensive or less risky to begin to obtain offsets earlier:

- As emission limits become more stringent, the growing demand for offsets is likely to drive up prices faster than the time value of money (discount rate).
- Buying offsets over a longer period of time reduces the risk of price volatility, compared with waiting to buy all needed offsets at one time.
- It is possible to mitigate price risk by buying options on future offset purchases.

### Carbon offset purchase models

A carbon offset buyer is not necessarily an investor in an emission reduction project such as an energy-efficiency project. Rather, the carbon buyer may expect to pay on delivery for certified carbon offset credits, which may occur only after the project has been operating for some time. This can be achieved by executing a contract that includes:[21]

- The unit price (*e.g.*, $/mtC)
- The expected number of offsets (*e.g.*, in mtC) and the minimum quantity to be purchased
- The term of the offset purchase agreement
- Penalty for failure to deliver the minimum quantity of carbon
- Option to buy carbon offsets in excess of expected quantity
- The performance criteria for verifying offsets
- The ratio of up-front payment for the offsets to subsequent on-delivery payments

Modifications to this basic model include:

- The call option model, including strike date and strike price
- The carbon performance contracting model, including baseline adjustment methods

Other issues to consider include:[22]

- Demonstrating that the emission reductions are “additional,” compared to a credible baseline, and in excess of any governmental obligation
- Assuring ownership of the emission reductions and resulting offsets
- Comprehensive and consistent carbon accounting and measurement procedures
- Use of an external registry to document the offsets exchanged
- Proof of the permanence or durability of the reductions (especially in forestry)
- Demonstration that the project will not cause emissions beyond the project boundary (so-called “leakage”)
- Demonstration of the buyer’s and seller’s creditworthiness

### Recommendation

*Report emissions reductions achieved in an official carbon registry. Consider establishing an internal GHG emission trading program. Implement all emission reduction measures that cost less than the internal or external price of carbon offsets. Begin buying external offsets before they are needed. The best way to do this might be to buy call options for the future period.*

***Firms that have international operations in the EU or other Kyoto-compliant countries will still be faced with some form of GHG limit that will become binding in 2008.***

An option on future purchases of carbon offsets is the right to buy carbon offsets ("call option") at a specified date in the future ("strike date," *e.g.*, 2010) for a specified price ("strike price"). Options might be an attractive risk-reduction mechanism, because options purchases at varying strike prices represent a hedge strategy against price fluctuations. The value of options on carbon offsets relative to the value of current-price offset purchases is similar to the relationship between the value of options in conventional securities markets and the value of the underlying securities.

### Energy cost *vs.* carbon offset costs

There is a significant quantity of potential carbon offsets involving methane emission recovery (from landfills and agriculture) and carbon sequestration (in land use and forestry initiatives). Nevertheless, the bulk of future offsets, assuming the carbon emission market matures, will have to be in the energy sector, where about 80 percent of all GHGs are emitted. The main emission-reduction strategy in the energy sector involves replacing fossil-based electricity generation with cleaner fuel technologies, renewable sources, or energy efficiency improvements.

The cost of a carbon offset from emission reductions in energy-sector projects depends on the cost premium for providing cleaner energy services and on the carbon emission intensity of the energy source being replaced, as shown in Table 4.

Offset cost [$/mtC] = Energy cost [$/MWh] / Carbon intensity [mtC/MWh]

For example, consider a wind farm with a cost premium of $20/MWh that replaces a rather dirty generation source with carbon intensity of 0.25 mtC/MWh (which is equivalent to 1.0 ton $CO_2$/MWh or 2.0 lbs $CO_2$/kWh). The carbon offset cost from the resulting emission reductions would be $20/ton-$CO_2$ ($80/mtC). Offset cost = $20/MWh / 0.25 mtC/MWh = $80/mtC ($25/ton $CO_2$)

### Long-term investments to improve performance and increase profits

In the long term, binding emission limits are more likely, and proactive firms are preparing for the imposition of emission limits and the emergence of robust carbon trading markets. Long-term actions could involve substantial investments in advanced technology, carbon trading, and new products or services. These investments need to be planned carefully to maximize the revenues and cost savings, and to capture the most promising new business opportunities that might appear.

#### *Carbon trading and green power purchasing*

One of the reasons that we suggest early participation in the carbon market is because some amount of carbon trading, either buying or selling of carbon offsets, will probably be worthwhile to manage the costs and risks of reducing future emissions. In time, carbon trading could become a routine part of the procurement process for energy services. For each unit of fuel or electricity consumed, a corresponding quantity of carbon offsets could be purchased to balance the company's emission profile.

Similarly, fuel vendors and energy service providers will probably bundle carbon offsets with their energy commodity sales, perhaps offering a product line that is differentiated according to its carbon content.[23] In some markets, one can already purchase "green power" certificates, also called green tags or tradable renewable energy credits (TRECs), either bundled with the local electricity supply or separate from the power itself. "Green power" is energy certified as generated from renewable sources with negligible GHG emissions as well as other environmental benefits.

**Long-term actions could involve substantial investments in advanced technology, carbon trading, and new products or services.**

**Table 4: Costs of carbon emission reductions in the energy sector (\$/ton-$CO_2$)**

| | Reduction in carbon emission intensity* | |
|---|---|---|
| | 0.5 ton-$CO_2$/MWh (0.13 mtC/MWh) | 1.0 ton-$CO_2$/MWh (0.25 mtC/MWh) |
| **Energy cost premium** | **Cost of carbon emission reduction** | |
| \$10/MWh | \$20/ton-$CO_2$ (\$80/mtC) | \$10/ton-$CO_2$ (\$40/mtC) |
| \$20/MWh | \$40/ton-$CO_2$ (\$160/mtC) | \$20/ton-$CO_2$ (\$80/mtC) |
| \$30/MWh | \$60/ton-$CO_2$ (\$240/mtC) | \$30/ton-$CO_2$ (\$120/mtC) |
| \$40/MWh | \$80/ton-$CO_2$ (\$320/mtC) | \$40/ton-$CO_2$ (\$160/mtC) |
| \$50/MWh | \$100/ton-$CO_2$ (\$400/mtC) | \$50/ton-$CO_2$ (\$200/mtC) |

* For energy-efficiency projects, this is the carbon intensity of the energy being saved.

***About one-third of U.S. states have renewable portfolio standards (RPS).***

Thus, buying green tags or TRECs represents a form of carbon offset associated with purchased electricity. The present cost premium for green power products is generally around \$25/MWh, which translates into an offset cost of about \$25/ton-$CO_2$ (\$100/mtC) or more. At this price, green power would be an expensive offset; however, as both green power and carbon markets mature, one can expect this value to converge to the combined price of the equivalent carbon offsets and other environmental benefits provided.


In terms of the nascent carbon market, what role can and should American firms play while the United States still rejects the Kyoto Protocol commitments? First, any firms that have international operations in the EU or another Kyoto-compliant country will still be faced with some form of GHG limit that will become binding in 2008. Emission limits could come in the form of a domestic emission cap-and-trade program, a carbon tax, or possible direct emission standards. In these countries, emitters should also be eligible to participate in the Kyoto flexibility mechanisms, which allow compliance by purchasing carbon offsets *via* joint implementation (JI) with Annex I countries or the Clean Development Mechanism (CDM) in developing countries.

As 2008 and the beginning of the first Kyoto commitment period approaches, there will be an increasing emphasis on the use of carbon trading for compliance with emission limits. National allowances (AAUs) and reduction credits that are expected to comply with Kyoto Protocol requirements will be at a premium, and more trading programs will be designed for compliance purposes, similar to the recent Dutch ERUPT offset program. It is unclear what role U.S. emission reductions will play in carbon trading related to Kyoto compliance, but it is doubtful that they will be admitted to such programs.

In addition to carbon trading aimed at Kyoto compliance, there will continue to be transactions that carry the possibility (not a guarantee) of compliance with future GHG limits. These carbon offsets are now known as "verified emission reductions (VERs).[24] This means that the parties to the trade have verified the reductions in accordance with international guidelines, but they have not applied for approval, or are not eligible, for Kyoto compliance. With countries such as the United States and possibly Australia rejecting the Kyoto commitments, the VER market should remain active in the coming years.

Without the United States as a buyer, there will be limited demand for Kyoto-compliant carbon credits, and Japan will be the biggest buyer. It is possible that much of the early trade will involve "hot air" from Russia, although low prices might induce Russia to bank its surplus allowances to offset future emissions. Meanwhile, the EU will likely focus on trading within Annex I, using JI credits to back up allowance trading. Low credit prices and high transaction costs will probably limit CDM activity.

Beyond covering any exposure to EU (and possibly Canadian) emission limits,

## Green power and green tags


Ed Linton photo

Green power is electricity that is generated from wind and solar energy, with negligible GHG emissions. Geothermal power, biomass-fired cogeneration and new, small hydroelectric plants can also qualify as green power sources. Because it reduces emissions and demonstrates sustainable business practices, green power carries a price premium in the electricity market. To qualify for this premium, green power projects are certified by independent organizations, and this process is currently being consolidated and standardized. Also, green power projects have the ability to obtain emission reduction credits, which could be sold separately or together with the green power itself.

Several efforts are now underway to establish certification standards for green power, and to develop tradable products involving green power and green tags. Green-e is a program to certify green power products, led by the Center for Resource Solutions,[26] and the Bonneville Environmental Foundation has partnered with several northwestern utilities and municipal authorities to offer green power and green power certificates, or green tags.[27] Green tags represent the certificate part of a green power product, which includes the emission reduction credit. Green-e has developed standards for such certificate-only products, and they can certify green tags or tradable renewable energy credits (TRECs).

Existing green power programs are motivated by several sources of demand:

- Utility green pricing programs  A number of utilities offer green pricing programs to customers, who pay a premium (often $25/MWh) for a block of their electricity supply that represents new renewable generation. Green power certificates, or green tags, provide a way for utilities to offer this service. Buying green tags gives customers access to green power without changing their electricity providers.
- Deregulated markets  In states such as Pennsylvania, where deregulation has been relatively successful, customers can switch electricity providers to access cleaner or renewable energy electricity products. It is unclear at present if customers of green power marketers are entitled to the green tags or if the supplier retains them.
- Renewable portfolio standards (RPS)  A number of states have adopted RPS, which require a certain share of renewable energy in the overall electricity mix. Renewable production that is used to meet RPS requirements cannot also sell certificates. In RPS states, certificates must represent renewable generation above the RPS standard.
- Renewable electricity funds  Some states collect funds from a system-benefit charge (SBC) on electricity sold and channel all or part of these funds into the development of renewable generation. Certificates are not available from projects funded by SBC.
- Corporate purchases  Some companies have announced their intention to purchase renewable power over the next few years. For example, the "Green Power Market Development Group," composed of Alcoa, Cargill-Dow, Delphi Auto, DuPont, General Motors, IBM, Interface, Johnson & Johnson, Kinko's, and Pitney Bowes, plans to develop 1,000 MW of new green power by 2010, possibly through green tags.

About one-third of U.S. states have renewable portfolio standards, and another one-third have at least some sort of utility green pricing programs. To date, there has not been a direct link between green power and emission credit markets. GHG reductions represent one attribute of products such as the existing green tags. Buyers of such products can presumably use such reduction credits to meet their own emission limits, or have them retired to improve the environment. Looking forward, green power markets will likely evolve to explicitly recognize, value, and exchange carbon emission reductions.

***A more ambitious approach, beyond incremental steps, to clean energy and efficient resource use can improve a firm's competitive position while minimizing climate-related risks.***

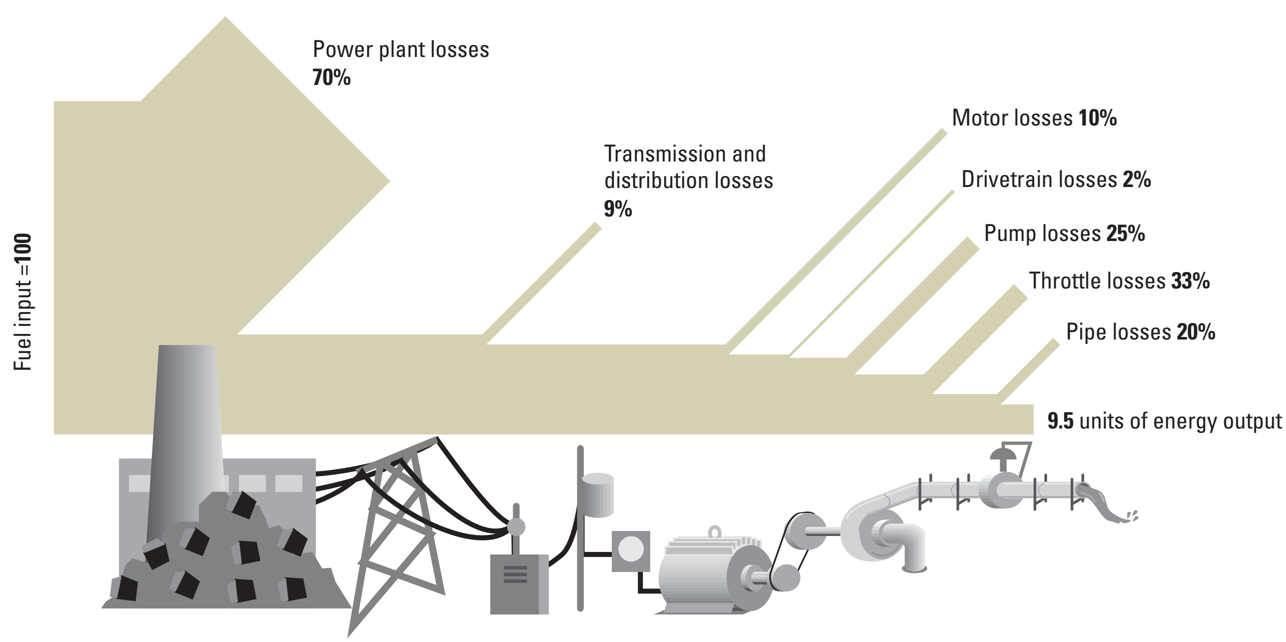
American firms can use VERs to position themselves to meet domestic regulations (if any) and possibly international limits following the 2008–12 Kyoto commitment period. They might also want to accumulate cheap Kyoto-compliant credits for later use when prices increase. The priority should be Kyoto compliance for operations in participant countries.

The carbon market options available in the future will depend on the actions taken in the short term. For example, a company with an internal trading program will have the option of comparing the cost of emission reductions available internally, as revealed by the internal market price, with the market price of external offsets and buying the least expensive offsets. Alternately, an institution that has options on carbon offsets can compare their strike price to the prevailing market price and buy the one that costs less.

### *Investment in advanced efficiency and clean generation technology*

In the longer term, carbon emission limits, if agreed to internationally and imposed domestically, will require fundamental technology change toward cleaner, more efficient conversion of energy resources. Cleaner energy will be needed for both the production of a firm's products and the operation of those products from the time of sale until disposal.

**Figure 1: Compounding losses...or savings—so start saving at the downstream end**




Source: ESOURCE. *Drivepower Technology Atlas.* www.esource.com

An incremental approach to energy technology would be to continue to capture available "no-regrets" efficiency opportunities, and to purchase "green power" or otherwise offset the GHG emissions associated with energy use. This approach will limit the risk imposed by the potential cost of compliance with emission limits. However, incremental measures might not be sufficient to succeed in an increasingly competitive industry.

A more ambitious approach, beyond incremental steps, to clean energy and efficient resource use can improve a firm's competitive position while minimizing climate-related risks. To communicate this "win-win" potential to clients and colleagues, RMI uses the natural capitalism framework, in which the first principle is radically increased resource productivity.[25]

There is little new in the idea that energy and resource efficiency investments pay for themselves, often more quickly than other investments. However, this principle goes beyond conventional zero-sum, diminishing-returns economic thinking, in which large, revolutionary efficiency gains are expected to cost more than small, incremental gains. *To capture the full benefits of radical resource efficiency, one must "tunnel through the cost barrier," where larger savings begin to cost less than smaller savings.*

Radical resource efficiency can be profitable because the efficiency improvements at the end use are multiplied upstream. As shown in Figure 1 and Table 5 (p. 40), a typical pumping system loses so much energy in each component in the energy transfer chain that only ten percent of the source energy (at the power plant) actually reaches the final end-use (fluid flow).

Thus, *every unit of energy saved in reducing pipe friction can save ten units of energy in power plant fuel.*

More efficient industrial piping reduces the pumping load; which, combined with efficient pumps, reduces the motor load; which, combined with efficient motors, reduces the power demand; which, combined with variable-speed controls, reduces the electricity use; which, combined with more efficient power supply, reduces the fuel consumption at the power plant. In addition to saving energy costs, downstream efficiency improvements also allow downsizing of upstream equipment, which provides additional savings in the capital costs of these components.

*Larger diameter pipes and straighter pipe layouts reduce friction and dramatically reduce the energy required to drive industrial pumps. This improves system performance and reduces both energy costs and capital cost for motors.*

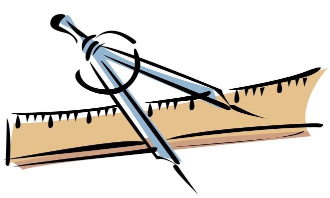
*"People who seem to have had a new idea have often just stopped having an old idea."*

*—Edwin Land*

The reason that such juicy savings are widely available is that most buildings and factories are designed by starting with a copy of an existing building or manufacturing plant, and then making incremental adjustments and improvements. *In terms of missing efficiency opportunities, most of the important errors are usually made on the first day of design.* Energy and resource efficiency are not adequately considered at the start of the design process—when improvements can be the largest, easiest and cheapest—and most facilities don't even measure energy usage in detail, making it difficult to improve later. An internal emission-trading program can create incentives to identify and exploit potential improvements.

Radically increased resource productivity does not necessarily require exotic technology, although new technology often helps. What is required is a combination of careful design, common sense, and the willingness to question long-accepted assumptions. As Edwin Land, inventor of the Polaroid Land camera, remarked, "People who seem to have had a new idea have often just stopped having an old idea."

The alternative is to apply *whole-systems thinking* as early in the design process as possible (Figure 2). By designing for the *least-cost* provision of the *end-use* service delivered, one can optimize the system, rather than making the typical mistake of sub-optimizing each *component* in isolation. This approach can be applied to buildings, industrial production, and power generation.



***By reversing the traditional rule-of-thumb design procedure and optimizing the entire system rather than designing individual components separately, a firm can radically increase energy efficiency.***

**Table 5: Example of multiplying energy losses in a pumping system**

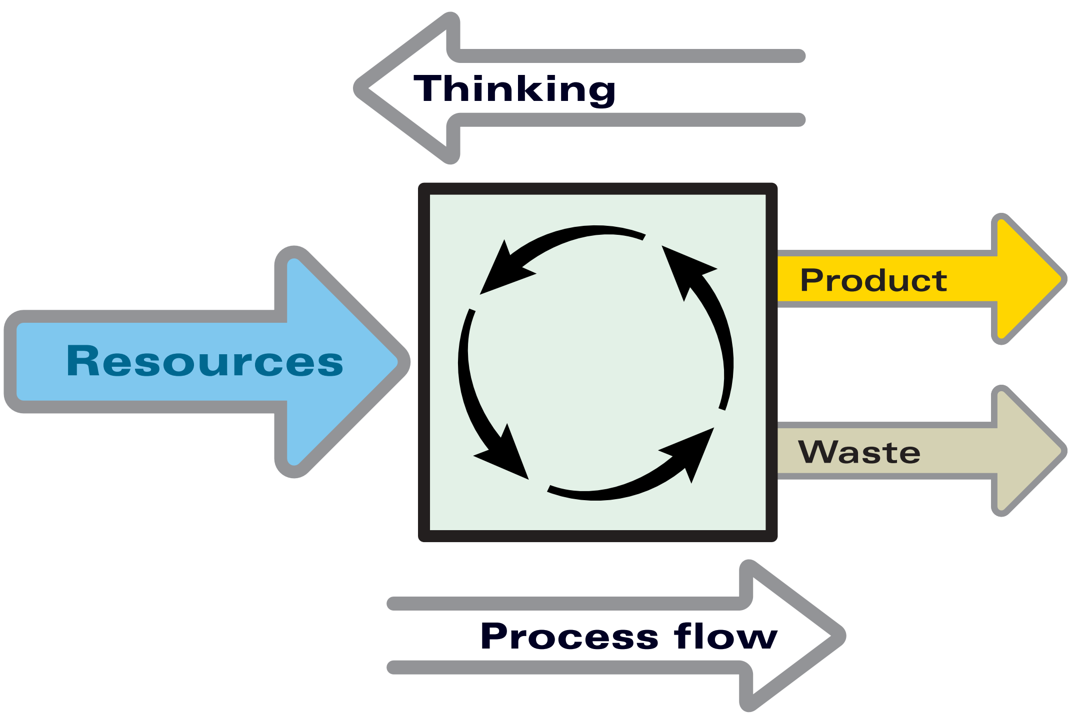
| Step in energy chain | Component efficiency | System efficiency from source energy | Ratio of source energy to energy delivered |
|---|---|---|---|
| Power generation plant | 33% | 33% | 3.0 |
| Transmission & distribution | 92% | 30% | 3.3 |
| Electric motor | 90% | 27% | 3.6 |
| Mechanical drive train | 98% | 26% | 3.7 |
| Pump | 75% | 20% | 5.0 |
| Control throttle | 67% | 13% | 7.5 |
| Pipe friction | 75% | 10% | 10.0 |

In existing commercial and institutional buildings, for example, state-of-the-art lighting components can reduce energy demand by 50 percent or more compared to typical design. However, comprehensive lighting design, which considers the lighting hardware, controls, and the building shell as a system, can use daylighting and control strategies to increase the savings to 75 percent or more.[28] The electric load reductions, together with improvements in loads such as office equipment, produce additional savings in air-conditioning, approaching 100 percent total savings compared to a typical design.[29] In addition, the cooling and air-handling equipment can be downsized, providing capital cost savings that help pay for the efficient equipment and design.

In new building design, impressive results can be achieved by using integrated building design, energy systems, and daylighting, which the International Netherlands Group Bank (ING) applied. Additional construction costs attributed to its energy systems were

**Figure 2: Whole-systems thinking**

To avoid the usual first-day errors, the designers' thinking should flow in the opposite direction of process flow, considering 1) downstream before upstream, 2) demand before supply, 3) application before equipment, and 4) people before hardware. To reduce waste and improve economic performance, consider the extent to which wastes can be made into products, recycled as inputs, or otherwise reduced or eliminated.



*At Sainsbury's grocery in Greenwich, UK, daylighting serves as the primary lighting component even on cloudy days, which are common in the rainy British climate.*

*Alexis Karolides photo*

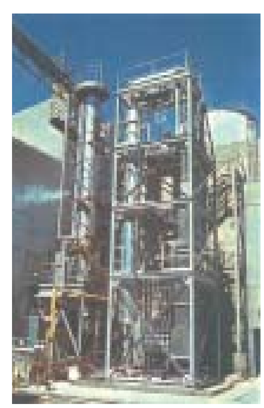
around $700,000. But the annual savings from daylighting and more efficient energy use are $2.6 million, providing a three-month payback. An adjacent bank built at the same time had similar construction costs but consumes five times as much energy per square foot. The new building is preferred by employees, and absenteeism is down, which has been attributed to the better work environment. The building has become well known and improved ING's public image.[30]

In industry, where 75 percent of all electricity use is in motor systems, the largest use of motors is pumping fluids. Pumping system design typically begins with selecting the pumps and motors, based on traditional rules-of-thumb, and then specifying the piping layout to connect these components to the process. By reversing this design procedure and optimizing the entire system rather than designing individual components separately, a firm can radically increase energy efficiency.[31] Using large, straight piping in place of small, bent piping greatly reduces pumping loads, and the energy and costs savings are multiplied upstream, as described above.[32] The motors themselves can be optimized using the MotorMaster+ software from the U.S. Department of Energy.[33]

In supplying electrical power to a facility, simply buying from the grid is no longer the only option. Small, clean, distributed power sources are now available for installation in commercial and industrial facilities. The technologies include small combustion turbines and micro-turbines, fuel cells, and even solar photovoltaics (PVs). In addition, biomass wastes from processing paper, sugar, beer, and other agricultural products can be converted to useful heat and electricity.

## Recommendation

*To improve a firm's competitive position while minimizing climate-related risks, pursue radical resource efficiency. This is profitable when designers "tunnel through the cost barrier" to where larger savings begin to cost less than smaller savings, and efficiency gains at the end use are multiplied upstream. Apply whole-systems thinking early in the design process to achieve the least-cost provision of the end-use service, rather than sub-optimizing components in isolation.*



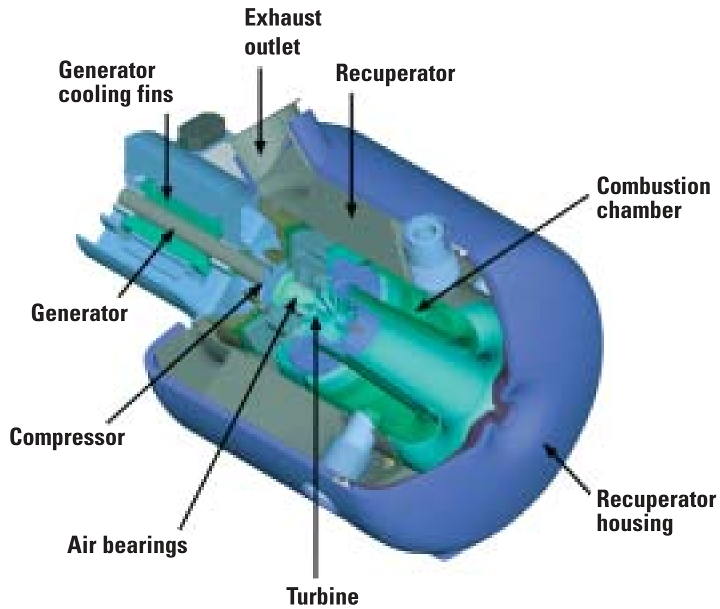
*Biomass processes of various types convert organic waste products to energy. This advanced ethanol fuel plant, developed by Merrick Engineers and the National Renewable Energy Lab at the Coors Brewery in Golden, Colo., uses brewery mash wastes as feed stock.*

*Photo courtesy U.S. Department of Energy*

An important advantage of most distributed generation (DG) technologies (except PV) is that they can produce both electricity and heat for space, water, and process heating. In commercial and institutional buildings, this heat supply can also be used to drive absorption-cycle or desiccant air-conditioning, making more electric production available for other uses. DG can also provide premium reliability power, by delivering power closer to the end-user than any source on the grid.

Although some utilities discourage the installation of DG, in many cases properly sited DG can help the local utility by reducing loads on the distribution system and deferring investments in new capacity. Another potential DG option will be fuel-cell cars, parked at commercial facilities during the day, which have the ability to generate electricity during peak-demand hours from the fuel cells that are on board but idle.

These fuel cell vehicle-generators could connect to the local electric infrastructure to deliver electricity generated on-board into the grid, providing high-value peaking power and additional electrical engineering benefits such as voltage support and reactive power.[34]




*Capstone Microturbines™ operate on natural gas or propane. Because they can handle low energy fuels, they can convert landfill and digester gas to electricity.*
*They can achieve high fuel utilization through cogeneration, producing both heat and electrical power. Small combustion turbines can be installed in industrial and commercial buildings.*

*Illustration courtesy Capstone*

*This PC25 Power Plant, by UTC Fuel Cells, is a 200kW commercial fuel cell unit that can operate on either natural gas or anaerobic digester gas fuel from wastewater treatment plants.*
*This installation is at the Yankee Gas Services Office in Meriden, CT.*

*Photo courtesy UTC Fuel Cells*

## Recommendation

*Consider installing DG based on small turbines or fuel cells to provide premium-reliability power and heat for space, water, and process heating or absorption or desiccant cooling. Solar PVs can reduce emissions still further.*

***Development of new products and services***

Exploiting the new business opportunities that emerge in a carbon-constrained world will require more than managing costs and risks in internal operations. Customers will be concerned about the carbon-content of the products they buy, or the energy requirements for operating those products. *Just as whole-systems thinking and end-use, least-cost design can improve performance of a firm's facilities, these concepts can be applied to the products and services that a firm designs, produces, and sells.*

## Fuel cells for clean distributed generation

Fuel cell technology is one of the promising sources of distributed generation (DG), although the technology is hardly new. The British physicist Sir William Grove made the first fuel cell, which he called the gaseous battery, in 1839. A fuel cell is essentially a battery that can be recharged by the addition of a chemical fuel, rather than the reverse flow of electric current. The most efficient fuel cells run on pure hydrogen and oxygen, and the only by-product of such a fuel cell is hot water. Until recently, the technology had been developed mainly for use in submarines and spacecraft. The oxygen tank that exploded on Apollo 13 was there to supply a fuel cell. (On Earth, fuel cells can use air.)

Back on Earth, the two main applications of fuel cells are electricity generation and powering motor vehicles. Power applications involve central generation by utilities, industrial cogeneration (of heat and electricity), and DG on or near the premises of commercial or residential customers. Vehicular applications of fuel cells make it possible to connect cars to the grid as mobile power plants.

Thus, fuel cells can provide a clean, efficient and reliable power source, and they can be scaled in size to fit nearly any application. The only technical drawback of fuel cells is that hydrogen and oxygen do not readily occur on Earth in their pure forms. Oxygen can be replaced by air, which is about one-fifth oxygen, with some loss of efficiency. But obtaining a steady flow of hydrogen is more of a challenge.

Several different types of fuel cell technologies are in development today. They are differentiated by the approaches taken to obtain hydrogen from more common sources of energy, such as natural gas. Four types of fuel cells are being developed for commercial energy applications: proton-exchange membrane, phosphoric acid, molten carbonate, and solid oxide. Also, alkaline fuel cells are used in space applications.

Each technology promises high electric output efficiencies and virtually no emissions, and each can deliver heating energy as a by-product. Low-temperature proton-exchange membrane fuel cells are less bulky and can start instantly, making them the preferred choice for fuel cell vehicles. The higher-temperature technologies, such as solid oxide fuel cells, have advantages in terms of higher efficiency, more useful heat output, and the ability to use natural gas without an expensive separate fuel reformer.

Fuel cells can run on natural gas with high efficiency, little pollution and few moving parts. They offer a power source that is clean, reliable and flexible in size. Maintenance costs are expected to be low due to relatively few moving parts, and the high efficiency and useful heat by-product provide for low fuel costs.

An incremental approach to low-carbon products involves product labeling and certification, including the possibility of carbon-neutral designation. Many industries, such as the forest products industry, are beginning to develop auditing and labeling standards with the goal being to certify products as carbon neutral, *i.e.* causing no net emissions, either *via* low-carbon production technology and/or purchase of sufficient carbon offsets to compensate for the remaining emissions.[35]

Climate Neutral Network (CNN) has created a certification process that designates companies and products as carbon neutral if they achieve significant emission reductions and purchase carbon offsets to cover remaining emissions.[36] CNN has certified three major U.S. companies as climate neutral, and they offer the Climate Cool designation for carbon-neutral products, based on CNN's metrics and procedures. As previously mentioned, an Interface Corp. institutional floor-covering product became one of the world's first certified carbon-neutral products, based on CNN certification.

Beyond reducing the climate impact of existing products, there will be opportunities for entirely new products and services in a carbon-constrained world. Emission limits will increase the value of products and services that improve energy efficiency or improve the performance of renewable energy systems. This will stimulate markets for new technologies such as advanced wind turbines, superwindows, fuel cells, fuel-efficient cars and trucks, methane-recovery systems, etc. Other new opportunities include services to help implement these technologies, such as design, engineering, and financial services.

***Beyond reducing the climate impact of existing products, there will be opportunities for entirely new products and services in a carbon-constrained world.***

The most innovative new products will combine advanced technologies with services tailored to improving performance while minimizing carbon emissions. Among others, these services could include:

- Packaging of carbon offsets with technical measures to reduce net emissions or achieve carbon-neutral certification.
- Third-party financing of energy-efficient building systems and continuous commissioning services to optimize ongoing operation, based on performance contracts that reward energy, emission, and dollar savings.
- Power-marketing services that combine "green power" procurement with brokering of ancillary electric power services (voltage support, reactive power, spinning reserve, etc.) from distributed cogeneration facilities.


**Recommendation**

*Develop new products that combine advanced energy technology with services such as financing, carbon offsets, green power or ancillary power services, tailored to improving performance while minimizing GHG emissions.*

## Part ID: Barriers to Capturing Profitable Emission-Saving Opportunities

Over the last 25 years, researchers at RMI and elsewhere have demonstrated widespread potential for radical improvements in energy efficiency at lower cost than that of competing supplies. These opportunities indicate low-cost or profitable emission reductions. There are now many examples of successful harnessing of this potential, but even greater amounts of potential energy savings and emission reductions have yet to be captured. The continued presence of this unfulfilled potential is explained by barriers that impede the innovations needed to implement energy efficiency and clean cogeneration projects, despite their equal or lower life-cycle costs compared to conventional energy supplies.

***A facilities manager committed to saving energy who is not permitted to influence purchasing decisions will be limited to savings available from his existing equipment.***

### Institutional changes from both supplier and customer

Sometimes it is the institutional structure of an organization or the allocation of job responsibility that precludes adoption of new technology. An employee charged with enforcing waste disposal regulations but given little authority will rarely be able to enact innovative and cost-saving ways of eliminating waste on the front end. A facilities manager committed to saving energy who is not permitted to influence purchasing decisions will be limited to savings available from his existing equipment. In the case of the building industry, the structure of interactions between owners and tenants and between contractors and subcontractors creates some of the structural barriers to change.

While it makes sense intuitively that a company adopting a certain technology might resist change, there is also the potential that the organization or company *selling the product or technology* may stumble over its own infrastructure. If a company is built around maximizing sales of its product, the sales department may resist a new way of doing business in which the incentive rests on increasing the value of the company's product while reducing its use. Some companies that have attempted to lease products that are conventionally sold (carpets, elevators, etc.) have encountered resistance from both customers and their own employees.

### Delayed or extended time cycles

Any technology that represents a *preventative innovation*, one that is adopted to lower the probability of a future unwanted result such as climate change, can prove difficult to sell and will often have a slow rate of adoption. The results of successfully applying such a technology are intangible, because it has helped to prevent an outcome rather than to yield a desired one. It requires, in many cases, long-term thinking and the ability to visualize an unfavorable result in the future (this is the so-called baseline case in the analysis of carbon offsets).

Climate change is a perfect example of this problem. In the case of energy savings, companies with rigid payback requirements often miss opportunities for large medium-term savings because the investment cannot be recovered within a much shorter time period. Intense schedule pressures can prevent designers and engineers from adopting efficiency opportunities because a looming deadline cannot be missed for any reason.

**Sophisticated level of whole-systems thinking**

Divisions between departments and budgets can prevent a firm from taking advantage of *whole-systems thinking* to solve design problems. A company can benefit from investing in super-efficient office equipment ahead of schedule because a smaller, cheaper cooling system could keep the new equipment from overheating. Because the money for a chiller comes from a different budget than for office equipment, the idea is likely to be scrapped.

One of the most frequent remarks heard in conjunction with technological fixes is that, "All we have to do is train people to…." The difficulties of, for example, increasing the energy efficiency of a window technology by a factor of two pales in comparison to the difficulty of getting people and organizations to change familiar behavior.

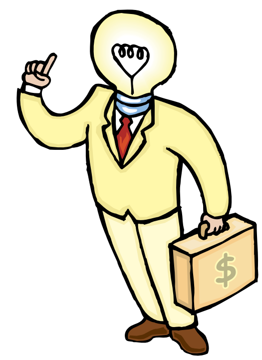
**Perceived payback gap compared to other business options**

Cash constraints, uncertainty about new technologies and practices, and risk aversion often present formidable barriers to motivating building and facility managers. Also, separation between those paying the costs of efficiency improvements (*e.g.*, building owners and facility managers) and those receiving the benefits of lower energy costs (*e.g.*, building occupants) removes much of the incentive to improve energy efficiency.

Energy-efficiency improvements are seen as expenditures that compete for scarce capital dollars, rather than investments that pay for themselves over time. Other budget requirements, such as plant expansion or construction and building renovation, also compete for capital and are often considered to be higher priorities.

While it is widely recognized that harnessing the vast potential for low-cost energy efficiency and clean DG could reduce GHG emissions at low or negative cost, decision makers in many companies and institutions consider the necessary investments to be risky. Because clean, efficient energy technology is less familiar, its performance appears less certain and thus more risky. This perception of risk causes facility managers to demand an extremely fast payback from investments in these technologies, such as a 1.5 year payback, which translates to a before-tax rate of return greater than 60 percent.

Similarly, DG sources, especially renewable energy and fuel cells, are still relatively new and unfamiliar to most potential customers. These customers tend to consider both the costs and the potential benefits of DG as relatively uncertain and risky. As with efficiency, the lack of DG information and market familiarity can be overcome using information programs and demonstration projects, as well as financial incentives.




***Energy-efficiency improvements are seen as expenditures that compete for scarce capital dollars, rather than investments that pay for themselves over time.***


### Lack of internal market for saved energy and limited information flow

The lack of an internal funding mechanism, or "market," within the budget structure of many businesses and most public institutions makes it difficult to increase a capital budget even slightly to finance energy efficiency measures that can reduce future operating budgets by a greater amount. Even efficiency projects with a one-year simple payback are often rejected. This is a nearly-universal barrier to energy efficiency, and overcoming it is one of the main motivations of most energy-efficiency policies and programs, such as financial incentives and rebates, low-cost financing, public procurement programs, public-private cooperative ventures, and codes and standards.

Many building managers recognize that investments in improving energy efficiency of buildings and production systems are often cost-effective and offer attractive rates of return. However, they may be unsure of how to develop an economic justification for energy-efficiency projects. *Cash constraints, competition for limited investment capital, and uncertainty about which types of technologies and practices are worth adopting present formidable barriers to energy efficiency* and DG.

***Performance contracting uses actual energy savings from installed efficiency measures to pay for the project, including energy-saving equipment, installation, and maintenance services.***

Performance contracting is an alternative financing strategy that allows facility managers to finance an otherwise unaffordable energy-efficiency project. Performance contracting uses actual energy savings from installed efficiency measures to pay for the project, including energy-saving equipment, installation, and maintenance services. An energy service company (ESCo) enters into an agreement with the party making the decision to improve energy performance and with a financial investor, which could be a commercial bank or the ESCo itself. As its name implies, a performance contract does not specify how an energy savings project must be implemented in terms of specific technologies, but rather what the project's outcome will be in terms of energy cost savings.

### Distorted energy prices and regulatory failure

For many firms, energy efficiency is discouraged by low electricity prices, which sometimes do not even cover the cost of supplying power, not to mention the external cost of environmental impacts such as global climate change. Also, electric tariffs do not reward the grid-support benefits of DG, which can defer investments in distribution capacity, provide voltage support and reactive power, and improve reliability. New utility rate structures could recognize these benefits, providing incentives for DG.[37]

Utility standards for interconnection and protection equipment to allow on-grid operation of DG sources vary widely and can create potentially prohibitive costs for DG developers. Because of the complexity, variation, and potential costs of utility interconnection requirements, uniform standards are under development that will make interconnection requirements more predictable, and they can be adopted at the local level. To help reduce DG connection and protection costs by making the requirements more predictable, the Institute of Electrical and Electronic Engineers (IEEE) is working to develop a national Standard for Interconnecting Distributed Resources with Electric Power Systems, which is expected to be published during 2002.[38]

## Recommendation

*Establish an internal market to finance the capital costs of efficiency improvements based on future energy savings. Contract with ESCos to implement efficiency projects on a performance-contract basis, providing third-party financing and guaranteed savings. Use performance-based fees or post-construction performance contracts to reward architects and mechanical designers for finding design solutions that improve energy and economic performance.*

## Performance contracting and ESCos

Performance contracting is an alternative financing strategy that allows companies and institutions to finance energy-efficiency projects. Performance contracting uses actual energy savings from installed efficiency measures to pay for the project, including energy-saving equipment, installation, and maintenance services.

An energy service company (ESCo) enters into an energy service agreement (ESA) with the party making the decision to improve energy performance and with a financial investor, which could be a commercial bank or the ESCo itself. As its name implies, a performance contract does not specify how an energy savings project must be implemented in terms of particular retrofit measures and technologies, but rather what the final outcome of the project must be in terms of energy cost per square foot.

The ESCo is paid based on the savings generated. The ESCo guarantees a minimum level of cost savings during the contract term, which is used to cover the financing costs. The savings are first estimated in the feasibility study, and later verified by energy performance monitoring. Because the ESCo has incentives to do jobs right, commissioning and metering are typical and essential elements of ESCo projects. Once the payments have covered the ESCo's cost of doing business plus a percentage profit outlined in the contract, further savings belong to the client.

The success of performance contracting for energy-efficiency retrofits has generated interest in the use of similar mechanisms to encourage the design of high-performance buildings and mechanical systems in new construction. The two basic ways to provide performance incentives to designers are performance-based fees and post-construction performance contracts.

Performance-based fees reward the architect or mechanical designer with higher fees on the basis of exceeding a predetermined level of energy performance. This provides an incentive to find cost-effective design solutions that improve energy performance. Typically, the designers' incentives are mostly to comply with existing codes and standards and to not exceed the capital budget, which leads to conservative, low-performance designs. This mechanism has been used little to date, and the lack of familiarity makes it difficult to introduce.

Post-construction performance contracts reward the designer with payments out of energy savings achieved during the operation of the building. This provides the designer with an even greater incentive to improve energy performance, as the potential revenue stream can be substantial over time, similar to a conventional performance contract. However, this mechanism also requires the designer to assume more risk in terms of the future operation of the building, over which the designer has little control.

## Part IE: Organizational Learning: Toward a Culture of Profitable Innovation

An organization's response to the challenge of climate change can be treated as a risk management problem, as explained earlier. The goal is to reduce one's exposure to potential future costs at minimum cost today. On the other hand, this challenge can also be transformed into a profitable business opportunity, which stimulates ongoing innovation that reduces costs and creates new products and revenue opportunities.

***Once a group of people steps beyond the boundaries of incremental, zero-sum thinking, innovation can become part of the everyday working culture.***

How does a company or institution begin such a transformation and encourage its management and staff to embrace the needed changes and seek innovative solutions? One of the best ways to begin, and to sustain momentum for change, is to create a culture of learning that supports and encourages energy- and emission-saving innovations. Once a group of people steps beyond the boundaries of incremental, zero-sum thinking, innovation can become part of the everyday working culture.

A culture of innovation is consistent with reducing emissions and sustainable business in general. According to Peter Senge, "If understanding natural systems establishes the guiding ideas for sustainability innovations, then learning provides the means to translate ideas into accomplishments. But, just as the logic of natural systems conflicts with take-make-waste industrial processes, so too does the logic of a learning culture conflict with traditional, control-oriented organizational cultures."[39]

What are the qualities of an organizational culture that support the kinds of innovations that are needed? An organization that creates a culture supportive of creativity and learning will empower its people to effect innovative change. Attempts to institute energy savings projects will be more effective and durable, and the entire organization will reap multiple, additional benefits, such as better comfort and performance.

This type of working culture is characterized as a *learning organization*. Learning organizations are more effective in improving quality, serving customers, and managing responses to change, for example GHG emission limitations. *A learning organization committed to addressing climate change can be a fun, energizing place to work, and this employee motivation can create a competitive marketplace advantage.*

The skills and capabilities of a learning culture fall into three natural groups:[40]

- *Aspiration*—the capacity of individuals and organizations to orient them selves toward what they care about and to change because they want to, not because they need to.
- *Reflective conversation*—the capacity to reflect on fundamental assumptions and patterns of behavior, both individually and collectively.
- *Understanding complexity and interdependence*—the capacity to see larger systems and forces at work and construct models to test and explore them.

As new skills and capabilities develop, a greater awareness develops of long-held assumptions and practices. Over time, this awareness is assimilated into shifts in basic attitudes and beliefs. As an architect of a learning culture, how can one begin to effect profound change?

*Measure Impacts and Potential Savings.*
One of the best ways to begin is by making information on climate impacts and potential energy savings projects available to all employees. Michael Porter writes, "One of the major reasons that companies are not very innovative about environmental problems is ignorance . . . the act of measurement alone leads to enormous opportunities to improve productivity."[41]

*Create the Right Incentives.* Incentives can be financial or performance based and can include public recognition and awards for innovative energy savings projects. The incentives can be top-down (as in the BP trading program driven by business unit leaders) or bottom-up (as in the Dow WRAP program, where engineers throughout the company competed for funding and recognition) (see Part III). Shell has found that "putting a cost of carbon into project economics is a valuable step. Although the impact on returns is often quite small, the impact is important because it makes engineers think about the implications at an early stage. It makes thinking of carbon impact a normal part of business."[42] Financial incentives should direct savings back to the project team or area that implements the projects. Savings that are absorbed into a general fund for operating expenses do not provide much incentive and are, in fact, a barrier to innovation.

*Match the Solution to the Organization.*
To improve the chances of adoption, the relative advantage of an innovation over the status quo needs to be made explicit, for example its relative advantage in costing; how easily it can be integrated into a production line; and how simple it is to operate. This needs to be true *across the company* in order to achieve employee buy-in.
If an energy-efficiency measure reduces emissions fourfold but requires a halt in the production line or is seen as a precursor to downsizing, it will encounter opposition from plant managers and union members. On the other hand, if the innovation is advertised as reducing GHGs, improving facility air quality, increasing worker productivity and *protecting* jobs, the amount of buy-in will increase.

***"The act of measurement alone leads to enormous opportunities to improve productivity."***

***—Michael Porter***

*Develop Collaborations.* Organizations that create a flexible network for sharing ideas on climate change are at an advantage in identifying and adopting innovative mitigation strategies. Be proactive in developing relationships with regulators, environmental groups, and other businesses. Similar industries can work together to tackle barriers to the introduction of innovations within their companies. For example, the ADOP2T program model developed at the Illinois Waste Management Research Center helps member companies identify pollution prevention needs and target potential technologies.[43] A member company tests the technology and reports findings to other members. By sharing the responsibility of trying innovations, member companies benefit from the trial and error process but reduce the burden of experiments with each proposed innovation.

*Cultivate Internal Change Agents and Innovation Champions.* There is considerable evidence within sustainable development projects that attempts by an outsider to introduce a new innovation to the population of a community will be far less successful than an individual change agent within that community championing the same innovation to his or her colleagues.[44]

*Allow Room for Flexibility and Initiative.* An initiative that can be "test-driven" first will likely have a higher level of acceptance. Technologies have a higher rate of adoption if a demonstration or pilot program is used. Most innovations in a company go through a redefining/restructuring phase, during which the new product or process is adapted to better fit the needs of the organizational structure. An emission reduction technology may achieve the reduced emission levels it was intended for, but a standard of continuous improvement can yield even more impressive performance results.

**Recommendation**

*Seek to create a culture of learning that stimulates innovation to find and implement emission reductions for fun and profit. Start by creating the right incentives, matching solutions to the organization, measuring impacts and savings, allowing for flexibility and initiative, developing collaborations, and cultivating internal change agents and innovation champions.*

## Part IF: Conclusion

Does your organization need a climate strategy? The decision to take action at this stage appears to be based largely on one's perception of timing. The risks of global climate change have not been accepted as requiring immediate action at the political level in the United States, nor are they likely to in the near future. Nevertheless, there is emerging scientific consensus on the need to respond to the threat and sufficient concern among the public to allow the policy debate to continue. In Europe, emission limits are already in place.

Ultimately, regulatory action and enforcement of regulations will drive the need for emission reductions and the market for carbon offset credits. If and when binding regulations are imposed is still unknown, so intensive and costly activities may not be justified. Nevertheless, developing a climate strategy may be an inexpensive step to take at this stage. The goal is risk mitigation at low cost.

Some of the options, such as improving energy efficiency, may have economic benefits in addition to climate benefits that justify their implementation on an economic basis alone. Both potential climate "winners" and "losers" can benefit from the development of an emission measurement and tracking process. Taking this step makes it possible to set a reduction target, to identify reduction measures, to demonstrate progress achieved, and to communicate these goals and achievements internally and externally. It also provides a way to educate staff on the risks and options related to climate change, and to get a head start on the competition.

In some cases, a potential "loser" might discover it has climate-friendly assets it was not aware of, which might turn it into a "winner." Meanwhile, "winners," that can realize opportunities to capture new markets in climate-friendly technologies and services will want to act early to position themselves for future growth in these markets. Smart firms will use the challenge of global climate change to stimulate innovation and improve business practices that help reconcile their environmental and business performance goals.

***Smart firms will use the challenge of global climate change to stimulate innovation and improve business practices that help reconcile their environmental and business performance goals.***

# Part II: Background and Context

*"It is not a question of whether the Earth's climate will change, but rather when, where and by how much. It is undisputed that the last decade has been the warmest this century, indeed the warmest for hundreds of years, and many parts of the world have suffered major heat-waves, floods, droughts, and extreme weather events leading to significant economic losses and loss of life. While individual events cannot be directly linked to human-induced climate change, the frequency and magnitude of these types of events are expected to increase in a warmer world."*

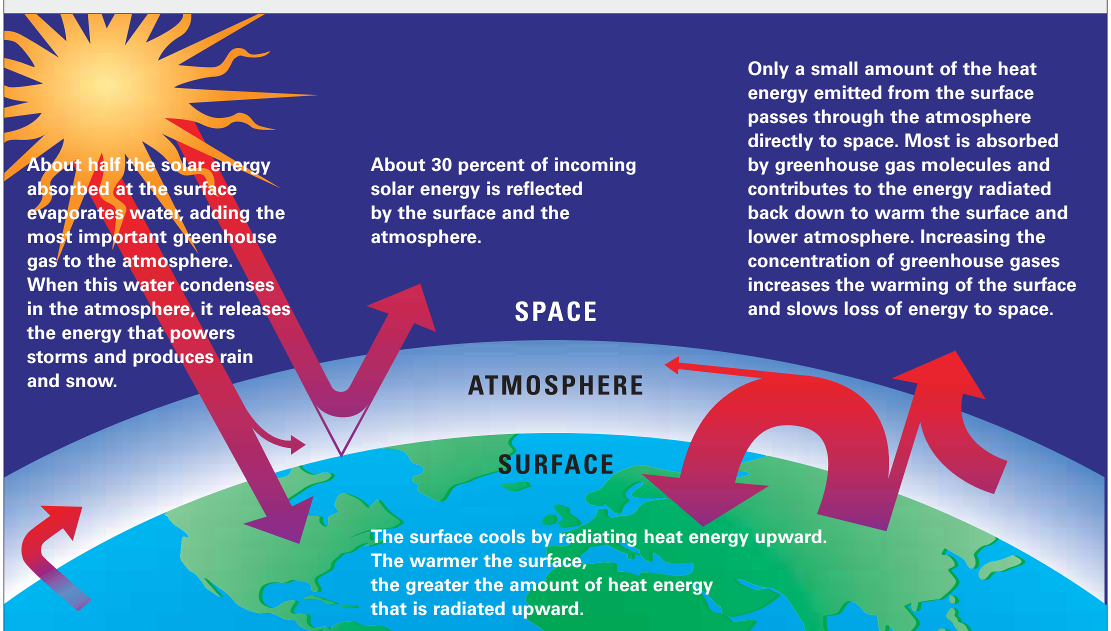
*Intergovernmental Panel on Climate Change (IPCC) Report to the Fifth Conference of the Parties of the United Nations Framework Convention on Climate Change, November, 1999.*

## Part IIA: Background: Climate Science Summary

### The Greenhouse effect

Earth's climate is determined by complex interactions between the sun, ocean, atmosphere, land, and living things. The composition of the atmosphere is particularly important because certain gases (including water vapor, carbon dioxide, methane, halocarbons, ozone, and nitrous oxide), called "greenhouse gases," absorb heat radiated from the Earth's surface. As the atmosphere warms, it radiates heat back to the surface, creating what is commonly called the "greenhouse effect." The average temperature of the Earth's surface is about 33°C (60°F) warmer than it would be if there were no atmosphere. The greenhouse effect makes life possible on Earth.

**Figure 3: The Earth's greenhouse effect**



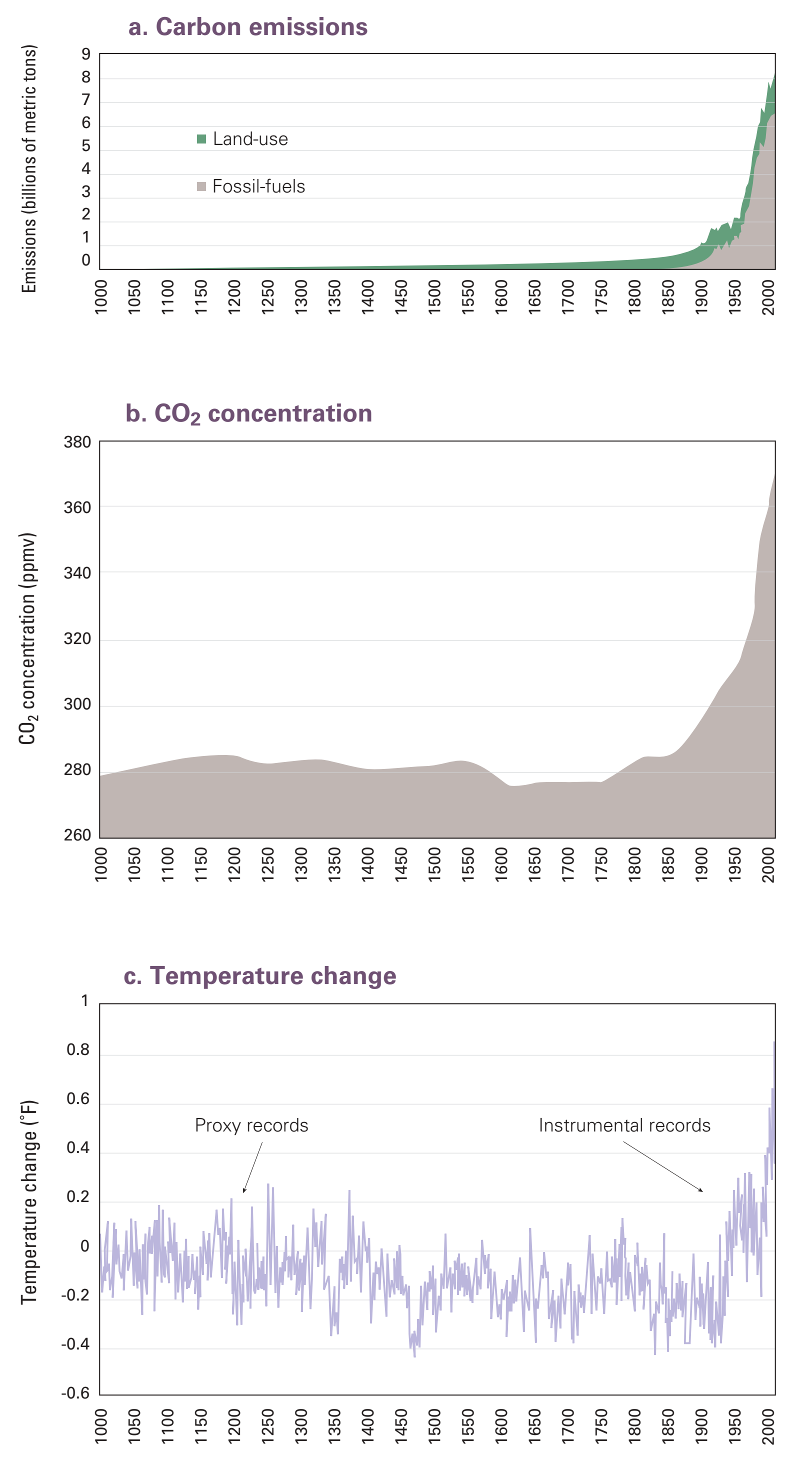

Source: National Assessment Synthesis Team. 2001. Climate Change Impacts on the United States. Report for the United States Global Change Research Program. Cambridge Univ. Press. www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewclimate.htm.

### Has the Earth warmed?

Since the industrial revolution, scientists have observed that the atmospheric concentrations of $CO_2$ and other long-lived GHGs are increasing. Higher atmospheric GHG concentrations intensify the greenhouse effect, making the earth warmer. During the 20th century, the global average surface temperature increased by over 1ºF (0.6ºC). About half this rise has occurred since the late 1970s, and 17 of the 18 warmest years in the 20th century occurred after 1980.[45]

The global warming of the past century has brought about a number of significant and observable changes, such as a reduction in global snow and ice cover, a rise in global sea levels, an increase in total global precipitation, and an increase in the frequency of heavy precipitation.


**Figure 4: 1,000 years of global $CO_2$ and temperature change**




Source: National Assessment Synthesis Team. 2001. Climate Change Impacts on the United States. Report for the United States Global Change Research Program. Cambridge Univ. Press. www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewclimate.htm.

***Since the beginning of the industrial revolution, humans have been transferring the geologic carbon pool into the biosphere by burning fossil fuels.***

## The carbon cycle simplified

The science of climate change rests on an understanding of the Earth's carbon cycle. There are two pools of carbon on earth, the biosphere pool and the geologic pool. The biosphere pool consists of carbon that cycles through living systems—oceans, plants, animals, soils, and the atmosphere. The geologic pool is composed of sedimentary rock carbonates and fossil fuel deposits such as gas, coal, and oil.

For most of human history, the geologic carbon pool remained separate from the biosphere pool. But since the beginning of the industrial revolution, humans have been transferring the geologic carbon pool into the biosphere by burning fossil fuels. At current rates, we are *annually* returning to the biosphere an amount of carbon that took about 100,000 years to remove.[46]

*Forests absorb and store carbon. Because reforestation projects have local environmental benefits beyond the reduction of greenhouse gases, they can enhance a firm's public image.*

*Norm Clasen photo*

Ninety-five percent of global emissions of carbon dioxide, the primary GHG, come from natural sources. These carbon emissions are reabsorbed by natural "carbon sinks," like vegetation growth and the ocean, in a finely balanced cycling of biosphere carbon. The influx of carbon to the atmosphere from human activities represents about only three percent of annual natural emissions, but it is enough to exceed the absorption capacity of the earth's carbon sinks.[47]

The upshot of this carbon cycle imbalance is striking; atmospheric concentrations of $CO_2$ have increased by 31 percent since 1750, to concentrations not likely seen for the past 20 million years.[48] As of 1998, the most recent year for which data are available, the United States, with five percent of the world's population, contributed 24 percent of global $CO_2$ emissions. American per capita $CO_2$ emissions (the quantity of $CO_2$ emitted per American citizen) exceeded those of all other western industrialized nations, sometimes by factors of two and three. Human activities are also causing an increase in concentrations of other GHGs such as methane (up 150 percent since 1750), nitrous oxide (up 17 percent since 1750), and halocarbon gases, which are entirely manmade.

Pound for pound, each of these other GHGs has an even greater potential to cause global warming than $CO_2$, as shown in Table 6. Though they have more global warming potential per unit, $CO_2$ is the primary GHG simply because of its sheer volume in the atmosphere. It contributes to 83 percent of all U.S.-caused global warming.

Once present in the atmosphere, GHGs can persist for tens or thousands of years. For example, several centuries after $CO_2$ emissions occur, about a quarter of the increase in $CO_2$ concentration caused by these emissions is still present in the atmosphere. Therefore, it is the long-term, cumulative emissions that determine the increase in atmospheric $CO_2$ concentration and the potential for climate change.

If we want to preserve the option of stabilizing atmospheric concentrations of carbon at 450 parts per million, a level 60 percent above pre-industrial levels, and the most ambitious target set out by global change forecasts, we can add only about 340 billion tons of carbon to the atmosphere. If we consider the rate of carbon dioxide emissions, this amount will be reached in about 50 years.

### Human activities cause global warming: a scientific consensus

The United Nations' Intergovernmental Panel on Climate Change (IPCC) is a highly visible international science effort examining the science of climate change and its impacts. In its 2001 report on climate change, the IPCC found that most of the warming observed over the past 50 years is likely to have been due to the increase in GHG concentrations.[49]

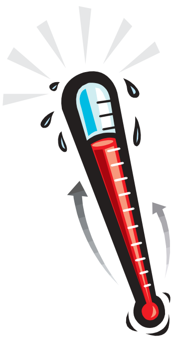
***IPCC found that most of the warming observed over the past 50 years is likely to have been due to the increase in GHG concentrations.***

**Table 6: Greenhouse gas contributions to global warming potential**

| Greenhouse gas | Atmospheric lifetime (years) | Global warming potential (GWP) - 100-year time horizon | Carbon equivalent based on 1998 U.S. emissions (metric tons) | Percent contribution to U.S. GWP, based on 1998 U.S. emissions |
|---|---|---|---|---|
| Energy related $CO_2$ emissions (electricity production, transport) | Variable | 1 | 1547 | 81.2% |
| Other $CO_2$ emissions (*e.g.*, cement production) | Variable | 1 | 36 | 1.9% |
| Methane | 12.2 +/-3 | 21 | 177 | 9.3% |
| $N_2O$ | 120 | 310 | 99 | 5.3% |
| Halocarbons* | 12–50,000 | 1,300–23,900* | 47 | 2.5% |

*Large range of atmospheric lifetime and GWP is due to different kinds of halocarbons.

Source: EPA. 2001. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–99. U.S. Environmental Protection Agency, Washington, DC, EPA 236-R-01-001, April 2001.



In response to a request from the Bush Administration in 2001 for further guidance on the findings of the IPCC, the U.S. National Research Council's (NRC) Committee on the Science of Climate Change prepared a review of the IPCC report. The NRC report, *Climate Change Science: An Analysis of Some Key Questions* found that the IPCC report is "an admirable summary of research activities in climate science." And, "The [panel's] conclusion that most of the observed warming of the last 50 years is likely to have been due to the increase in GHG concentrations accurately reflects the current thinking of the scientific community on this issue. Despite... uncertainties, there is general agreement that the observed warming is real and particularly strong within the past 20 years."[51]

## Projected climate changes and impacts

In 1992, the IPCC established several scenarios for global climate change for the next 100 years. These scenarios took into account a range of factors such as population growth, economic and technological developments, energy use, and environmental sensitivity to GHG emissions. In 2001, the IPCC revised and updated these scenarios. Global temperatures are predicted to rise in all six scenarios, ranging from an increase of 1.4 to 5.8 °C (2.5 to 10.4 °F) relative to 1990 levels.

These temperature increases are predicted to lead to further reductions of snow and ice cover; increased frequency and severity of precipitation events; increased risk of drought in some areas; a further rise in sea levels; and a weakening and possible shutdown of the ocean currents that warm the European continent. Indeed, global warming could cause a dramatic cooling of much of Northern Europe.[52] Moreover, even in the more conservative IPCC scenarios, the models project temperatures and sea levels that continue to increase well beyond the end of this century, suggesting that assessments that examine only the next 100 years may well underestimate the magnitude of the eventual impacts.[53]

### The role of CFCs and their substitutes

Chlorofluorocarbons (CFCs) are part of a larger family of halocarbons, molecules that contain carbon and at least one of the following: fluorine, chlorine, bromine, iodine, or astatine. CFCs were invented in 1928, and found widespread use in aerosols, refrigeration, air conditioners, foams, solvents, and fire extinguishers. CFCs are the compounds responsible for the deterioration of the Earth's ozone layer, and for the ozone layer hole that now appears over Antarctica every September. What is not as widely known about CFCs is that they also contribute to global warming. In fact, CFCs have many thousands of times the global warming potential of carbon dioxide (see Table 6).

The 1987 Montreal Protocol regulates the sale and use of CFCs, and aims to eliminate entirely the emissions of these substances. The atmospheric concentrations of CFCs are now increasing more slowly or decreasing in response to the Protocol and its subsequent amendments. However, substitutes for CFCs, especially halocarbons such as HCFC-22 ($CHF_2Cl$) and HFC-134a ($CF_3CH_2F$) and some other synthetic compounds such as perfluorocarbons (PFCs) and sulphur hexafluoride ($SF_6$), are also powerful GHGs, and their atmospheric concentrations are currently increasing.[50]

A recent report by the U.S. Global Change Research Program[54] outlines the potential impacts of climate change on the United States. While there are some beneficial impacts of global warming, such as a near-term increase in crop productivity and forest growth, the damaging and costly effects of warming are potentially much greater.

Among these are damage to coastal wetlands and human settlements from rising sea levels; shortages in water supplies, especially throughout the Western United States; large increases in the heat index; losses in biodiversity; and exacerbation of other stresses such as air and water pollution.[55]

### GHG emission reduction options

Reductions in net GHG emissions are possible in several areas, but the two principal categories of carbon emission reduction measures are energy and land use measures. In addition, GHG reductions can be achieved by capturing non-$CO_2$ GHGs such as methane released from landfills and perfluorocarbons released during aluminum production.

*Photovoltaic panels such as these allow generation of electricity on site with no emissions. Photovoltaic markets continue to grow at an average rate of 30 percent per year, and price per kilowatt is falling as efficiency rises.*

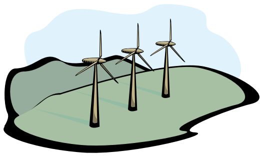
*Norm Clasen photo*

### Carbon sequestration

Although there is no proven, cost-effective technology for removing $CO_2$ from tailpipes and exhaust stacks, $CO_2$ can be removed from the atmosphere by photosynthesis, which is certainly a well-proven technology! A widely used method of achieving carbon sequestration is the selective planting and management of forests and other lands. This strategy, if implemented in a sustainable manner, can increase the Earth's carbon storage capacity, thus sequestering carbon from the atmosphere and helping to mitigate $CO_2$ accumulation.

In a carbon sequestration project, the cumulative increase in biomass determines the amount of net carbon storage capacity for a carbon offset. The goal of a carbon sequestration project is long-term sustainable carbon storage. Trees and other terrestrial carbon sinks do not accumulate carbon indefinitely; but they have a limit. Thus, the carbon-storage benefit of a carbon sink is a one-time increment in the carbon stock on land. Annual plants return most of their stored carbon to the atmosphere each year, so they do not accumulate or sequester carbon effectively.

Thus, the main carbon sequestration strategy is forest plantations that maintain the forest cover indefinitely. The forest management strategy can include some selective harvesting, as long as the total carbon storage capacity over time remains at or above the value claimed for the carbon offset. The first carbon offset projects were undertaken in the late 1980s by the AES Corporation, in the form of forest conservation and sustainable agroforestry in Guatemala.



Energy measures would include, for example, switching from fossil fuels to renewable sources to generate electricity or improving the end-use energy efficiency in buildings, factories, and vehicles. Land use measures would include carbon sequestration, long-term storage of carbon in terrestrial biomass, sustainable forest plantations, and forestry practices that discourage forest clearing. Many of the earliest carbon offset projects involved such activities.

### How do we know the atmospheric buildup of greenhouse gases is due to human activities?[56]

Four lines of evidence prove the recent buildup of carbon dioxide is due to human activities. First, scientists can distinguish carbon emitted from fossil fuel combustion from carbon emitted from natural sources by measuring the amount of natural radioactivity in the nuclei of carbon atoms, *i.e.*, $C^{14}$. Because they are much older, carbon nuclei from fossil fuel sources have much less radioactivity ($C^{14}$) than carbon from natural sources. Studies done on tree rings show that trees' uptake of newer, more radioactive carbon has been decreasing over time, as the concentrations of older, less radioactive carbon increase in the atmosphere.

Second, in the 1950s, scientists began making precise measurements of the total amount of carbon dioxide in the atmosphere. Their data show that both global atmospheric $CO_2$ concentrations are rising and that these increases are consistent with the rise in human-caused $CO_2$ emissions.

Third, evidence from ice cores corroborates this finding. Air bubbles in samples of ancient glacial ice provide a historical record of carbon dioxide concentrations, dating back over 200,000 years. $CO_2$ concentrations in shallow ice, only a few decades old, are nearly identical to those measured in the atmosphere, thus supporting the scientific credibility of this method of measurement. The older ice core samples show that carbon dioxide amounts were about 25 percent lower than today's concentrations for the ten thousand years prior to the onset of industrialization and changed very little over that period.

Finally, most of the human activities that produce carbon dioxide are in the northern hemisphere. These $CO_2$ emissions take about a year to circulate through the atmosphere and reach the southern hemisphere. As might be expected, measurements show a slightly higher atmospheric $CO_2$ concentration in the northern hemisphere than in the southern.

*Most carbon dioxide emissions come from natural sources and are absorbed by natural carbon sinks such as forests and oceans, in a finely-balanced cycle. But human-caused carbon emissions have exceeded the capacity of earth's carbon sinks and upset the earth's carbon balance.*

# Part IIB: Context: National and International Policies on Climate Change

*"Those who think we are powerless to do anything about the greenhouse effect forget about the White House effect."*

*U.S. President George H. W. Bush, 1989*

Global climate change was first recognized as a serious problem by the international scientific community at the first World Climate Conference in 1979. In 1988, the World Conference on the Changing Atmosphere called for a 20 percent reduction in $CO_2$ emissions from industrialized countries by the year 2005. The first international agreement on global climate change came into existence in 1992, when the United Nations Framework Convention on Climate Change (UNFCCC, or the Convention) was adopted at the Earth Summit in Rio de Janeiro. The Convention came into force in 1994 with the ratification by 186 parties. The Convention's "ultimate objective" is to stabilize atmospheric concentrations of greenhouse gases at safe levels, which the Convention does not quantify. To this end, the industrialized countries that have historically contributed the most to climate change (called the Annex I Parties), committed to voluntarily reducing their GHG emissions to 1990 levels by the year 2000.

## The Kyoto Protocol

The Convention governments recognized early on that voluntary commitments to reduce GHG emissions would not be adequate to achieve their ultimate objective. At the first session of the Conference of the Parties (COP 1) in Berlin in 1995, the Parties came to a decision known as the Berlin Mandate, which identified the need for stronger commitments for the Annex I countries. In 1997, the first quantitative commitments were adopted in Annex B of the Kyoto Protocol at the Third Conference of the Parties (COP 3) in Kyoto, Japan.

**The Convention's "ultimate objective" is to stabilize atmospheric concentrations of greenhouse gases at safe levels.**

The Kyoto Protocol commits all Annex I Parties, excluding Turkey and Belarus, to legally-binding targets to limit or reduce six main GHGs—carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride ($SF_6$). Table 7 shows the emission targets for these countries, which are called Annex B Parties for the purposes of the Kyoto Protocol. The Protocol set a target of a global average reduction in GHG emissions of five percent from 1990 levels by 2012.

The Kyoto Protocol was originally signed by 84 countries, including the United States. In order to enter into force, the Protocol must now be *ratified* by 55 Parties to the Convention, and by some combination of Annex B Parties that together account for 55 percent of total $CO_2$ emissions in 1990. Subsequent annual Conferences of the Parties (COP 4 through COP 7) finalized agreements on some of the details for implementing the Protocol. COP 6 Part II in July 2001 produced the Bonn

Agreements, which resolved a number of outstanding issues such as financial assistance, technology transfer, and methods for reducing GHG emissions.

The COP 7 meeting in Marrakesh, Morocco in November 2001 centered on the Bonn Agreements. After two weeks of difficult negotiations a set of compromises was reached, and the provisions of the Bonn Agreements were legalized. Led by a unified European Union contingent, the negotiations preserved the delicate consensus around the Kyoto Protocol, and maintained the buy-in of a critical mass of Annex B Parties needed for ratification without the United States. The Kyoto Protocol can now finally be ratified, although the compromises made at COP 7 make it unlikely that the original Kyoto reduction targets will be met.


At this writing, 101 countries have ratified the Protocol, including 30 Annex I countries (such as Canada, Japan, Germany, France, Italy, and the U.K.), which together represent 44 percent of total 1990 $CO_2$ emissions from Annex I countries. The majority of the Annex I countries, including the European Union members, Canada, Japan, and Russia have pledged support for the Protocol,[57] and are in various stages of the ratification process. It is possible to bring the Protocol into effect without U.S. ratification, and the recent accord of Marrakesh opens the way for full ratification of the treaty.

The United States, with 36 percent of the Annex I 1990 $CO_2$ emissions and 24 percent of the world's emissions, is not supporting the Kyoto Protocol. In March 2001, the Bush Administration announced that it had no intention of ratifying the Protocol, and would submit an alternative plan for reducing GHG emissions.

### Kyoto flexibility mechanisms

An important element of the Kyoto Protocol is that Parties to the Convention agreed to three so-called "flexibility mechanisms" by which reductions achieved in one party can be credited to another Annex I party to meet its emission target. These mechanisms are referred to as Joint Implementation (JI, in Art. 6), the Clean Development Mechanism (CDM, in Art. 12) and International Emissions Trading (IET, Art. 17). Both Joint Implementation and International Emissions Trading apply to Annex I parties with emission commitments; reductions achieved by one party beyond its emission objective in 2008–12 could be transferred to another party, using one of these flexibility mechanisms.

The Clean Development Mechanism is also a project-specific regime, under which "certified emission reductions" can be produced by non-Annex-I host countries for purchase by Annex I countries. The governments of both parties to the transaction must agree to it, as they are solely responsible for meeting their emission goals under the Kyoto Protocol.

## Convention parties

The positions of different national groups in the international climate negotiations can be categorized according to industrialized *vs.* developing country positions and in terms of willingness to participate in implementing emission reductions. The basic North-South divide results from the fact that about 70 percent of current global emissions come from industrialized countries, mostly in the northern hemisphere. Industrialized nations are responsible for an even greater share of historic emissions, which have created the present build-up of global atmospheric GHG concentrations.

Because of this disparity in past and present emissions, as well as the impression that rich countries can better afford to limit emissions than poor countries, it is widely agreed that the industrialized countries must shoulder much or all of the responsibility for reducing emissions in the near term. The U.S. position, however, urges some degree of meaningful participation by developing countries in setting and achieving overall emission limits, while other positions would excuse developing countries completely in the short- to medium-term.

There are significant differences within these country groups as well. Among the industrialized countries, the European Union generally endorses the most ambitious emission limits, and several European countries have committed to reduce emissions as much as 21 percent below 1990 levels by 2012. The United States, together with Japan, Canada, Australia, Norway, the Russian Federation, and New Zealand (the so-called *Umbrella Group*) favor more gradual reductions to limit the cost of compliance. The latter group is also the most enthusiastic about the benefits of using "flexibility mechanisms" such as JI, CDM, and emission trading to reduce the cost of achieving emission limits and involving additional participants.

In recent negotiations at COP 7 in Marrakesh, Japan, Canada, Australia, and the Russian Federation extracted major concessions, knowing that without the participation of the United States, their ratification was essential for saving the Kyoto treaty.

Meanwhile, the *Eastern European and former Soviet states* are willing to accept emission limits based on the very high emission rates that existed before their economic transition began, giving them room to grow in the near term. With emissions closely correlating to economic activity, most of these countries are currently well below their Kyoto Annex B levels. The difference, which can potentially be traded under article 17, is often referred to as "hot air" because the emission credits would not represent any intentional reductions. At COP7, the Russian Federation succeeded in securing emission credits for "hot air." Most fuel-exporting countries (including most of the OPEC block, which are also members of the G-77 [see below]) are opposed to any emission limit due to fear of depressing global oil prices.

The developing countries (the so-called *Group of 77* [or G-77] and China) are mostly united around the demand that the industrialized nations take responsibility for reducing emissions. However, there are variations on this position. For example, a group of low-lying and island countries (the so-called *AOSIS block*) favor aggressive reduction targets and early participation by developing countries to limit the rate of climate-induced sea-level rise that threatens their territory and their very existence.

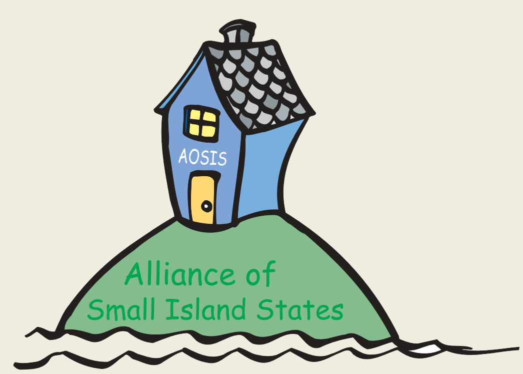


**Table 7: Total $CO_2$ emissions of Annex I Parties in 1990, and Kyoto targets**

| Country | 1990 emissions (million metric tons) | $CO_2$ emissions in 1998 (% 1990) | Original Kyoto target (% of 1990) | Target after EU burden sharing[a] | Target after EU burden sharing[a] (million metric tons $CO_2$ equivalent) |
|---|---|---|---|---|---|
| Australia | 289 | 125% | 108% | 108% | 312 |
| Austria | 59 | 112% | 92% | 87% | 51 |
| Belgium | 113 | 106% | 92% | 92.5% | 105 |
| Bulgaria | 83 | 62% | 92% | 92% | 76 |
| Canada | 457 | 109% | 94% | 94% | 430 |
| Czech Republic | 170 | 56% | 92% | 92% | 156 |
| Denmark | 52 | 107% | 92% | 79% | 41 |
| Estonia | 38 | 69% [b] | 92% | 92% | 35 |
| Finland | 54 | 100% | 92% | 100% | 54 |
| France | 367 | 104% | 92% | 100% | 367 |
| Germany | 1,012 | 123% | 92% | 79% | 799 |
| Greece | 82 | 119% | 92% | 125% | 103 |
| Hungary | 72 | 100% | 94% | 94% | 68 |
| Iceland | 2 | 116% | 110% | 110% | 2 |
| Ireland | 31 | 130% | 92% | 113% | 35 |
| Italy | 429 | 104% | 92% | 93.5% | 401 |
| Japan | 1,173 | 107% | 94% | 94% | 1,103 |
| Latvia | 23 | 62% [b] | 92% | 92% | 21 |
| Luxembourg | 11 | 83% | 92% | 72% | 8 |
| Netherlands | 168 | 112% | 92% | 94% | 158 |
| New Zealand | 26 | 126% | 100% | 100% | 26 |
| Norway | 36 | 119% | 101% | 101% | 36 |
| Poland | 415 | 93% | 94% | 94% | 390 |
| Portugal | 42 | 127% | 94% | 127% | 53 |
| Romania | 171 | 60% | 92% | 92% | 157 |
| Russian Federation | 2,389 | 72% [b] | 100% | 100% | 2,389 |
| Slovakia | 58 | 88% [b] | 92% | 92% | 53 |
| Spain | 261 | 120% | 92% | 115% | 300 |
| Sweden | 61 | 107% | 92% | 104% | 63 |
| Switzerland | 44 | 101% | 92% | 92% | 40 |
| United Kingdom | 584 | 96% | 92% | 87.5% | 511 |
| United States | 4,957 | 113% | 93% | 93% | 4,610 |
| **Total** | **13,728** | **102%** | **94%** | **94%** | **12,956** |

[a] EU burden sharing is an adjustment of the individual emission targets of the 15 members of the European Union to meet an overall EU target of an eight percent reduction from 1990 levels. Under burden sharing, some EU members are allowed to increase emissions, while others must reduce emissions well below the original eight percent target.

[b] These emissions are a percent of emissions in 1992, the earliest year for which data are available, instead of 1990. Nineteen ninety-eight emission data are from the Carbon Dioxide Information Analysis Center: cdiac.esd.ornl.gov

## U.S. climate change policy

In February 2002, the Bush Administration released its climate change plan as an alternative to Kyoto. The plan proposes to slow the rate of growth of GHG emissions relative to the growth of the overall economy (measured in gross domestic product, or GDP). This ratio of emissions to GDP, called "greenhouse gas intensity" is targeted for an 18 percent reduction by 2012 under the Bush plan, and would be achieved entirely through voluntary measures.

However, the proposed 18 percent reduction in GHG *intensity* will allow *total* U.S. emissions to grow by 12 percent by 2012. Under this plan, emissions in 2012 would be 30 percent above 1990 levels, the base year used for the Kyoto Protocol, which calls for a seven percent reduction in U.S. GHG emissions by 2012. Moreover, the proposed reduction in GHG-intensity only continues the same trend of GHG-intensity reductions and GHG emissions increases experienced over the last two decades.[58]

## State participants

A great many U.S. cities and states are acting to reduce their climate impacts. As of early 2002, 20 states had completed Climate Action Plans for reducing their GHG emissions, and six more are in progress.[59]

California, Massachusetts and Oregon have led the way with comprehensive, far-reaching plans to reduce energy use and encourage the growth of renewable energy sources.[60] California's plan focuses on commercial energy efficiency, renewable electricity generation, and alternative vehicles. The state has enacted legislation that commits it to supporting private and public emission reductions that generate credits for future federal or international GHG standards. In addition, the State's Renewable Resource Trust provides rebates for new and existing renewable energy technologies. California is aggressively pursing transportation programs such as low- and zero-emission autos, trip reduction ordinances, and increases in public transportation.

A bill to limit automotive $CO_2$ emissions, which amounts to a fuel economy standard, has been passed by the California legislature and signed into law by the governor. In Massachusetts, a regulation to limit $CO_2$ emissions from power plants went into effect in 1999. Compliance can be achieved by obtaining emission credits from other sources.

Oregon's Climate Action Plan aims for the goal of stabilizing Oregon's $CO_2$ emissions at 1990 levels, a mandate put forth by an independent state planning and oversight body, the Oregon Progress Board. Oregon's strategy relies on demand-side management and renewable energy goals, which are set out in electric utilities' integrated resource plans (IRPs). The State of Oregon now requires new power plants to meet a $CO_2$ emission standard to receive a site certificate. This standard is so stringent that, to comply, developers of combined-cycle power stations still need to offset some of their emissions.


**As of early 2002, 20 states had completed Climate Action Plans.**

***Seattle's municipal electric utility has committed to becoming the first major utility in the country to achieve zero net GHG emissions.***

Offsets can be obtained by direct investment, by purchases on the open market, or by funding the Oregon Climate Trust (OCT), which serves as the standard's monetary compliance path.[61] The OCT uses the money to contract for carbon offsets from projects that directly avoid, displace, or sequester $CO_2$. Recently, the Seattle City Council approved a resolution requiring that its municipal electric utility, Seattle City Light, fully mitigate the GHGs from its purchase of power from a new combustion turbine plant in Oregon. Seattle City Light is partnering with OCT to buy carbon offsets, although Seattle will consider offsets involving any GHG.

*Coal-fired power-generation plants are a major source of atmospheric carbon dioxide. Converting a coal plant to natural gas halves the carbon intensity of each kilowatt-hour of electricity generated and reduces or eliminates other pollutants.*

## Local participants

U.S. cities are becoming increasingly involved in activities to reduce GHG emissions. The Cities for Climate Protection (CCP) was established in 1993 by the International Council for Local Environmental Initiatives (ICLEI), and currently has 507 member governments across the world. Members of the CCP pledge to develop a local action plan to reduce local emissions of pollutants, with an emphasis on $CO_2$ emissions.[62] The City of Portland, Oregon, one of the original Urban $CO_2$ Reduction Project cities, adopted their CCP local action plan in 1993 with a goal of reducing $CO_2$ emissions 20 percent below 1988 levels. Through implementation of the plan, as of 1997 Portland's per capita GHG emissions were three percent below 1990 baseline levels, transit ridership increased by 30 percent, auto commutes to the central business district were cut by 15 percent, and solid waste disposal per household was reduced 13 percent. These accomplishments were achieved during a time of both strong economic and population growth. In April 2001, Portland adopted a Local Action Plan on Global Warming with a goal of reducing GHG emissions by ten percent below 1990 levels by 2010, slightly more aggressive than the original U.S. Kyoto Protocol target.

Seattle thinks it can do even better, up to a 40 percent reduction in emissions by 2012. And as noted above, Seattle's municipal electric utility, Seattle City Light, has committed to becoming the first major utility in the country to achieve zero net GHG emissions.

### Business sector participants

The Global Climate Coalition (GCC), a trade association formed in 1989 and including many large automobile manufacturers and coal and oil producers, was the business community's first concerted effort to address climate issues. Throughout the 1990s, the now-disbanded GCC proved to be one of the most outspoken groups questioning the science of climate change, and lobbied aggressively at climate negotiation meetings. In 1997, amid growing scientific and public consensus regarding global warming, BP Amoco withdrew from the GCC, stating, "The time to consider the policy dimensions of climate change is not when the link between GHGs and climate change is conclusively proven, but when the possibility cannot be discounted and is taken seriously by the society of which we are a part. We in BP have reached that point."[63] Other companies, including American Electric Power, Dow, Dupont, Royal Dutch Shell, Ford, Daimler Chrysler, Southern Company, Texaco, and General Motors followed suit, and in 2002 the GCC was formally deactivated.

Some of the former GCC members are now part of the more moderate International Climate Change Partnership (ICCP), which includes Boeing, BP, Dow, DuPont, Kodak, General Electric, and General Motors. In contrast to the GCC, the ICCP accepts the science of climate change and its potential impacts, and supports policymakers' efforts to "slow the rate of growth of greenhouse gas emissions."

Other business alliances, such as the Business Environmental Leadership Council (BELC) of the Pew Center on Global Climate Change, are described in Part 1A of this document. These groups are working to develop emission or energy reductions targets, stimulate innovation and improvements in the bottom line, and demonstrate a proactive stance to government regulators.

***"The time to consider the policy dimensions of climate change is not when the link between GHGs and climate change is conclusively proven..."***

***—BP Amoco***

[1] Pew Center on Climate Change, "Corporate Greenhouse Gas Reduction Targets," November 2001, www.pewcenter.org.

[2] Porter, M.E., and C. van der Linde, "Green and Competitive: Ending the Stalemate," *Harvard Business Review*, September–October 1995.

[3] Browne, J., British Petroleum, "Beyond Petroleum: Business and the Environment in the 21st Century,"speech at Stanford University, 11 March 2002, www.bp.com/centres/press/stanford/media_resources/speeches/index.asp.

[4] See www.pewclimate.org/belc/ch2m.cfm.

[5] See www.carbonneutral.com.

[6] Moody-Stuart, M., Shell International, "Energy for Sustainable Development," Conference on Health, Safety and the Environment in Oil and Gas Exploration and Development, Kuala Lumpur, 20 March 2002.

[7] Pew Center on Climate Change, "Corporate Greenhouse Gas Reduction Targets," November 2001, www.pewcenter.org.

[8] Romm, J.J., and W.D. Browning, 1998. "Greening the Building and the Bottom Line," Rocky Mountain Institute, www.rmi.org/sitepages/pid174.php.

[9] Porter, M.E., and C. van der Linde, "Green and Competitive: Ending the Stalemate," *Harvard Business Review*, September–October 1995.

[10] Pew Center on Climate Change, "Corporate Greenhouse Gas Reduction Targets," November 2001, www.pewcenter.org.

[11] See www.ghgprotocol.org.

[12] From Swisher, J., 1997. "Joint Implementation under the U.N. Framework Convention on Climate Change: Technical and Institutional Challenges," *Mitigation and Adaptation Strategies for Global Change*, vol. 2, pp. 57–80.

[13] U.S. Department of Energy (DoE), 1997. "International Performance Measurement and Verification Protocol," DoE Efficiency and Renewable Energy Network, Washington, DC.

[14] Swisher, J., and K. Wang, 1997. *Office Complexes Guidebook*, EPRI/TR-109450, Palo Alto CA: Electric Power Research Institute.

[15] STMicroelectronics Corporate Environmental Report, 1999.

[16] See www.climatetrust.org.

[17] Natsource, 2001. "Review and Analysis of the Emerging International Greenhouse Gas Market," prepared for the World Bank Prototype Carbon Fund.

[18] Lovins, A., 1998, *Negawatts for Fabs. Advanced Energy Productivity for Fun and Profit*, www.rmi.org/images/other/E-NegawattsForFabs.pdf.

[19] Browne, J., British Petroleum, "Beyond Petroleum: Business and the Environment in the 21st Century,"speech at Stanford University, 11 March 2002, www.bp.com/centres/press/stanford/media_resources/speeches/index.asp.

[20] See www.eia.doe.gov/oiaf/1605/frntvrgg.html.

[21] Swisher, J., 2000. "The Role of Carbon Performance Contracting in Climate Change Mitigation," *Proceedings, ACEEE Summer Study on Energy Efficiency in Buildings*, Monterey CA.

[22] Pew Center on Climate Change, "The Emerging International Greenhouse Gas Market," March 2002, www.pewcenter.org

[23] For example, coal-fired and inefficient oil-fired generation might sell into a ("brown") power market with a carbon content of 200 mtC/GWh; while natural gas-fired combined cycle generation would sell into a ("grey") power market with a carbon content of 100 mtC/GWh; and hydro, solar, wind and biomass-fired generation would sell into a ("green") power market with practically zero carbon content.

[24] Natsource, 2001. "Review and Analysis of the Emerging International Greenhouse Gas Market," prepared for the World Bank Prototype Carbon Fund.

[25] Hawken, P., Lovins, A., and Lovins, H., 1999. *Natural Capitalism: Creating The Next Industrial Revolution*. Little, Brown and Co., Boston. The four principles are 1) radically increased resource productivity, 2) biomimicry: design following nature, 3) shifting from production of goods to delivery of services, and 4) reinvesting in natural capital.

[26] See www.resource-solutions.org/CRSprograms/T-RECS.

[27] See www.greentagsusa.org/GreenTags.

[28] Audin, L. *et al.*, *ESOURCE Lighting Technology Atlas,* 1997.

[29] Each unit of energy used by lighting and other equipment becomes a unit of cooling load that must be removed by the air-conditioning system. Thus, a reduction in lighting and other equipment loads also reduces the cooling load. For example, if 80% of the lighting load can be eliminated, about one-quarter as much energy can be saved in air-conditioning. The total savings (80% + 20%) can amount to 100% of the original lighting load, even though lighting still demands energy.

[30] Von Weizsäcker, E., Lovins, A., and Lovins, H., *Factor Four*, Earthscan Publications Ltd., London, pps. 27–29.

[31] Howe, B. *et al.*, *ESOURCE Drivepower Technology Atlas*, 1999.

[32] The energy required to move a fluid through a round pipe is inversely proportional to approximately the *fifth power* of the pipe diameter. Thus, increasing pipe diameter by 15% reduces friction loss and energy use by 50%, and doubling the diameter reduces friction loss and energy use by 97%. In addition, reducing pipe length and removing or softening curves saves both energy and equipment costs.

[33] MotorMaster+ helps the user to adopt motor specifications and design purchase policies, to identify and replace problem motors, to design cost-effective "repair versus replace" practices, to appropriately deal with oversized and under loaded motors, and to know when to replace an operable motor immediately. See www.oit.doe.gov/bestpractices/motors.

[34] See Swisher, J., 2001. *Cleaner Energy, Greener Profits: Fuel Cells as Cost-Effective Distributed Generation Sources,* Rocky Mountain Institute, www.rmi.org/sitepages/pid171.php.

[35] See www.carbonneutral.com.

[36] See www.climateneutral.com.

[37] See Lovins, A. *et al.*, 2002, *Small Is Profitable,* Rocky Mountain Institute, 2002. www.smallisprofitable.org

[38] This standard, IEEE SCC 21 P1547, will include requirements for the performance, operation, testing, safety, and maintenance of DG interconnections.

[39] Senge, P. *et al.*, *The Fifth Discipline: The Art and Practice of the Learning Organization,* New York: Doubleday, 1990.

[40] Senge, P. *et al.*, *Fifth Discipline Fieldbook,* New York: Doubleday, 1994.

[41] Porter, M.E., and C. van der Linde, "Green and Competitive: Ending the Stalemate," *Harvard Business Review,* September–October 1995.

[42] Moody-Stuart, M., Shell International, "Energy for Sustainable Development," Conference on Health, Safety and the Environment in Oil and Gas Exploration and Development, Kuala Lumpur , 20 March 2002.

[43] Lindsey, T.C., 1999. ADOP2T model citation: "Accelerated Diffusion of Pollution Prevention Technologies (ADOP2T)™" Pollution Prevention, Spring.

[44] Grundy, R. and W., 2001: "Diffusion of Innovation: Solar Oven Use in Lesotho," College of DuPage, Glen Ellyn, IL 60137, www.cs.columbi.edu/~bgrundy/papers/sbci.html.

[45] National Assessment Synthesis Team. 2001. *Climate Change Impacts on the United States*. Report for the United States Global Change Research Program. Cambridge Univ. Press, www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewclimate.htm.

[46] Personal communication with David Hawkins of the Natural Resources Defense Council, 2 April 2002.

[47] From the World Meteorological Program Commonly Asked Questions about Climate Change, www.gcrio.org/ipcc/qa/05.html.

[48] Intergovernmental Panel on Climate Change Working Group 1, 2001. *Third Assessment Report Summary for Policymakers.* www.ipcc.ch.

[49] *Ibid.*

[50] *Ibid.*

[51] National Research Council, *Committee on the Science of Climate Change, Division on Earth and Life Studies. Climate Change Science: An Analysis of Some Key Questions*, National Academy Press, 2001, www.nap.edu.

[52] See, for example, Broecker, W.S., "Thermohaline Circulation, the Achilles Heel of Our Climate System: Will Man-made $CO_2$ Upset the Current Balance?" *Science*, 278, 1582–1588, 28 November 1997.

[53] Intergovernmental Panel on Climate Change Working Group 1, 2001. *Third Assessment Report Summary for Policymakers.* www.ipcc.ch.

[54] National Assessment Synthesis Team. 2001. *Climate Change Impacts on the United States.* Report for the United States Global Change Research Program, Cambridge Univ. Press, www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewclimate.htm.

[55] *Ibid.*

[56] Adapted from the World Meteorological Program Commonly Asked Questions about Climate Change, www.gcrio.org/ipcc/qa/05.html.

[57] See www.climnet.org/EUenergy/ratification.htm.

[58] *Analysis of President Bush's February 14th Climate Policy*, Pew Center on Global Climate Change, Change Plan. www.pewclimate.org/policy/response_bushpolicy.cfm

[59] See yosemite.epa.gov/globalwarming/ghg.nsf/actions/state. Also, the Pew Center for Global Climate Change also lists State and Local Net Greenhouse Gas Emissions Reduction Programs at www.pewclimate.org/states/index.cfm.

[60] *PCFplus Market Intelligence Report Appendix I*, October 2001, prepared by EcoSecurities.

[61] See www.climatetrust.org.

[62] See www.iclei.org/co2/index.htm.

[63] Browne, J., British Petroleum, "Climate Change: The Steps BP is Taking," speech at Stanford University, 19 May 1997.

## BP Amoco: Meeting and Beating Self-imposed Emission Limits at Negative Net Cost

**BP's Objectives:**

On 1 January, 2000, BP Amoco initiated the first corporate greenhouse gas (GHG) trading system in the world with the stated goal of reducing internal greenhouse emissions by ten percent below 1990 levels by 2010.[1] In the face of the Kyoto protocol and rising public concern about corporate contributions to social and environmental problems, Sir John Browne, CEO of BP Amoco, announced that "that target will now sit alongside our financial targets" as a commitment that must be met.[2] With this commitment, BP Amoco has taken a leading role in developing corporate responses to social and environmental concern and has seized an opportunity to improve its own business through innovation, experimentation, and improved efficiencies.

Ostensibly, this is a program aimed at reducing the amount of $CO_2$ and other GHGs the company emits into the atmosphere. This is a good and noble aim, but not one that is clearly in the best financial interest of the company. The hidden message is that the company is striving to engage its employees in business development and to learn from the experience to better compete in the market. Furthermore, it can get a head start on compliance with potential regulations resulting from ratification of the Kyoto Protocol.

The enactment of Kyoto would undoubtedly increase regulation of many of BP's business streams and alter the markets for BP products. This preemptive action seeks to minimize the risk associated with the changing regulatory environment and to prove that there is potential for business and government to work together to address climate change without damaging economic strength.

**BP's Strategic Thinking:**

The global energy and petrochemical markets are in transition. The emergence of new technologies and increasing concern about the links between energy and the environment are threatening the traditional business plans of energy suppliers. Questions are being raised concerning the role of corporations in society.

BP is responding to the market by diversifying its energy interests into new sectors such as the hydrogen economy and solar power, and seeking out efficiencies within its operations. And it has adopted a precautionary approach to environmental issues, seeking early, proactive involvement, rather than grudging consent to regulation. This proactive involvement has allowed BP the time and flexibility to prove it can work with public interests while improving its business.

BP chose to consider GHG emissions as an indicator of opportunities for improvement rather than waste to be disposed of. In the longer term, emissions are a risk, as they expose the company to public relations problems and governmental regulation. Limiting and trading GHG emissions and reducing them as if Kyoto were enacted maximizes those opportunities and seeks to minimize that risk, while building institutional experience with nascent GHG markets and emerging efficiency tools.

[1] BP Amoco statement on Climate Change and proposed trading system. See www.bp.com/environ_social/environment/climate_change/index.asp.

[2] Sir John Browne speech to Yale University School of Management, September 18, 1998.

**BP's Implementation Plan**:

The chosen method for achieving the emission reductions is the simple, economically sound system of tradable permits. BP is divided into 127 individual business units (BU) throughout the world, ranging from exploration to retail sales.[3] Prior to the program's launch, each BU was allocated a certain emission limit based on 1998 emission data, the most current and complete available, and given a preliminary indication of expected annual allocations through 2005. The sum of all the emission limits, called a Group Cap, equaled BP's total GHG footprint in 1998. The Group Cap will be lowered annually, based on expectations for the coming year and necessary progress toward the target, and each BU's limit will be reallocated accordingly.

The key to this system is the ability of each BU to trade emissions with each other—or more precisely the ability to emit. Emission allowances are bought and sold through an internal website that tracks the account of each BU. This system allows for the most economically efficient allocation of emissions as those BUs with low abatement costs trade with those with high abatement costs. As opportunities arise for reduction, each BU has the incentive to pursue those emission reducing measures that cost it less than the current price for emission credits offered by other BUs. Once a BU has achieved those reductions it is free to sell emissions, equal to the difference between its allocated limit and its actual emissions, to the highest bidding BU.

**BP's Successes**:

On 11 March, 2002, Browne announced that BP had already surpassed its ten percent reduction target and is refocusing on maintaining that emission level through 2012 while increasing oil and gas production by 5.5 percent per year.[4] Furthermore, the measures already taken will save the company $650 million over the next ten years by using less energy to produce its products and reducing gas flaring and venting.[5] The rapid success of the program confirms the efficiency of the cap-and-trade system and the vast efficiency opportunities available to companies.

The rapid achievement of BP's goal was the result of hundreds of initiatives taken throughout the company rather than one universal solution. Each BU was allowed to create its own mixture of technology and efficiency to meet emission targets. This allowed grassroots ideas to flourish and individuals to initiate programs based on their local knowledge and hands-on experience with the systems they were seeking to improve. The solutions ranged from reducing waste to reducing the energy demands of a process to reducing the carbon intensities of fuels themselves:

- The Texas City Refinery saved $5 million through energy demand management measures, producing 300,000 fewer tons of $CO_2$ equivalent per year.[6]
- Implementation of a new, combined cycle cogeneration heat and power plant in Hull, UK, is saving 150,000 tons of $CO_2$ equivalent and reducing the site's energy costs.[7]
- A range of measures throughout BP's natural gas system in Canada, such as the installation of eight air/fuel ratio controllers on large compressor engines, is reducing emissions by 50,000 tons per year.[8]
- Trinidad offshore oil production facilities reduced gas-flaring rates to achieve reductions of nearly 141,000 tons of $CO_2$ equivalent per year.[9]

3 BP Amoco, KPMG, DNV, and ICF Consulting. "Development and Implementation of a Process to Audit BP Amoco's Greenhouse Gas Emissions: Audit Overview" February 2000. See www.bp.com/environ_social/environment.

4 Sir John Browne speech to Stanford University Graduate School of Business. "Beyond Petroleum: Business and the Environment in the 21st Century" March 11, 2002.

5 *Ibid.*

6 BP Amoco and Ernst & Young. *North America Case Studies: Cleaner Refineries.* See www.bp.com/environ_social/case_studies/index.asp

7 Sir John Browne speech to Stanford University Graduate School of Business. "Beyond Petroleum: Business and the Environment in the 21st Century" 11 March 2002.


- The London bus system has recently adopted BP's new combination of fuels and lubricants, which reduces visible smoke by 65 percent, particulates by 25 percent and $NO_x$ by 13 percent. When applied to the fleet of London buses, this will cut $CO_2$ emissions by 66,000 tons per year.[10]
- Continued development of BP's solar energy business, which will grow by 40 percent this year and which already holds a 17 percent world market share.[11]

These successes point to the massive gains in efficiency and environmental performance that are possible with the right combination of effort and technology. BP created a framework that specifically allowed employees to directly improve the company and rewarded units that acted on opportunities as they presented themselves. The largest success of the program may be reaching the goal in such a dramatically short period of time and at a net saving. These are the most powerful arguments for further pursuit of emission reductions in and beyond the energy services sector. The rapid success reveals that these are not complex issues that require large amounts of effort to master, nor do they require retraining or replacing large parts of the workforce. Instead, this experiment with simple, flexible mechanisms improved the company and the environment using existing business resources.

**BP's Lessons Learned**:

BP set up a nascent global emission trading system that had not existed before. From that process BP learned how to turn what had formerly been considered waste into an opportunity for new knowledge and profit. It can now measure emissions more precisely, inventory emissions more completely, and track reductions more easily than competing companies. BP's employees now understand how to trade GHGs and apply the right resources in the right places to reduce the costs involved. This engagement increased the institutional knowledge of the company, allowing it to become more competitive.

BP also learned that it is possible to produce more while using less energy and saving money. Efficiency improvements continue to refute the assumption that production requires a certain amount of waste. By addressing that waste directly rather than permitting it to occur by default, the new program revealed the true opportunity cost of waste.

Finally, BP gained insight into the social responsibility of corporations. By transparently and proactively addressing a problem it was helping create, it built new bridges between business, government, and science, paving the way for competitive technological and political advantages in the future. By bearing some corporate responsibility, it succeeded in raising its own financial outlook and the opinions of those who look upon it.

8 BP Amoco and Ernst & Young. *North America Case Studies: Energy Efficient Canadian Gas Production.* See www.bp.com/environ_social/case_studies/index.asp.

9 BP Amoco and Ernst & Young. *Latin America Case Studies: Trinidad Offshore Gas Flaring.* See www.bp.com/environ_social/case_studies/index.asp.

10 BP Amoco and Ernst & Young. *European Case Studies: London Bus Efficiency.* See www.bp.com/environ_social/case_studies/index.asp.

11 Sir John Browne speech to Stanford University Graduate School of Business, "Beyond Petroleum: Business and the Environment in the 21st Century" 11 March 2002.

## Dow Chemical: Cutting Waste from the Shop Floor Up

**Dow's Objectives**:

Dow Chemical was an early entrant into the field of internal waste reduction. In 1981, Dow's 2,400 employee Louisiana Division launched an official contest to find efficiency opportunities within their business streams.[12] Entering was open to everyone, from shop floor workers through upper executives. The minimum requirements were a return on investment of at least 50 percent in one year and that the initial cost be less than $200,000.[13] The explicit goal was to restore the technological innovation that fueled Dow's rise to prominence through the 1960s and 1970s and to increase shareholder value. The first competition yielded 27 projects at a total cost of $1.7 million, which averaged a 173 percent return on investment.[14]

Since then the program has been expanded throughout the company and is the prime example of Dow concurrently creating value and reducing environmental impact. The current goal is to repeat the 20 percent energy efficiency gains—defined as Btu per pound of product, and realized between 1990 and 1994—again between 1995 and 2005.[15] Dow intends to invest $1 billion over the 10-year period and expects a 30–40 percent return on investment.[16] Dow is expecting increased cogeneration capacity to provide most of the efficiency gains, and therefore increased value and profits, in the near future.

Though Dow has not specifically associated its efficiency gains with a goal of reduced climate impact, it maintains that climate change is a source of concern. Primarily, Dow views climate change as an impediment to the integration of economic, environmental, and social concerns that it considers as sustainable development.[17] It has not set an explicit, quantitative climate change mitigation goal.

**Dow's Strategic Thinking**:

The "Waste Reduction Always Pays" or WRAP Initiative in Louisiana was based on the assumption that by harvesting the collective knowledge of the employees, opportunities would be discovered that a top-down survey might miss. Dow expected that those with hands-on experience with its chemical production and processing would know specifically what could be improved. Work on one project would lead to better understanding of the systems at work in a specific production line, throughout a plant or within the entire company. This understanding revealed more inefficiency, creating self-sustaining progress toward increased productivity.

Dow's priorities for the expansion of WRAP were, in order of importance:[18]

- *"Enhancing current operations and profitability"* while continuously improving material and energy use efficiency.
- *"Expansion and growth"* which requires a new efficiency mindset; delivering products and services to meet increasing demand without more emissions using life cycle considerations.
- *"Innovation-intensive projects"* to transform industries and make significant contributions to stabilizing GHG concentrations in the atmosphere through new materials, processes, technologies, and approaches.

12 Von Weizsäcker, E., Lovins, A., and Lovins, L. *Factor Four: Doubling Wealth, Halving Resource Use.* Earthscan Publishers, London. 1997, p. 65.

13 *Ibid.*

14 *Ibid.*

15 Dow Chemical Company. "Dow Public Report—2000 Results: Environmental Goals." An interim public report on Dow's pursuit of sustainable growth. 2000. See www.dow.com/about/pbreports/00results/index.htm.

16 Smolik, Samuel. "Environment, Health & Safety Performance Improvement at Dow." Speech to National Goals Roundtable, College Station, Texas. August 1, 2001.

17 Dow Chemical Company. "Dow Public Report—2000 Results: Environmental Goals." An interim public report on Dow's pursuit of sustainable growth, 2000. See www.dow.com/about/pbreports/00results/index.htm.

18 Russell, R. "Challenging Leadership Issues for A Multinational Corporation." Speech to Pew Center on Global Climate Change Conference on "Innovative Policy Solutions to Global Climate Change" panel on "Cross-Cutting Issues: Competitiveness and Trade Harmonization" 26 April 2000. Washington, DC.

This program was not specifically aimed at Dow's GHG emissions or climate impacts, though the resulting reductions are pleasant by-products. It was intended to cut costs and create shareholder value. Thus, it serves the dual function of improving company finances and its public image. An ethos of efficiency, in Dow's case, was proposed and pursued purely for financial reasons, rather than being spurred by environmental regulation or social pressure and then discovering the economic opportunities.

**Dow's Implementation Plans:**

The WRAP initiative grew from the Louisiana Division's early success in 1981.[19] The competition was open to any employee and the most promising entries pursued on a local basis. The winning ideas were given funding and the flexibility to achieve their goals within the corporate structure. As the benefits became clearer, the program became a priority for the entire corporation and coordination responsibilities were assigned to managers in all of Dow's divisions. This responsibility required some training but the learning curve was gentle as the responsibility for specific ideas was distributed among all employees.

In 1990, Dow set a specific energy-efficiency improvement goal of 20 percent, to be met by 1994. That challenge was repeated in 1995 for the next decade. Ideas continued to be solicited from all levels of the workforce. By setting ongoing progress goals, efficiency had become institutionalized as a proven path to increased productivity.

[19] Von Weizsäcker *et al.*, 1997, p. 65.

[20] Hawken, P., Lovins, A., and Lovins, L. *Natural Capitalism: Creating The Next Industrial Revolution.* Little, Brown & Co. 2000, p. 245.

[21] *Ibid.*

[22] Russell, 2000.

[23] *Ibid.*

[24] *Ibid.*

**Dow's Successes:**

Dow required early efficiency projects to return 50 percent of invested capital in the first year and fit within an initial outlay cap. Those requirements were easily met by the 27 projects adopted in the first year, 1981, returning 173 percent on the $1.7 million invested. In 1982, 32 projects were accepted at a cost of $2.2 million and realized a 340 percent average return. Between 1983 and 1993, the 900 projects accepted returned an average of 204 percent per year.[20] By 1996, payback periods had dropped from six months to four months and "engineers were learning faster than they were exhausting the cheapest opportunities" already under consideration.[21] The faster Dow learns, the faster its GHG emissions will decline. This is a classic example of what RMI calls "tunneling through the cost barrier."

Dow continues to explore cogeneration technology, or combined heat and power (CHP), as a primary source of efficiency gains. It offers the potential for energy and monetary savings along with reduced carbon dioxide emissions. An ex-East German chemical complex known as BSL and recently purchased by Dow was retrofitted with CHP technology resulting in significant reductions in carbon emissions. In the United States[22] Dow recently received a DOE/EPA sponsored Energy Star award for combined heat and power for its Texas Energy facility.[23] That project uses over ten percent less fuel than state-of-the-art separate power and heat generation systems.

Dow also reduced GHG impacts by switching to blowing agents with lower global warming potential (GWP) in Styrofoam brand insulation operations.[24] In Europe, Dow can now produce insulation foam from recaptured and reused $CO_2$, further reducing emissions.

The 1990 efficiency goals for energy per product ensured that Dow would maintain the momentum to achieve these results. The goal was met, and sufficient opportunities remained so that the goal was renewed in 1995. Dow is currently improving energy efficiency rapidly enough to meet that goal early.

Financially, each return equated to increased shareholder value. In 1993, it was estimated that efficiency measures were paying Dow shareholders $110 million per year, about 15 percent of the annual dividend payment at the time, and this figure has surely increased since then.[25] These gains fuel the continued effort, but they are difficult to translate into gains in mitigating Dow's climate impacts. Because the effort has been primarily targeted at economic gains, there has not been an accompanying effort to improve the transparency of the emission impacts of WRAP and related programs. There have undoubtedly been large gains, as evidenced above, but further documentation is lacking, impeding the widespread adoption of similar programs throughout the industry. Dow can do more to address the risks to its business and society posed by climate change by creating an environmental audit, establishing an emission baseline, and setting specific emission reduction goals. It is reasonable to predict that further economic gains can be realized from such an effort.

**Dow's Lessons Learned**:

Dow proved that improvements in productivity and shareholder value are often rooted in improvements in efficiency. Dow has improved its business model by engaging all levels of its workforce in improving efficiency and turning all its employees into efficiency detectors. The result was a network of communication and interaction that addressed problems to which a more hierarchical system would have been blind.

Dow proactively improved the efficiency of its manufacturing and production systems. In making those improvements, it discovered that financial value can be created in concert with environmental progress. Environmental improvements can provide positive economic externalities, and vice verse, if measures are pursued in concert and developed intelligently. This is a step toward dissolving the impasse between business and environmental interests that has dominated policy discussions since environmental regulations were first put in place. Dow now needs to expand its procedures to address climate impacts specifically in order to maintain the expansion of its efficiency programs and the resulting economic benefits.

[25] Hawken *et al.* 1999.

## Herman Miller's Pursuit of Sustainability

**Herman Miller's Objectives:**
Furniture maker Herman Miller's stated goal is to "become a sustainable business."[26] While refraining from explicit climate-related goals, the company is reducing climate impacts through a portfolio of programs that set a specific path toward improved environmental performance. Importantly, it understands that there is no immediate solution available to the company's environmental impacts. Instead, the company is taking a long-term, life cycle approach to improving its environmental performance and reducing its climate impacts.

Herman Miller has set specific resource efficiency goals as steps on its path to sustainability. The company has adopted short- and long-term tactics and programs aimed at producing sustained, reinforcing improvements. The quantitative goals for 2002, based on a set level of sales, are:[27]

- *Energy Conservation*—A three percent reduction in energy use per $1,000 of sales.
- *Product Design*—Complete a Life Cycle Analysis on 100 percent of all new products.
- *Hazardous Waste Emission Reduction*—A ten percent reduction in waste per $1,000 of sales. This would remove 35,000 gallons of waste from the environment.
- *Transportation*—A five percent reduction in fuel used per $1,000 of sales, offsetting the cost and emissions of eight typical delivery trucks for one year.
- *Solid Waste Reduction*—An eight percent reduction in waste per $1,000 of sales. This would eliminate 240,000 cubic feet of solid waste.
- *Green Buildings*—Incorporate sustainable construction practices in new and existing buildings relative to the U.S. Green Building Council's LEED program standards.
- *Air Emission Reduction*—A three percent reduction in emissions per $1,000 of sales. This would eliminate the equivalent of volatile organic compound emissions in 33,000 cans of spray paint.

While none of these directly reduce climate impacts, they do address the issue of energy use and efficiency, and this sets the stage for direct adoption of climate goals. These plans are all framed by the institutional belief that understanding of the life cycle impacts and performance of each product produced is necessary to improving that product.

**Herman Miller's Strategic Thinking:**
Since the construction of Herman Miller's Energy Center in Michigan in the late 1970s, the company has successfully integrated resource efficiency strategies to reduce operating costs and recycle materials.[28] Combining engineering and business expertise to improve environmental performance is, as Herman Miller's CEO Michael Volkema puts it, "Simply the right thing to do."[29] The company's original theory was that an integrated production system would make financial sense by reducing costs that would repay the larger initial investments in the long run. The Energy Center, which uses waste from Herman Miller facilities in the region to heat, cool, and power surrounding production centers, institutionalized the notion of optimizing production systems to minimize inputs in the collective minds of the company's designers, engineers, and managers. Environmental performance improved as costs dropped, investments were rapidly repaid, and the innovative approach was applied to more of the company.[30]

By using waste from one unit to power and supply others, Herman Miller discovered the dual benefits of integrated

[26] Herman Miller. "About Us: Journey to Sustainability." 2002. www.hermanmiller.com/CDA/category/aboutus/0,1243,c29,00.html

[27] Herman Miller. "Journey to Sustainability: Goals and Tactics for 1999 to 2001." 2001. www.hermanmiller.com/CDA/category/aboutus/0,1243,c32,00.html

[28] Herman Miller. "Journey to Sustainability: Green Buildings" 2001. www.hermanmiller.com/CDA/category/aboutus/0,1243,c38,00.html

[29] Volkema, M., CEO, Herman Miller. "Introduction to Sustainability." 2001. www.hermanmiller.com/CDA/category/aboutus/0,1243,c30,00.html

[30] *Ibid.*

systems design. First, it reveals opportunities to reduce production costs, ranging from raw materials to energy inputs to shipping and packaging to reducing raw material cost by recycling used products. Second, reducing raw material inputs, energy consumption and hazardous material production lowers the company's environmental footprint, locally and globally, adding environmental value to the company and its products.

As this approach has been fine-tuned, the company has continued to reduce costs and environmental impacts. Gains on one side encourage further progress on the other. The company has discovered that manufacturing improvements provide marketing opportunities and a more productive workforce. Herman Miller does not plan to give up these financially and environmentally friendly strategies.

**Herman Miller's Implementation Plans:**
Herman Miller has laid out specific goals for improvement in various environmental performance parameters, ranging from energy use to education on eco-friendly technologies.[31] To reach those goals, environmental impacts throughout the company will be addressed. The first targets for improvement are projects under development. These are the most flexible and therefore most easily improved to meet new design criteria such as lower raw material consumption or better durability. The longer products are used, the less often replacements are needed, so longevity equates to better environmental performance and increased value to the consumer. Furthermore, maintaining quality standards, while incorporating environmentally friendly materials and manufacturing processes, is easiest for products still on the drawing board. Herman Miller has incorporated environmental criteria to the construction of its Zeeland headquarters site by paying attention to the environmental aspects of its facilities, such as the placement and quality of windows, and the landscaping and building materials. New technologies supplement these criteria, such as energy efficiency systems, motion-detector-controlled lighting, passive heating and cooling systems, and on-site wastewater bio-treatment facilities.[32]

Manufacturing systems are improved by redesigning and integrating production. These efforts relate to five primary areas of waste management: solids, hazardous materials, air emissions, water emissions, and energy use. Herman Miller seeks to reuse materials, generate steam and electricity at the Energy Center, and earn revenue from recycling.[33] Some of Herman Miller's activities include:

- Wood waste is used as fuel by the Herman Miller Energy Center and a local utility.
- Rugged, reusable plastic bins, rather than disposable packaging, are used to ship materials from vendors and between factories. Returnable packaging reduces damage to shipped goods and increases efficiency and productivity in the manufacturing areas.
- Scrap fabric is converted into sound-deadening material in automobiles.
- Leather is made into attaché cases and duffel bags.
- PVC vinyl edging is returned to the supplier to be re-extruded.
- Paper is recycled into bathroom tissue.

Likewise, hazardous material use has been steadily declining as new manufacturing technologies and techniques have been implemented. Herman Miller has been tackling the problem of volatile organic compounds by the introduction of:[34]

- Conversion from liquid paint to powder coat on metal components.
- Conversion from solvent-based to water-based adhesives.

[31] Herman Miller. "Journey to Sustainability: Goals and Tactics for 1999 to 2001." 2001.

[32] Herman Miller. "Journey to Sustainability: Green Buildings" 2001.

[33] Herman Miller. "Journey to Sustainability: Manufacturing" 2002. www.hermanmiller.com/CDA/category/aboutus/0,1243,c36,00.html

[34] *Ibid.*

- Introduction of powder coat on wood.
- Introduction of autodeposition on metal.
- The use of paint heaters.
- A reduction in the amount of solvents used for clean-ups.
- Incinerators to destroy over 96 percent of the VOCs that might otherwise escape.

Few of these projects consider climate change a primary motivation. Instead, they address financial viability and environmental performance without addressing any specific issue. But most of the projects do have positive climate implications. Every unit of energy saved corresponds to emissions not produced. Decreased wood demand leaves sequestered carbon in the forest. Reused materials save the fossil fuels that would have gone into their production. And the money saved can be reinvested in further improvements.

**Herman Miller's Successes**:
Herman Miller's improvements have been fueled by a shift in its thinking about expenditures and investments. Rather than looking only at the initial cost of a project, the company now includes long-term benefits in return on investment calculations.[35] This encourages environmentally friendly projects, many of which produce profitable returns that would remain unrealized without the additional initial investment. Projects requiring larger up-front investments in equipment or technology are yielding returns on investment ranging from 20 to 400 percent.[36] Energy programs and projects planned for the next seven years will reduce energy costs at Herman Miller by approximately $1 million annually.[37]

Lighting energy demand has dropped though participation in Green Lights, a program sponsored by the U.S. Environmental Protection Agency (EPA) that encourages the implementation of energy-efficient lighting. With the new lighting, Herman Miller has reduced energy costs by $200,000 annually, while earning a 47 percent return on investment.[38]

Building and system improvements have produced significant gains. The Energy Center diverts 13,000 tons of solid waste from the landfill each year, equivalent to 1,625 garbage truck loads.[39] This waste is used to generate all of the heating and cooling and eight percent of the electricity for the main Zeeland complex. The Green House, a Miller manufacturing facility in Holland, has cut use of natural gas by seven percent, water and sewer costs by 65 percent, and electricity use by 18 percent compared to the previous facility.[40]

Manufacturing process improvements have reduced waste volume across the board. During 1994–98, total solid waste increased from 52 million pounds to 59 million pounds, but the part of that total sent to landfills dropped from 21 million pounds to eight million pounds while the recycled fraction increased from five million pounds to 21 million pounds. Overall waste per $1,000 of sales dropped from 44 pounds to 31 pounds, a 30 percent reduction.[41]

For particular products, Herman Miller has achieved the following recycled content:[42]

- *Ergon 3 chair*—44 percent recycled content including steel, polypropylene, nylon GF, aluminum, foam, and fabric.
- *Equa 2 chair*—77 percent recycled content including steel, polypropylene, PET FG, aluminum, foam, and fabric.
- *Aeron chair*—60 percent recycled content including steel, polypropylene, nylon GF, PET 30 percent GF, and aluminum.

35 Herman Miller. "Journey to Sustainability: Green Buildings" 2001.
36 *Ibid.*
37 *Ibid.*
38 *Ibid.*
39 *Ibid.*
40 *Ibid.*
41 Herman Miller. "Journey to Sustainability: Manufacturing" 2002.
42 Herman Miller. "Journey to Sustainability: New Product Development." 2001.

- *Ambi chair*—42 percent recycled content including steel, polypropylene, nylon, nylon GF, polystyrene, foam, and fabric.
- Four vertical surface fabric lines are made from 100 percent recycled polyester.
- The recycled content of plastic in seating and systems furniture is 10–15 percent.
- The particleboard used in woodwork surfaces contains 90 percent recycled content.
- Recycled soda bottles are the primary source of plastic for Equa and Aeron seat shells. Each shell uses approximately 36 two-liter bottles.
- The total recycled content of an Ethospace workstation is high, based on its components:
    - Work surfaces: 90 percent recycled content,
    - Steel frames: 30 percent recycled content,
    - Tiles: 30 percent recycled content.

**Herman Miller's Lessons Learned:**

Herman Miller has received the gospel of waste reduction and has reaped its environmental and economic benefits. The most powerful example of this is the gain revealed by including long-term return-on-investment calculations in waste reduction calculations. Weighing the benefits with the sticker price has led to investments that return significant financial and environmental benefits, while revealing further opportunity for improvement.

Herman Miller's goal of sustainability requires that it maintain these gains in order to stay competitive. Product innovation goes beyond style and function. A product's value is based on those attributes, but also includes production costs, durability, and intangibles such as environmental performance. By reducing raw material and energy costs, the company can now directly return that value to the marketplace, maintaining a competitive edge.


*Bill Browning photo*

## Interface: On Course

**Interface's Goals**:
Interface, a global floor covering manufacturer, has adopted a broad corporate sustainability initiative that addresses much more than the company's climate impacts. Measures to mitigate the company's climate footprint range from general energy efficiency and renewable energy investments to specific programs such as the Solenium "Climate Neutral"™ carpet.

Interface has set an internal goal of reducing GHG emissions by two percent per unit of product per year between 1996 and 2005, at which point the target will be reset.[43] In other words, each square yard of carpet produced in 2002 will be responsible for the emission of two percent fewer pounds of $CO_2$ equivalent than a square yard produced in 2001.

Also, Interface has set a goal of reducing its total energy consumption per unit of product to 20 percent below a 1996 baseline by 2005.[44] This provides a roadmap for achieving the first goal, as energy efficiency improvements are the main source of expected emission reductions.

Finally, Interface plans to continue to purchase at least ten percent of its overall energy from renewable sources through 2005, when it will consider increasing that figure.[45] The company reduced its climate footprint as it built its demand for renewable energy to ten percent, and that has been reflected in its declining emission-per-product ratio.

These targets are embodied in Interface's Solenium carpet, the first of its products to seek and receive climate neutral certification.[46] That certification is the first step toward the company's ultimate goal of eliminating all net GHG emissions, a target central to the company's sustainability model.[47] In this framework, all emissions and non-renewable energy are defined as waste to be eliminated.

**Interface's Strategic Thinking**:
Interface's objectives are based on the belief that "by striving for sustainability (the company is) discovering better ways to make a bigger profit. Sustainability ultimately means achieving maximum return on investment."[48] The company thinks there is an opportunity to continue to increase the value of its products by maximizing the value derived from its material, time, and personnel inputs and maintaining that value for the customer through the lifetime of the product. In the company's view, the climate impact of a product decreases that product's value, so mitigating that impact adds value.

In pursuit of value, Interface is seeking to eliminate waste. However, the company is taking a novel approach to what it views as waste, the definition of which the company has broadened to "any action that does not produce value to the customer," rather than the traditional "unusable or unwanted substance or material."[49] This new view includes all GHG emissions, including all energy consumption from non-renewable sources, as climate instability will increasingly impose costs on communities and economies worldwide. Eliminating waste requires increasing efficiency in production processes, which will yield the internal financial and material savings to fund an ongoing cycle of further improvement. It also requires that remnant material and used products become inputs into other value-adding systems rather than simply being removed or discarded, revolutionizing the production system. Interface is attempting to internalize the full costs of its business.

[43] Interface, Inc. "Our Environmental Position Statement." 2002. www.interfacesustainability.com/posist.html.

[44] *Ibid.*

[45] Interface, Inc. "Renewable Energy" 2002. www.interfacesustainability.com/renew.html.

[46] Hartzfeld, Jim. "SOLENIUM™: The First Climate Neutral™ Product" Interface, Inc. press release sent to Rocky Mountain Institute, May 2000.

[47] Interface, Inc. "Our Environmental Position Statement."

[48] Hendrix, Daniel. "Executive Statement on Sustainability." President and CEO, Interface, Inc. 1996. www.interfacesustainability.com/danh.html.

[49] Interface, Inc. "Interface's Commitments." 2002. www.interfacesustainability.com/commit.html.

Interface's approach to waste is the first stage of its transition toward a novel, climate-friendly business model. After addressing waste by eliminating inefficiencies, creating closed-loop products and processes, and switching to renewable energy, the company hopes to institutionalize these gains by "creating a culture that integrates the principles of sustainability into what (it does) everyday (and) creating a new model for business" that transforms products into services.[50] This final step allows the company to control the environmental impacts of its products through their entire life cycle by selling, for example, an ongoing floor covering service rather than simply selling square yards of carpet. This provides a stable revenue stream and allows the company to keep used products within a closed loop, reducing input costs.

**<u>Interface's Implementation Plan</u>:**

The primary focus of Interface's waste elimination effort is on internal efficiency opportunities. The first step is an ongoing, public audit of all of the company's GHG emissions, including the production systems, transportation methods, and energy sources behind those emissions.[51] With these local metrics in hand, Interface energy managers and engineers identify and prioritize "near-term opportunities to reduce and sequester greenhouse gas emissions from facilities, products, and supply chains worldwide."[52] These demand-reduction improvements are the simplest and fastest steps toward reducing emissions.

A key component of the audit and general waste reduction effort was company-wide training in systems thinking.[53] This created an institutional skill base that allows individual employees to identify waste and suggest improvements. The opportunities that such training produces differ from those of top-down "value engineers," in that a dispersed network of employees comes into direct contact with specific opportunities invisible to those further removed. The training also motivates employees and involves them with a corporate mission beyond their individual job descriptions. Their involvement is key to continued success.

To complement the progress on waste, Interface is seeking to use only renewable energy to meet remaining energy demand.[54] Though this is a long-term goal, the company now considers non-renewable energy as waste, encouraging individual business units to procure renewable energy and creating economies of scale for renewable energy sources. Each unit of energy from a renewable source rather than a fossil-fuel-based source is a quantifiable step toward Interface's emission-per-unit-of-product reduction goal.

Interface's final step enlists a combination of the top-down and grassroots networks of employees in an effort to "develop new technologies, close production loops, and re-engineer systems into self-sustaining product cycles."[55] This is an ongoing process that seeks points in the production cycle where used product and material can be reinserted and reused to take advantage of that material's residual value. Materials that cannot be eliminated nor reinserted into production systems prompt the reengineering of systems and altering the composition of products so those materials are no longer necessary. This addresses those wastes that cannot be eliminated through more efficient resource use.

These steps directly address Interface's climate impacts, but are only a portion of the larger transition underway at the company. These quantifiable climate improvements are framed in an effort to "create a culture that integrates the principles of sustainability into what (Interface does) everyday by creating a new model for business, redesigning it, by pioneering sustainable commerce."[56] The plan to implement this business model includes far more than

[50] *Ibid.*

[51] Interface, Inc. "Eliminate Waste" 2002. www.interfacesustainability.com/elim.html

[52] Interface, Inc. "Benign Emissions." 2002. www.interfacesustainability.com/benign.html

[53] World Business Council for Sustainable Development. "Interface: A Learning Experience." 2002. www.wbcsd.ch/casestud/interface/index.htm

[54] Interface. "Our Environmental Position Statement."

[55] Interface. "Interface's Commitments."

[56] *Ibid.*

climate mitigation. It is an effort to create a business that cleans the environment, by "mining" waste and used materials to create value, at a profit.

**Interface's Successes:**

Interface's flagship climate success is the Solenium "Climate Neutral" floor covering line. Solenium is a woven textile product designed to be 35 percent more efficient in terms of raw materials, and to recycle all components back into the Solenium production stream. Solenium is manufactured using on-site solar panels at Interface's LaGrange, Georgia plant.[57]

To certify Solenium as climate neutral, Interface calculated its GHG footprint, including all upstream impacts such as transportation and energy used to manufacture primary materials, manufacturing process energy including electricity, boilers, and transportation to the customer, and downstream installation, use, and maintenance. Most emissions were eliminated by using solar energy and improving product design so each component can be reprocessed without losing any material and a portion of the old carpet's embodied energy can be regained. The remaining emissions are offset through a portfolio of investments in energy efficiency improvements and fuel switching at public schools in Portland, Oregon and Philadelphia, Pennsylvania, with the additional benefit of reducing those schools' overhead costs. The Climate Neutral Network certified Solenium as having zero net climate impact.

On a broader scale, Interface is on track to meet its corporate commitments to emission and energy use reductions per unit of product. Globally, the company has:

- Reduced the carbon intensity, including total supply chain petrochemical material and energy use, of each dollar of revenue by 31 percent between 1994 and 2000.[58]
- Reduced average non-renewable energy consumption per unit of product by 18 percent between 1996 and 2001. This is due to a combination of reductions in total energy use per unit of production and in the carbon intensity of energy used.[59]
- Maintained an average renewable energy consumption of 11 percent of total energy use between 1996 and 2001, while transitioning toward "green" energy.[60]
- Increased use of non-petrochemical based materials from 13 percent of total material consumption in 1994 to 24 percent in 2001.[61]

These gains have come from individual projects and Interface installations that have reduced their climate impacts. Locally, these improvements include:

- A 65 percent reduction in GHG emissions per unit of product at the Belleville, Ontario flooring systems plant between 1996 and 2001. This was achieved by changing the manufacturing process to require lower temperatures and using the cost savings to purchase 25 percent of plant electricity from wind generators.[62]

[57] Hartzfeld, 2000.

[58] World Business Council for Sustainable Development. 2002.

[59] Interface, Inc. "Global Metrics." 2002. www.interfacesustainability.com/metrics.html

[60] *Ibid.*

[61] *Ibid.*

[62] Interface, Inc. "Metrics by Location: Flooring Systems—Belleville, Ontario Canada." 2002. www.interfacesustainability.com/met_bell/00.html

- A 31 percent reduction in GHG emissions per unit of product at the Guilford, Maine plant between 1996 and 2001. The facility uses wood chips, a by-product of a local business that would otherwise discard the chips, to meet a share of plant energy needs.[63]
- Interface's factory in Shanghai originally required 14 pumps drawing a total of 71 kW. Interface cut required pumping power to only 5 kW by straightening pipe layout and using larger diameter pipes to reduce friction. This reduced capital cost and improved performance, and thermal insulation of the straighter pipes saved additional energy.[64]
- Interface Europe's Craigavon, Ireland plant purchases 100 percent of its electricity from wind generators, avoiding a Climate Change Levy on the consumption of fossil fuel.[65]

These gains would not be possible if they did not make financial sense. Reduced material and energy waste are tied to increased savings, and Interface has realized significant savings by auditing and reducing waste. Interface estimates it has saved a cumulative $185 million since 1995 through waste reduction efforts.[66] This has paid for all of the company's environmental upgrades and training, and has delivered over 27 percent of the company's operating income over the period.[67] The company is stronger for these efforts and uniquely prepared for the future implementation of climate change mitigation policies.

**Interface's Lessons Learned**:

Interface's progress is evidence that there is no correct ratio of waste to product. Instead, the company has learned to account for all the economic, social, and economic costs of its products, and it strives to eliminate all those that do not add equal or greater value to the customer and society. The most important lesson the company has gained is the ability to consider systems and product cycles as a whole, including all lifetime inputs, outputs, and opportunities for recycling. Improved data and understanding improves business in general by identifying what can be further improved. This institutional understanding gives the company a competitive advantage by allowing it to capitalize on cost reduction and recycling opportunities that would have remained hidden otherwise.

However, Interface discovered that there were different learning curves for different parts of the company. The employees who made the most gains in reducing environmental footprints were in either the manufacturing or the research areas, where people are "used to talking about the environment, systems, and material substitution" and have the pre-existing "ability to implement green energy purchases, waste elimination, and recycling."[68] There was a significant lag period before the sales, marketing, and other less engineering-based departments achieved similar understanding and improvements.

As a result, "whole-company issues such as strategic product development planning and communicating sustainability externally" were delayed.[69] The company's inability to explain to customers the reasoning behind and benefits of its efforts hindered its attempts to capitalize on the marketing advantage and promise that these efforts have produced. Effort to bring the "whole company" to a common understanding and viewpoint are ongoing.

[63] Interface, Inc. "Metrics by Location: Guilford of Maine, Guilford, Maine." 2002. www.interfacesustainability.com/met_guil/00.html

[64] Hawken, P., Lovins, A., and Lovins, H. *Natural Capitalism: Creating the Next Industrial Revolution.* Little, Brown and Company, Boston, MA. 1999.

[65] Interface, Inc. "100% Wind Energy at Craigavon." 2002. www.interfacesustainability.com/100wind.html

[66] Interface. "Global Metrics."

[67] World Business Council for Sustainable Development, 2002.

[68] *Ibid.*

[69] *Ibid.*

## Royal Dutch Shell: Running Toward Kyoto

**Shell's Objectives:**

On 16 October 1998, Royal Dutch Shell announced that it would cut its global emissions of greenhouse gases by at least ten percent from 1990 levels by 2002.[70] This commitment mirrors a similar pledge made by British Petroleum in September 1998.[71] Furthermore, Shell plans to maintain that reduced level of emissions through 2010 and beyond.[72] This goal sets a simple cap on corporation emission limits, which it can meet through any combination of internal emission reduction measures.

The company aims to reach that target by reducing its own emissions through established programs for reducing methane venting and flaring, fuel switching, and improving energy efficiency. It will also establish new programs to include the cost of carbon reduction in major investments, establish an internal emission trading system to achieve least-cost abatement and encourage system thinking about the "wells to wheels" emission implications of projects. The combined effect of these efforts will eliminate or even surpass Shell's potential exposure to the Kyoto Protocol's emission reduction requirements.[73]

**Shell's Strategic Thinking:**

Shell is taking a pragmatic yet supportive approach to reducing its climate impact. The company believes that oil and gas will continue to meet a large part of the world's energy demand for the foreseeable future, so emission reduction efforts should primarily target current systems. A company publication states, "We are doing this [making this effort toward Kyoto compliance] to prepare for a *carbon-constrained future*, which could include a mandatory compliance regime imposed on industry…which will result in a cost being applied to carbon in emissions, either through carbon taxes or through the value of permits in a trading system."[74] In other words, Shell's efforts are preemptive actions in response to the financial risks associated with government efforts to reduce emissions in the future.

With that in mind, Shell supports Kyoto's approach to reducing atmospheric carbon concentrations through market based cap-and-trade programs, Joint Implementation (JI) projects and the Clean Development Mechanism (CDM).[75] The company sees these methods as the best ways to achieve a minimum cost of abatement, which are particularly applicable to large, diversified energy corporations such as Shell. Shell's many divisions provide ample opportunity for reductions measures and more than enough market participants to encourage innovative approaches and active trading, further driving down the cost of carbon.

Shell's early actions toward Kyoto compliance allow it to develop an institutional understanding of the carbon trading markets. These will become increasingly valuable as the carbon market develops and expands. To maximize the value of these efforts, Shell is seeking to engage applicable international organizations, such as the IPCC and World Business Council for Sustainable Development, and stay ahead of developments in climate policy that will affect its business streams.

Finally, Shell realizes that climate-friendly energy systems provide an opportunity for growth. Hydrogen has the potential for revolutionizing energy generation and storage systems and eliminating carbon from the system. Early entrance into this market provides the dual benefits of enhancing a portfolio of climate-friendly actions and reaping the economic benefits of market share in a blossoming sector. This approach, like all of its actions on climate change, is firmly rooted in improving Shell's economic performance while addressing social and

[70] Royal Dutch Shell. "The Shell Tradable Emissions Permit System: An Overview." 2000. Report in pdf format from www.shell.com/climate.

[71] British Petroleum. www.BP.com/green

[72] Shell, 2000.

[73] Royal Dutch Shell. "Our Approach to Climate Change." 2002. www.shell.com/climate.

[74] Shell, 2002.

[75] Shell, 2000.

environmental concerns that could affect that performance in the future.

**Shell's Implementation Plan**:
Shell has six separate goals. These are to reduce internal emissions, to help customers reduce emissions associated with Shell's products, to involve climate concerns in business decision making, to develop market-based solutions, to improve understanding of the issue, and to improve measurements and reporting of Shell's climate impacts.[76] Shell's various business units are encouraged to use methods within the applicable areas to reduce their emissions toward the global commitment of a ten percent reduction below 1990 levels.

The primary area targets Shell's own GHG emissions. Shell believes a "credible response to climate change must start with further action to cut GHG emissions from our own operations."[77] This includes investment in energy efficient production, manufacturing, and transportation operations, and a halt to the continuous disposal of gas through venting and flaring as early as possible. Shell currently plans to eliminate venting by 2003 and continuous flaring by 2008,[78] and Shell is expanding its forestry business to increase carbon sequestration.

Beyond the company's boundaries, Shell seeks to help customers reduce GHG emissions. The company is working to increase the availability of fuels with a lower carbon content, such as natural gas for heating and power, alternative fuels such as LPG and hydrogen for cars, and renewable energy such as solar power and biomass energy. Shell is promoting fuel switching from coal to natural gas in electricity generation, which halves the carbon intensity of each kilowatt-hour of electricity generated.[79]

[76] Shell, 2002.
[77] *Ibid.*
[78] *Ibid.*
[79] *Ibid.*
[80] *Ibid.*
[81] Shell, 2000.
[82] Shell, 2002.

In order to prepare for the future costs of carbon emission limits, Shell is adjusting its business decision making to consider the effect of a carbon penalty in investment calculations for new projects and existing assets with GHG emissions. These assumed costs can tilt project decisions toward more climate-friendly options, even before governments institute emission limits. Also, these projects will be assessed in terms of energy efficiency, carbon intensity, and carbon sequestration to fully include climate impacts and identify opportunities for improvement.[80]

Market-based solutions provide Shell with a pathway to least-cost mitigation. Shell has developed the Shell Tradable Emissions Permit System (STEPS) to allow over 30 percent of Shell's business units to achieve emissions cuts efficiently. Currently the program is limited to businesses in Annex I countries, but it can be expanded globally if practicable. The company will gain experience in the operation of a carbon trading system, which it can use to support the development of national and international emission trading systems. Businesses in the trading system can look to reduce emissions through CDM and JI transactions.[81]

To promote internal institutional understanding and knowledge of the issue, Shell plans to remain involved in the policy debate at the national and international levels. It will expand support for climate research through organizations such as the IPCC. Internally, Shell is developing a "well to wheels" program to comprehensively assess project emissions, improve understanding of its business streams, and uncover opportunities for efficiency improvements.[82]

Finally, Shell will continually measure and report its climate impacts and progress. This is fundamental to both internal and global progress on the issue. Accurate reporting allows Shell to pursue measures that have high rates of return on investment, further encouraging the potential for concerted financial and environmental progress. Shell's achievements will be closely watched and, if properly reported, can become a model for corporate climate progress.

**Shell's Successes:**

Though Shell increased its GHG emissions by two percent in 2001, a result of expanded flaring in Nigeria, the company still expects to meet its emission reduction target of ten percent below 1990 levels by the end of 2002. In 1990, it emitted 114 million tons of $CO_2$. By 2000, emissions were down to 101 million tons and Shell expects that to drop to 92 million tons by 2003.[83] Shell's emission reductions are on course to meet the reduction goal, so 2001 appears anomalous. Reductions have been achieved through several programs:

- The ongoing STEPS program has capped emissions for its participants below the ten percent target, providing momentum that will bring much of the company near to the goal. The program has traded over a million tons of $CO_2$ emissions per year between business units representing over 30 percent of the company's total $CO_2$ and methane emissions. The system has aided Shell in understanding the process of trading GHGs, which is expected to become a standard international compliance mechanism.
- Shell has established investment decision procedures to include costs of $5/mtC to 2010 and $20/mtC thereafter in financial projections for new large projects. This preempts potential future carbon costs while illuminating opportunities for carbon improvements at marginal costs that otherwise would have been unknown or ignored. In light of Norway's current carbon tax of $30–40/mtC, this is prudent preparation.[84]
- Shell initiated a CDM project in South Africa to bring solar power to poor, off-the-grid homes. At the end of 1999, program staffers had installed over 6,000 solar units; the hope is to install over 50,000 total. Based on a fee-for-service model to minimize initial cost, consumers purchase units consisting of a photovoltaic cell, battery, metering unit, and a type of debit card that depreciates as electricity is consumed. New cards can be purchased from local businesses that sell, install and service the systems, promoting local job growth. By replacing domestic consumption of fossil fuels, paraffin wax and wood, each system is estimated to displace 230 kilograms of $CO_2$ per year. Also, fire danger and indoor air quality health risks are greatly reduced.[85]
- Shell has identified eight other projects that could qualify under the CDM. These are all in non-Annex countries and therefore not eligible for the STEPS program that could otherwise finance these improvements.[86]

**Shell's Lessons Learned:**

Shell has learned that continued growth and fiscal responsibility require the company to consider new technologies and energy delivery methods as well as environmental impacts. By taking environmental responsibility, Shell has opened itself up to new markets and productive interactions with outside groups that would have been invisible or impossible if it had resisted diversifying its energy sources. By moving beyond oil, Shell has forced itself to be more innovative in fields such as renewable energy and efficiency, and has discovered that within those fields are unexploited new business opportunities.

The market mechanisms that allow the company to meet environmental requirements at a minimal cost, such as STEPS and the CDM, do not demand a single type of energy or product. Rather, they require flexibility, transparency, and forward-looking business decisions to meet the end-use needs of consumers. In the short term, Shell has improved its institutional understanding of climate and how to perform in the face of changes such as the imposition of carbon constraints. In the long term, Shell is learning how to meet the highly diverse needs of its current and potential customers, needs that range from the environment and public health to providing energy products to the open market.

[83] Royal Dutch Shell. "People, Planet and Profits: The Shell Report." 2002. Report in .pdf format from www.shell.com/climate.

[84] *Ibid.*

[85] Kleiburg, R. "Clean Development Mechanism Demonstration Project: South African Rural Electrification Project." Royal Dutch Shell. 1999. www.shell.com/cdm/sarep.html.

[86] Shell. "People, Planet and Profits: The Shell Report." 2002.

## Shaklee Corporation: Climate Neutral Now

**Shaklee's Objectives:**

Shaklee simply sought to achieve complete climate neutrality for its entire business stream, and on 15 April 2000, it reached that goal.[87] The Climate Neutral Network (CNN) certified Shaklee as the first climate-neutral company in the United States after Shaklee completed a comprehensive audit of its emissions and documented Shaklee's CNN-approved emission offset.[88] Neutrality was achieved through a balance of internal demand-side management (DSM) measures and carbon offsets from investments in projects that reduce emissions in institutions such as schools and landfills.

Internal improvements were focused on the climate impacts of Shaklee's corporate headquarters, production facilities, and distribution systems.[89] By auditing emissions sources and examining potential improvements, Shaklee identified measures that would be most economically efficient to employ in concert with external offsets. Internal improvements were considered preferable to simply buying offsets, as identified improvements increase the global pool of available improvements and facilitate larger climate gains.[90] CNN requires that at least 60 percent of a company's offsets come from direct reductions of fossil fuel usage, which is the primary source of GHGs, and that potential offsets reflect the location of the emissions they are intended to offset.[91] The external offset projects were based on the belief that the partner institution could not or would not reduce their emissions without outside investment and ingenuity. Thus, Shaklee sought carbon offsets representing the difference in emissions between the predicted business-as-usual *baseline* scenario and the realized scenario produced by the investment. These projects made up the difference between what Shaklee could achieve internally and the goal of complete climate neutrality.

**Shaklee's Strategic Thinking:**

Shaklee's climate-neutral goal is rooted in a belief that corporate environmental performance will add value to its products.[92] The company is attempting to add value by reducing negative environmental externalities of its products. Products with this added value are worth more to consumers, raising their market price and increasing demand. Thus climate neutrality improves Shaklee's products.

Shaklee was seeking more than increased product value by improving its climate performance. In seeking certification, Shaklee was pursuing the dual goals of mitigating climate change and gaining ground in the market for environmentally responsible products. Financial returns on its climate investments come from securing Shaklee's reputation as an eco-friendly corporation. That reputation is an increasingly important marketing advantage in the health food, dietary supplement, and household product markets, where consumers are often acutely aware of environmental issues and concerned about exposure to harmful substances.[93]

According to Shaklee U.S. CEO Bob Schults, Shaklee became climate neutral because, "We wanted to take on the issue of global warming and be first in the marketplace with a climate-neutral choice, thereby taking a leadership role and setting an example for others to follow."[94]

[87] Shaklee Corporation. "Shaklee U.S. Leads the way on Global Climate Change issue, Becomes Nations First Climate Neutral Company." Press release, April 11, 2000. www.shaklee.com/about/global/pressroom.

[88] Trexler and Associates, INC. "Shaklee Corporation's Application for Climate Neutral Enterprise Certification: Public Distribution Copy" Submitted to Climate Neutral Network February 24, 2000, approved by Climate Neutral Network Environmental Review Panel March 17, 2000. www.climateneutral.com.

[89] *Ibid.*

[90] *Ibid.*

[91] *Ibid.*

[92] Perkins, K. "Going Climate Neutral: Beyond Benchmarking" US EPA Labs For The 21st Century. See www.epa.gov/labs21century/conf/conf2000/abstracts/kperkins.htm

[93] Lovins, A. As quoted in "Shaklee Climate Neutral: Comments About Climate Neutral." www2.shaklee.com/company/comments.cfm

[94] Perkins, 2000.

Certification demonstrates a concrete achievement rather than the "greenwash" that some firms have used to distract or influence public opinion. Shaklee's certification allows it to trump any challenge to its reputation as the most environmentally concerned company in the market.

Finally, certification through buying carbon offsets strategically places Shaklee ahead of the learning curve for carbon trading. In this developing market, the supply of possible offset measures is large and demand for credits is low, resulting in a low price per ton. As demand rises and "low-hanging fruit" becomes more scarce, the price will rise, leaving Shaklee with increasingly valuable credits as well as a strong stewardship record. This approach is based on predictions that other companies will follow Shaklee's lead and voluntarily improve their climate performance, or that emission restrictions will eventually become law, increasing demand and therefore the value of the credits Shaklee already holds. By getting into the market early, Shaklee will have gained important institutional understanding and experience that will benefit it in the long term.

**Shaklee's Implementation Plan and Successes**:
As one of the largest personal care and household product manufacturers and distributors in the United States, Shaklee took responsibility for emissions from all its energy and chemical inputs, manufacturing flows, and delivery systems. These were compiled in a comprehensive emission inventory that allowed the company to identify opportunities for improvement internally. Internal opportunities were addressed first, primarily through improvements in manufacturing efficiency and building performance. The two primary projects internally were:

- *Eco-Efficient Hacienda Campus World Headquarters.* Shaklee recently completed construction of its new world headquarters in Pleasanton, California. The building's design maximizes the use of daylight to increase ambient light and reduce electric lighting, uses ventilation and passive thermal systems that minimize the need for additional heating and cooling systems, and relies on motion sensors to control equipment and lighting. The building is oriented for optimal exposure to the sun and incorporates window recesses to reduce glare and cooling loads while maximizing daylight. Building materials include recycled, certified-sustainable wood, Interface carpeting made from recycled fibers (which in turn is recyclable), and textiles dyed with recycled inks.[95]

- *State of the Art Norman Manufacturing Facility.* This Oklahoma facility was developed with extensive consideration of the ISO 14001 standard. Shaklee's manufacturing activities have increased recycling, chemical substitution with less harmful materials, inventory control, and careful waste management. The hot and chilled water systems were retrofitted for improved efficiency, the old chillers were replaced with new models that are 24 percent more efficient, and two 20,000 lb/hr boilers were replaced with a single high-efficiency 25,000 lb/hr model. The historically uncomfortable warehouse office space was dramatically improved by the installation of solar film and window screens, reducing the need for air conditioning. Additional pipe insulation was installed and air leaks were repaired, reducing compressor loads.[96]

Besides improvements achieved internally, the remainder of Shaklee's emissions were balanced through the purchase of carbon offsets from projects that reduce emissions elsewhere. Quantification of gains from these projects required a thorough emission audit and business-as-usual baseline projection for the full commitment period. A partnership with experienced auditors and CNN facilitated the understanding needed to maintain a comprehensive emission balance sheet and achieve the goals. The reductions from these projects have offset the company's emissions for 2000–01, after which it will need to expand its offset portfolio to maintain climate neutrality. Shaklee invested in four projects, ranging from carbon-intensity improvements to fuel switching. They include:

[95] Trexler, 2000.

[96] *Ibid.*

- *Rural Solar Electrification through Photovoltaics in India and Sri Lanka.* Solar photovoltaics (PVs) offer an immediate alternative to kerosene lamps, diesel generators, and batteries in rural areas. Solar rural electrification is also an alternative to expensive (and sometimes impossible) extensions of the power grid or construction of new fossil-fueled power plants. Replacing kerosene with solar power eliminates kerosene's $CO_2$ emissions. The distributed PV generation reduced the need for expansion of centralized power grids, increasing the indirect $CO_2$ benefit over the long term. Homes using PV systems will also eliminate fire and health risks associated with indoor fuel use. Shaklee worked with local solar electric companies to lease these systems to consumers at rates comparable to their current energy costs. Defaults on these leases are virtually nonexistent due to applicant screening. This project provides 24,000 tons per year of $CO_2$ reductions over 20 years, of which Shaklee is credited with 15,000.[97]

- *Coalbed Methane Utilization in Ohio and Pennsylvania.* Large quantities of methane are vented to the atmosphere from coal mines with no or limited use being made of the methane's energy. This project involves using vented methane gas from abandoned coal mines to produce electricity by combusting it in off-the-shelf engines. By utilizing methane that would otherwise be vented, the emission reduction benefits of the project are particularly significant, because methane's global warming potential per ton is 21 times that of $CO_2$. Shaklee worked with a local methane recovery company to offset 44,550 tons of $CO_2$ equivalent from methane emissions, from which Shaklee is credited with 10,000 tons.[98]

- *Boiler Replacement in Portland, Oregon.* This offset project replaced many of the 230 existing oil-steam boilers in 105 schools with high-efficiency natural gas-fired steam boilers. The new, efficient boilers reduce fuel demand and $CO_2$ production. They also reduce operating costs to the school district. The switch from oil to gas creates additional emission savings from the elimination of electricity needed to pump and heat the oil, and to compress air to atomize the oil prior to combustion. This project will also help to improve the general air quality in the Portland metropolitan area. Shaklee's investment improved net efficiency from 64 percent to 76 percent and saved 660 tons of $CO_2$ per year. Over 25 years, Shaklee receives 14,210 tons of $CO_2$ credits.[99]

- *Green Power Purchases in the United States.* The methane capture project above replaces fossil-fuel-based sources of electricity by selling the methane-generated electricity to the grid. The resulting electricity is climate friendly because the carbon intensity of methane combustion is much lower than the average carbon intensity of grid electricity. This project will be fully developed and implemented in the second year of Shaklee's portfolio and will provide the company with 10,000 tons of $CO_2$ credits per year.[100]

These projects provided Shaklee with the credits it needed to achieve climate neutrality. By assessing the costs per ton of carbon, Shaklee created a supply curve of available offsets and internal measures which were pursued until Shaklee's emissions were completely mitigated, meeting the self-imposed goal.

**Shaklee's Lessons Learned**:

Shaklee learned that climate neutrality can be achieved rapidly with the help of the developing carbon market. While the value of climate-neutral certification will benefit Shaklee's product line, the knowledge gained of the carbon market and carbon offset projects might be more valuable. Shaklee's emissions will fluctuate in the future and it will need to develop new emission reduction portfolios to neutralize future emissions. It will need to draw on the experience it has gained to meet that goal and develop beneficial projects in the future. Shaklee must ensure that future projects do not tarnish the reputation and advantage that this effort has realized. The company has developed a model for environmental stewardship and set a precedent. Others following the same path might need to emphasize internal projects more, as external offsets increase in price.

97–100 *Ibid.*

## DuPont: Far Beyond Kyoto

**DuPont's Objectives:**

In 1991, DuPont set three climate-related goals for its global operations to achieve by 2010. First, the company committed to a 65 percent reduction in greenhouse gas (GHG) emissions below 1990 levels, equivalent to eliminating 100 million metric tons of $CO_2$ emissions each year.[101] Second, DuPont pledged to limit overall energy use to 1990 levels, implying an average five percent annual efficiency improvement.[102] This commitment is intended to limit $CO_2$ emissions from fossil fuel-burning power plants serving DuPont's electricity demand, while other measures address the other GHGs. Finally, DuPont will buy ten percent of its energy from renewable sources by 2010.[103] As of 2000, DuPont received three percent of its energy from renewable sources, primarily hydroelectric generators, but to meet the 2010 goal the company intends to acquire wind and biomass energy.[104]

The last two goals help meet the first. They directly reduce internal emission sources and reduce the impact of remaining energy demand—which is better than simply purchasing external offsets. This approach requires DuPont to do more of the work itself, but it might also lead to improvements that cost far less than the purchase price of offsets, and it might generate profits.

[101] DuPont Chemical, Inc. Global Climate Change Position Paper. 2002. www.dupont.com/corp/news/position/global_climate.html

[102] *Ibid.*

[103] *Ibid.*

[104] *Ibid.*

[105] Reilley, Dennis. Speech to Pew Center Conference. Washington, DC. September 13, 1999. www.dupont.com/corp/whats-new/speeches/reilley/pewconf.html

[106] Pfeiffer, Gary. Speech to The Year 2000 Conference on Environmental Innovation: Creating Sustainable Business Assets for Today and Tomorrow. New York, NY. March 8, 2000. www.dupont.com/corp/news/speeches/pfeiffer_03_08_00.html

[107] DuPont, 2002.

**DuPont's Strategic Thinking:**

Since 1991, DuPont has gone "from a mindset that said environmental performance was defined by external regulations, to a fuller perspective that says environmental performance is part of an all-encompassing internal drive toward true sustainable growth."[105] As a result, DuPont is acting as if the Kyoto Protocol has already been ratified and the government is enforcing emission caps. By committing to reduce its climate impacts early, DuPont believes that it has gained a competitive advantage over companies that have only recently turned their attention to climate change.[106] Since the early 1990s, company scientists have recognized that climate change would be a problem. Management has responded by reducing the risk of potential costs of compliance with international emission limits. DuPont has begun "positioning (its) business for the marketplace of 20 to 50 years from now, one which will demand a markedly smaller 'environmental footprint' from industrial activity."[107] In the face of the Kyoto process and the science, this is prudent business practice.

If binding emission limits are instituted, DuPont's early action will put it ahead of the curve and allow it to shape the market for carbon offsets. The adoption of Kyoto's flexibility mechanisms could reward the offset credits that DuPont has accumulated during its 65 percent reduction. Where others see costly regulation, DuPont has realized business opportunities in the potential value of its offset portfolio.

Early action has allowed the company to adopt the easiest and most flexible approach to meeting Kyoto reduction commitments and gain a return on its investments in climate change mitigation. However, to truly slow long-term accumulation of atmospheric $CO_2$, "longer term strategies will require innovation and market-driven dispersion of new technologies; and the efforts of all countries to ensure that economic growth proceeds wisely…to develop an economically and environmentally secure future and to shape and advance a longer-term, market-oriented strategy for securing it."[108] Though DuPont committed to aggressive goals early in the climate mitigation process, it is not willing to continue to invest in improvements without a policy framework that supports and rewards progress.[109] This has led the company to support broad, flexible trading rules for joint implementation (JI) and the Clean Development Mechanism (CDM). The company has addressed criticism of these mechanisms, *e.g.*, claims that they are tools for avoiding true reductions and for exporting pollution, by limiting total energy consumption and reducing the carbon intensity of purchased energy. Early action on its climate impacts has created a lucrative and environmentally friendly opportunity for DuPont, but its value depends on governments agreeing on a climate strategy that recognizes DuPont's actions so far.

**DuPont's Implementation Plan:**
DuPont operates in 70 countries worldwide, with 135 manufacturing and processing facilities, 40 research and development laboratories and customer service centers in the United States, and more than 35 laboratories in 11 other countries.[110] In 1998, the company had revenues of $24.8 billion, net income of $ 4.7 billion, and employed 83,000 people worldwide.[111] This diverse assortment of facilities and business streams needs an equally varied approach to emissions. To significantly reduce emissions from the 1990 baseline of over 156 million metric tons of $CO_2$ equivalent, the company has developed a portfolio of mitigation options from which operations can choose applicable measures.

The primary tool has been increased efficiency in manufacturing, building technology, lighting, air compression, and other energy consuming processes.[112] Progress in this area has focused on increasing cogeneration throughout the manufacturing process in order to produce more product while using less energy. A Corporate Energy Leadership Team, composed of members from DuPont's businesses, functions, and energy-related disciplines worldwide, was formed to develop and promote measures to maximize energy efficiency, lower the environmental impact of energy consumption, and renew the power supply across business units.[113] This multidisciplinary approach provided insights that individual disciplines or experts could not provide. These include specific engineering and scientific improvements, refining economic planning to incorporate long-term returns on investments, and facilitating institutional learning within business units. At its inception, the team committed to reduce energy consumption per unit of product by 15 percent by 2000, a target point they surpassed.[114]

Secondly, DuPont has taken aim at GHG emission sources throughout its industrial processes.[115] Primarily, it has pledged to eliminate $N_2O$ emissions by implementing projects that will destroy or recapture $N_2O$ emissions for beneficial use. Other specific targets are boiler emissions of $SO_2$ and $CO_2$ and emissions of other by-product fluorochemicals. These point sources are easily identified and capped, and account for much of the emission reductions since 1990.

DuPont is expanding its focus on chemicals and chemical engineering to include a broader range of skills and products, including a greater focus on biology and information science.[116] This transition will fuel a significant drop in the carbon intensity of the company's products, as these new business streams have lower energy and chemical intensities. As this part of the plan continues, revenues from renewable sources such as agricultural feedstocks and from consulting will expand. The goal is to earn 25 percent of revenues in 2010 from these new efforts.[117]

[108] *Ibid.*

[109] Pfeiffer, 2000.

[110] DuPont, 2002.

[111] *Ibid.*

[112] Romm, Joseph J. *Cool Companies—How the Best Businesses Boost Profits and Productivity by Cutting Greenhouse Gas Emissions.* Island Press. 1999.

[113] *Ibid.*

[114] *Ibid.*

[115] Reilley, 1999.

[116] *Ibid.*

All of DuPont's major sites have made voluntary commitments to become European Eco-Management and Audit Scheme (EMAS) verified, and all other sites were scheduled to be ISO 14001 certified by the end of 2000.[118] These processes will describe DuPont's environmental footprint and reveal further specific activities for improvement. Furthermore, they will improve dialogue with local communities and third parties that are willing to work with the company to foster improvement.

There are myriad tools and initiatives being developed on all levels to meet DuPont's emission commitments. By combining top-down initiatives with encouragement for grassroots program development, DuPont is shrinking its ecological footprint globally.

**DuPont's Successes**:
DuPont is on or ahead of schedule to meet the first two of its ambitious goals and is gaining ground on the third after making little progress on renewable energy in the decade since the company made these commitments. As of early 2002, DuPont had reduced its greenhouse gas emissions 63 percent below 1990 levels.[119] To meet that goal, $50 million has been invested in fluorochemical and $N_2O$ emission reduction. This accounts for most of the progress toward the first goal of 65 percent GHG reductions, as these gases are more easily reduced by DuPont than $CO_2$.

A few particular programs have had significant success:

- $N_2O$ abatement technology installed at the Nylon Intermediates plant in Wilton, UK, began operating in late 1998. By the end of 1999, the technology was fully installed, yielding reductions equivalent to 80 percent of all 1995 $N_2O$ emissions.[120]
- The Chambers Works in New Jersey introduced extensive cogeneration systems between 1993 and 1997. Energy consumption per pound of product dropped by one third and GHG emissions per pound of product dropped by one half. While production rose by nine percent, energy bills dropped by $17 million. Energy efficient waste water treatment saved an additional $2 million and optimization of air distribution for aeration eliminated the need for a 1,000 horsepower engine.[121]
- The same Chambers Works plant began an audit of failing steam traps, devices used to drain condensate from steam lines, in 1991. Improved maintenance of the traps and improved insulation repair have saved $1.5 million and 12 percent of steam used by the plant.[122]
- A partnership with Praxair Company to improve industrial production of carbon monoxide and hydrogen from natural gas identified a single improvement in the energy-intensive process that cut electricity costs by $400,000 per year.[123]
- The development of new technology for the manufacture of Terathane brand PTMEG, a key raw material for Lycra®, has increased yields, resulting in additional revenues of $4 million while eliminating 4.4 million pounds of waste per year.[124]
- A DuPont engineering team developed and implemented methods to reduce approximately three million pounds of annual releases of HFC-23 by optimizing a production process. The innovation saved $20 million in capital investment while reducing GHG emissions by 20 million tons of $CO_2$ equivalent.[125]

These reductions provide DuPont with ample offset credits to begin trading with other businesses concerned about climate change and the risk of future regulation. In fact, DuPont completed the first trade on the United

[117] *Ibid.*

[118] *Ibid.*

[119] DuPont Chemical, Inc. "Sustainable Growth 2001 Progress Report: Creating Shareholder and Societal Value While Reducing Our Footprint Throughout the Value Chain." 2002.

[120] Pfeiffer, 2000.

[121] Romm, 1999.

[122] *Ibid.*

[123] *Ibid.*

[124] Pfeiffer, 2000.

[125] World Business Council for Sustainable Development. "DuPont: 'Zero' Targets Driving Innovation." 2002. www.wbcsd.ch/casestud/dupont1/index.htm.

Kingdom's nascent carbon trading system, selling 10,000 tons of emission allowances to the Japanese conglomerate Marubeni to offset Marubeni's oil exploration activities.[126] The development of a strong carbon market is seen as key to attracting further corporate commitment to climate mitigation.

DuPont has succeeded in capping total energy consumption, its second goal. While production rose 35 percent between 1991 and 2001, energy consumption has remained steady.[127] The company estimates that this gain in productivity per unit of product can be equally attributed to process and powerhouse efficiency improvements, improvements in the production processes inputs, and changes in the products themselves. Although its goal was originally considered a stretch, DuPont's demand-side management has added significant value to products and played a large part in mitigating the company's climate impacts.

Unfortunately, the fraction of DuPont's total energy consumption that comes from renewable sources has not risen significantly.[128] This is not to say that the company cannot reach its goal in 2010, as it can simply switch over to renewable energy at that time. This goal may be the most audacious, requiring 300 megawatts of renewable capacity by 2010.[129]

If the company were to enter the market suddenly with such a large demand, it could cause a demand spike in the renewables market, possibly leading to suddenly inflated prices. This is not what DuPont wants. Instead, investments made as early as possible will boost the development and deployment of renewable energy systems, which will help to bring prices down and avoid price spikes. By sending a market signal that it is committed in the short and long term to renewables, DuPont could encourage renewables growth. Though fuel cells are not a completely renewable energy source, DuPont has organized a fuel cell energy group to study and develop the proton-exchange membrane technology. Widely considered the engine of the future, a fuel cell is highly efficient and its use emits only water. Investing in fuel cell development sets the company on track toward zero environmental impact energy systems that might help it achieve its renewable energy goal.

**DuPont's Lessons Learned:**

Early action and ambitious goals have allowed DuPont to surpass by far any emission cutback called for in the Kyoto protocol. This environmental improvement has provided the company with emission reduction know-how that will be increasingly valuable as scientific consensus leads to regulatory action and other companies pursue efficiency and climate goals. DuPont's primary body of institutional learning is centered on these technical achievements.

Furthermore, DuPont has improved its ability to accurately and comprehensively record, report on, and frame its environmental performance. This is a fundamental tool that enables the company to identify economically and environmentally profitable projects beyond those described above.

DuPont's climate efforts have been an experiment in business planning that shifts emphasis from short-term profitability to investments that reduce long-term economic risk and improve environmental performance. While businesses are expected to improve their productivity and competitiveness continually, DuPont has found that improving its environmental performance can enhance its bottom line.

[126] DuPont Chemical, Inc. DuPont and Marubeni Execute First UK Greenhouse Gas Emissions Allowance Trade. Press release. www.dupont.com/corp/news/releases/2001/nr09_21_01.html

[127] DuPont, "Sustainable Growth 2001." 2002.

[128] *Ibid.*

[129] Pfeiffer, 2000.

## ABB: Selling Climate-Friendly Technology

**ABB's Objectives**:
Although ABB has not set ambitious climate goals, the company aims to reduce emissions by one percent annually between 1999 and 2004.[130] Beyond specific reduction targets, ABB is betting on the emergence of the market for small scale, distributed energy generation that will lead to improved efficiency and lower carbon-intensity of energy delivered to customers.[131] ABB sees vast potential for its technical and engineering expertise in these sectors. As such, it is investing heavily to develop products that are economically competitive with traditional energy systems in hopes of gaining a dominant position in the market for distributed power.

The climate-friendly attribute of this initiative is that distributed power systems are generally less carbon intensive than centralized fossil fuel-fired power plants. On the whole, distributed energy relies on natural gas-fired combustion turbines, microturbines, and fuel cells, all of which are more efficient than large plants due to their ability to cogenerate both heat and electricity, as well as carbon-free renewable and alternative energy sources such as wind power and solar cells.

**ABB's Strategic Thinking**:
ABB is a world leader in developing resource-efficient technologies in industries such as electricity transmission and transportation, and provides the technical abilities, maintenance service, and financing in a single package. The company has come to consider the market for traditional centralized energy production and transmission as oversaturated and under increasing pressure from environmental regulations such as Norway's $50 per ton carbon tax.[132] The deregulation and privatization of world energy markets in combination with developing countries' demand for suppliers capable of providing energy quickly and with low up-front capital costs are pushing energy development toward small-scale power systems. Furthermore, environmental pressures, including the Kyoto Protocol, present two choices: either cut energy use or reduce the GHG emissions from that energy use. Reductions in carbon intensity will create burgeoning markets for high-efficiency distributed and renewable energy sources. In ABB's view, improving its products will do far more to mitigate climate change than fine-tuning its own production methods.[133]

ABB believes it is "uniquely placed to take advantage of this political push" to reduce the carbon intensity of energy for three reasons.[134] First, its global reach allows for rapid dispersal of technologies. Second, it has institutional understanding of power generation, transmission, and distribution that it can apply to distributed energy systems. Finally, ABB believes that its "investment in developing a full package of alternative energy technologies and solutions to suit the many different demands of customers and society" sets it apart from the competition and puts it in a position to lead this market.[135] The main opportunity for growth is the delivery of complete energy solutions offering everything from the energy supply to the management systems to the consumer's grid connections.

ABB's own internal emissions are small, less than two million tons of $CO_2$ per year, compared to the one billion tons of $CO_2$ emitted annually by ABB-built power plants run by customers.[136] Improving the products used by these customers, therefore, has much leverage. ABB's largest contribution to climate mitigation will be a demonstration that there is an alternative to centralized fossil fuel-fired energy

[130] *Ibid.*

[131] Burgin, S. "Profitable Sustainability Through Alternative Energy Solutions." Power Economics, March 2001.www.abb.com/global/abbzh/abbzh251.nsf!OpenDatabase&db=/global/ABBZH/abbzh258.nsf&v=2DD6&e=us&c=915F5441A48D103C412567C2005C7264.

[132] Eliasson, B. "The Road to Renewables: Energy Technologies for the Post-Kyoto World." World Energy Council Journal, July 1998.

[133] ABB, 2001.

[134] Burgin, 2001.

[135] *Ibid.*

[136] Lindahl, G. "Oikos—From Greenhouse to Cleanhouse." Presentation given to Oikos—International Student Organization for Sustainable Economics and Management. 20 April 1999. www.abb.com/global/abbzh/abbzh251.nsf!OpenDatabase&db=/global/ABBZH/abbzh258.nsf&v=2DD6&e=us&c=915F5441A48D103C412567C2005C7264.

systems that is economically efficient, flexible, and easily installed worldwide.

**ABB's Implementation Plan**:
ABB's internal emission reduction plan targets efficiency measures within its own production streams. An extensive ISO 14001 certification commitment has led to the certification of over 700 sites, accounting for over 90 percent of ABB's installations.[137] The company intends to seek certification of the remaining sites in the near future. This ongoing process will allow the company to identify further reduction opportunities as it audits its material inputs and emissions site by site. As CEO Göran Lindahl puts it, "What gets measured, gets done."[138]

ABB annually invests eight percent of its revenues, approximately $2.5 billion, in research and development, half of which directly or indirectly improves environmental performance of its products and systems.[139] Particular technologies and systems include:[140]

- Upgraded electricity transmission systems that are more efficient than traditional systems.
- Smaller, all-in-one electricity transformers that can be installed with any energy source worldwide to regulate distributed generation systems. This allows for easy, rapid installation of new electricity grids.
- Simple grid tie-ins, allowing small generators to contribute to the supply grid.
- Reengineered motors and manufacturing systems to reduce end-use demand.
- Offshore wind power installations that are competitively priced, efficient, and have little visual impact.

These projects frame the growth of economically feasible distributed generation. As a result, ABB has divested entirely from large fossil fuel plants and traded its interest in large-scale generation for smaller scale, environmentally friendly energy products, which it predicts to be a major growth sector worldwide.

The climate-friendly systems that ABB intends to build need market demand if they are to replace less efficient technologies. To initiate this market transition, ABB has expanded its presence in developing countries between 1990 and 2000—from 20,000 to 65,000 employees and business volume from $3 billion to $8 billion.[141] These are the prime markets for distributed generation, as they often lack comprehensive energy delivery systems, so expansion in these regions will prevent the adoption of more carbon-intensive systems.

**ABB's Successes**:
Internally, ABB has already surpassed its one percent emission reduction per year goal.[142] Beyond its corporate borders, ABB's vision of new energy markets based on distributed and renewable energy sources will be realized in new projects and approaches to energy demand in the future. These steps will vary from small improvements and fuel switching on a local level to installations of clean power sources to new connections to national grids. Already, products and life-cycle systems thinking have opened up the market for improved energy production, transportation, and use. In particular:[143]

- ABB's high-voltage direct current (HVDC) electricity transmission systems carry up to five times as much power as conventional systems with 20–30 percent less energy loss. These HVDC systems are being installed worldwide.
- ABB's process automation systems in the textile industry have been shown to increase productivity

[137] Lindahl, G. "From Fiction to Restriction." Presentation given to The Swedish Steam Users' Association's Research Foundation, Stockholm. 28 October 1999. www.abb.com/global/abbzh/abbzh251.nsf!OpenDatabase&db=/global/ABBZH/abbzh258.nsf&v=2DD6&e=us&c=F6094D9B2ACBF593C125696F0020828C

[138] Lindahl, April 1999.

[139–40] *Ibid.*

[141] Lindahl, April 1999.

[142] ABB, 2001.

[143] Lindahl, April 1999.

[144] Eliasson, 1998.

[145] *Ibid.*

by up to 15 percent, lower energy consumption by 20 percent, and decrease chemical use by 15 percent.

- ABB's Powerformer grid tie-in eliminates the need for a step-up transformer, along with its accompanying cooling system, switchgear, and other equipment, to attach a power plant to the grid.
- ABB has delivered more than 3,500 wind generators around the globe.
- ABB's Windformer enables the economical development of wind farms of 300 MW or more, expanding the flexibility and scale of wind generation.
- ABB's HVDC Light allows very small-scale generation sources to connect to a national grid, economically opening up distributed generation opportunities.
- ABB redesigned transmission substation components into a single unit, providing a 60 percent space savings that makes it easier to install substations in more places.
- ABB's Azipod marine propulsion unit uses a variable-speed AC motor and integrated propeller and rudder to save space and weight, improve maneuverability, and increase efficiency.
- The Northern Ireland utility NIGEN upgraded to ABB's high efficiency combined-cycle natural gas generation system, replacing a coal-fired system.
- The China Energy Technology Program, which assesses the impact of electricity generation in China from fuel input to end use, will help China deal with the harsh environmental impacts of its coal-based power generation systems.

These developments are promising, but their overall potential will not be realized until they have moved beyond niche applications and are adopted on a large scale. There are, however, promising indicators. Photovoltaic markets continue to grow at an average of 30 percent per year and price per kilowatt continues to drop as efficiency rises.[144] Wind power's worldwide installed base is increasing by over one gigawatt per year and has become competitive with fossil fuel-fired generation.[145] Cogeneration has strong market momentum and is reaching ever smaller and more decentralized applications. These indicators all support ABB's investment in the growth of distributed power.

**ABB's Lessons Learned**:

ABB simultaneously took on the climate impacts of both its internal production and the end-use of its products. While its internal goals were modest, they were easily met and have encouraged further efforts toward climate change mitigation. This may be the beginning of a cycle of improvement that will create both financial and climate gains.

Beyond its internal gains, ABB took on a share of responsibility for the emissions created by its products, a reflection of the potential it saw in providing customers with a line of off-the-shelf distributed generation devices. ABB identified a growing market for decentralized energy systems in less developed regions, and a demand for more efficient, climate-friendly energy. Switching the focus of its research, development, and expertise away from traditional energy systems has put the company in a position to take a large share of the distributed generation market. This shift toward emerging technologies has allowed the company to become more flexible and responsive.

ABB's efforts in emerging energy markets are based on an understanding of the balance between production and efficient consumption that has led the company to address both sides of this equation. Its experience with large scale, centralized systems allowed the company to realize that those markets were stagnating. Instead, demand is rising for more situation-specific, smaller-scale generation options to fill the gaps in old systems. Combining that demand with a recognition of the potentially costly political responses to climate change led the company to technical solutions that now make climate and financial sense.

The New **Business Climate**

A **Guide** to
Lower Carbon Emissions
and Better Business Performance

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Rocky Mountain Institute (www.rmi.org), founded by Hunter and Amory Lovins in 1982, is an independent, entrepreneurial, nonpartisan, nonprofit applied research center. Its ~50 staff foster the efficient and restorative use of natural and human capital to help make the world secure, prosperous, and life-sustaining. The Institute's ~$6-million annual budget comes roughly half from programmatic enterprise earnings, chiefly private-sector consultancy, and half from grants and donations. RMI is known worldwide for its work in advanced resource productivity, business innovations related to natural capitalism, and highly original transdisciplinary syntheses at the nexus of energy, resources, environment, development, and security.

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# The New Business Climate

A **Guide** to
Lower Carbon Emissions
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## About this guide

**Global climate change and the potential costs of $CO_2$ emission limits can impose risks to business performance and asset values.**

**On the other hand, these concerns also present new business opportunities for proactive companies and institutions. Profitable "no-regrets" energy-efficiency improvements are widely available today, and longer-term investments in clean energy technology will be increasingly attractive in a carbon-constrained world.**

**Meanwhile, flexible regulation and careful use of the emerging carbon markets can help manage costs. *The New Business Climate: A Guide to Lower Carbon Emissions and Better Business Performance* demonstrates how these and other opportunities can be captured by responding to the challenge of climate change in a way that stimulates innovation and improves business practices.**

***The New Business Climate: A Guide to Lower Carbon Emissions and Better Business Performance* contains the information you need to help you gain a basic understanding of climate science, climate policy, and the strategic options available for reducing $CO_2$ emissions and positioning your business to thrive in a carbon-constrained world. Specific recommendations for climate action follow most sections of this document.**

**Also, *The New Business Climate: A Guide to Lower Carbon Emissions and Better Business Performance* contains detailed case studies describing actions taken on climate change by several well-known companies.**