During the 1950s, a small band of meteorologists, physicists and chemists began conducting observations and building models linking an increase in CO2 and other gases in the atmosphere to the general warming of the earth’s climate, a phenomenon dubbed “the greenhouse effect”. Since CO2 was a byproduct of the burning of fossil fuels, these models implied that human activity was a contributor to this increase in global temperature. During the 1980s, the models drew more scientific adherents as additional observations lent further support to the theory. In 1988, the greenhouse effect hit the front pages, as NASA scientist James Hansen told a Congressional committee that he was “99 percent certain” that global warming due to the greenhouse effect was underway and could have potentially devastating consequences for the ecology of the planet.4

Since automobiles were a substantial contributor of CO2 to the atmosphere, scientists at General Motors, the world’s largest automaker, had started looking at the greenhouse effect in the mid-1980s. The wide-ranging discussions within GM had led to an ambitious program to improve the efficiency of internal combustion engines (ICE) and to seek an alternative powertrain that did not use fossil fuels. For GM, the search for a new powertrain required a substantial change in mindset, since the ICE had been a mainstay of the automotive industry for over 80 years. Nonetheless over the next decade, GM spent billions of dollars experimenting and building prototypes with an array of technologies; including diesel, battery, hybrid gas and electric systems, and hydrogen fuel cells. While GM researchers had made progress by 1998, the technical hurdles were steep; and GM believed it was nowhere near placing an automobile with a new type of powertrain on the market.

Besides the technical hurdles it was facing, GM’s efforts to introduce more fuel efficient vehicles had run into resistance from consumers, oil companies and the government. While consumers generally indicated that they liked the idea of an environmentally friendly automobile, they did not want to give up the performance they had come to expect from ICE-powered vehicles. Indeed, the trend in the US during the 1990s had been to ever larger and less fuel efficient sport utility vehicles and light trucks. Oil companies had proven resistant to the reformulation of gasoline and had not invested in alternatives to fossil fuels. Government officials refused to increase taxes on gasoline (which would make efficient cars more attractive) or allow more efficient diesel engines on the U.S. market.

Meanwhile, international efforts to prevent global warming had accelerated. A series of UN-sponsored conferences, bringing together the nations of the world, had culminated in a 1997 meeting in Kyoto, Japan. At the Kyoto meeting, an agreement was reached that the developed nations of the world would bring their greenhouse gas emissions back to 1990 levels within 15 years. The United States had signed the agreement, but most observers believed that the
agreement would not be ratified by the Senate. In 1988, a vocal, well-financed lobbying organization
called the Global Climate Coalition (GCC) had been formed by dozens of large corporations to debunk
the mounting scientific evidence concerning global warming and to warn of the catastrophic economic
consequences from capping greenhouse gases. The GCC’s lobbying efforts had paid off and the Kyoto
accords had little political support in the United States.

GM did not support the Kyoto Accords because the climate agreement exempted developing nations such
as China and India. However, GM did agree that global warming was “an area of concern,” and the
company was pushing ahead with its development efforts. While GM had been a founding member of the
GCC, GM executives and board had become aware that the debate had become increasingly polarized
with the GCC denying the existence of global warming while environmental groups were calling for
drastic cuts in the consumption of fossil fuel. With its significant investment in new technologies, in 1998,
GM believed the debate should be shifted to discussing feasible alternatives, but how could the company
position its environmental efforts in an increasingly polarized atmosphere?

GM’s Investment in the Future of Powertrains

Internal discussions

Scientists at GM’s large research and development center had first taken notice of global warming in the
mid-1980s. In 1987, the R&D staff assigned a few researchers to review the available scientific evidence
and present it to GM scientists, powertrain engineers and auto designers. This kind of forward-looking
research was possible because GM was going through something of a resurgence at the time. The
company had once again taken the top spot on the Fortune 500. After ceding some market share to the
imports during the early 1980s, GM had stabilized its position and was projecting strong sales for the rest
of the 1980s. Earnings were robust. (See Exhibits 1 and 2 for financial overview of GM.)

The discussions about CO2 led to rethinking the basic technology that automobiles had relied upon for
over 50 years. Not just global warming, but also the dwindling supplies of fossil fuels made it a real
possibility that over the next decades, automobiles would have to rely on an entirely new powertrain
system. Harry Pearce, vice-chairman of GM’s board, noted,

> The interest in the greenhouse effect opened the door to a much broader discussion about the
> industry 20 or 30 years down the road. A fundamental change in the powertrain would have
> enormous financial and competitive implications. The industry had a huge sunk investment in
> internal combustion engines and was trying to incrementally improve the efficiency of those
> engines. But the company recognized that if we are going to shift to hybrids and fuel cells there
> were significant economic implications. Independent of doing the right thing environmentally,
> you have to do the right thing financially for your shareholders.

The discussion required and furthered a dramatic change in mindset for the company. For decades, GM
researchers and engineers had been devoted to reducing the toxic gas emissions from automobiles such as
carbon monoxide and incrementally improving the efficiency of internal combustion engines. Indeed, the
company took some justifiable pride in its emissions reduction programs -- catalytic converters had been
installed in cars during the 1970s and in conjunction with unleaded gasoline had been able to reduce the
toxic gases in the environment.

But in the 1980s, the global warming research was implicating CO2, a gas that had always been
considered benign. “Prior to the 90s, if you could have everything end up as a CO2 emission, you were a
hero.” Dennis Minano, GM’s vice president for public affairs and chief environmental officer, observed.
“It was all about toxic emissions for thirty years.”
As GM’s mindset shifted, so did its research personnel. New technologies such as fuel cells required employing physicists, chemical engineers and technologists from the space program (which had been the first to employ fuel cells). Pearce noted,

Suddenly we are bringing to our company people who had never seen an automobile built. These engineers knew everything about fuel stacks but were clueless about how you would integrate such a device into a car. We had a lot of debates in the company, but eventually we were able to convince our people that these new hires may well be the company’s future powertrain engineers. There was resistance because historically our engineers had been wed to the internal combustion engine for all of their lives and couldn’t believe that there was going to be this transformation.

It took some time for the changes to work their way through the organization. GM was one of the largest industrial organizations in the world. Senior managers kept the board abreast of the developments. Pearce noted,

The discussion on global warming came up to the board in any number of ways. Sometimes there were direct reports on the topic. Other times it would come up as a reaction to prototypes of fuel-cell and hybrid vehicles that we developed for the auto shows. Directors would see these vehicles and would want to know about the science behind the cars, the environmental problems that these products were created to address and the economic potential of these products.

**Fundamental commitments**

As discussion of global warming made its way through GM, a consensus formed around three points:

- The environmental impacts of any new technology should be measured not just in the operation of the automobile, but for the entire system required to produce the energy;
- GM would consider the environmental impacts of not just of its products, but of the manufacturing processes it used to make the vehicles;
- Technical improvements would be evaluated by the number gallons of gasoline saved.

The cradle-to-grave approach to measuring emissions complicated consideration of the various technologies. For example, hydrogen fuel cells basically took the automobile out of the environmental debate, because their only byproducts were heat and water. But looking at the entire system proved more daunting. First, GM researchers spent an enormous amount of effort in trying to find the most efficient way to generate hydrogen for the fuel cells. One way was to run a fuel stack backwards, i.e. put electricity in and get hydrogen out. This would be done at service stations using the power grid and storing the hydrogen on site to be delivered to the vehicles. But this meant that the researchers had to consider how the electricity was being generated. If the electrical grid was powered by coal or natural gas, this would mean that this technology was implicated in the production of greenhouse gasses.

Despite the difficulty of making these kind of calculations, the approach had a great deal of support within GM. Senior management and the board agreed that in order to be environmentally responsible, the company had to look at every emission along the whole production chain.

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Whereas carbon monoxide and other pollutants were the byproducts of incomplete combustion and therefore could be curbed without influencing ICE performance, CO2 was the natural byproduct of combustion. For every ICE engine, a gallon of gasoline burned would emit five and half pounds of carbon. So reducing gallons burned, reduced CO2.
GM also made a commitment to monitoring the greenhouse and other emissions emanating from their plants. Pearce noted, “We were ready to go out and disclose things that other manufacturers would typically not disclose. Our view was if you don’t go out and disclose and monitor your improvements no one is going to believe that you have a commitment to improving.” But this effort of monitoring and improvement represented an extraordinary effort. Minano noted:

> Just consider how many reports had to be filed. We had 450 plants at the time and they were reporting air emissions, water emissions, toxic emissions - plant managers are reporting to the government under penalty of perjury all of time. And the fundamental integrity ethic has to drive them -- they have to believe that the company really believes in it. We made it clear that the management team and the board were behind this program. And while we may have exceeded a standard or two -- there was never any complaint about our reporting.

GM’s commitment to measuring their progress by the total gallons of gasoline saved greatly influenced the direction of the company’s programs. The mathematics of “gallons burned” could be counterintuitive. For example, increasing the efficiency of pick-up truck that got 10 MPG (miles per gallon) by 20% to 12 MPG would result in greater gallons saved then improving a 24 MPG compact car by 50% to 36 MPG, assuming that both vehicles drove the same distance. If one factored in that a commercial truck would likely be driven more miles than the compact, the incremental savings from improving the truck’s efficiency would swamp that of the compact.

Unlike other car makers that concentrated their environmental efforts on compact cars, the commitment to “gallons burned” led GM to look to trucks, busses and SUVs as candidates for commercial production of new technologies. Pearce noted:

> We weren’t going to go out there and market something just to be cute - so that we could say we had the first hybrid vehicle out… This wasn’t going to be a PR battle, this was going to be battle about technology and the environment.

**Working on a number of technologies at once**

GM’s research and development division began pursuing a number of different technologies at once, designing and testing multiple power train systems as well as working on incremental improvements on ICE vehicles. Pearce argued,

> This is an evolution and it is going to take a long time. Therefore it makes sense to do a number of things simultaneously. You want to be developing fuel cells, you want to be improving existing internal combustion engines, you want to be moving toward diesel technology. All this has to go on at the same time if you are serious about the end game environmentally.

Work on ICE vehicles led to incremental improvements to the existing fleet. GM worked on all aspects of vehicles to improve fuel efficiency, including nonpowertrain related aspects such as aerodynamics, tire design and vehicle mass. While these improvements rarely resulted in headlines, GM was incorporating these technologies into new models of its existing fleet and thereby was able to offer the most fuel-efficient model in many classes of vehicle.

GM also worked to improve diesel engines. Diesel engines were inherently more efficient than ICE engines, but earlier diesel engine cars had been noisy, odorous and unresponsive, making them unpalatable to most consumers. GM engineers worked on these problems and were able to produce

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1 Assume both vehicles drive 24,000 miles a year. At 10MPG, the truck burns 2,400 gallons and at 12 MPG, the truck would require 2,000 gallons - a savings of 400 gallons. In contrast the car would require 1,000 gallons at 24 MPG and 667 at 36MPG -- a savings of only 333 gallons.
diesels with similar performance to ICE vehicles. Pearce noted, “If you put someone in a modern diesel car, many couldn’t tell the difference between it and an internal combustion engine car.”

GM led in the development of hybrid powertrain systems. Hybrid powertrains combined a diesel or ICE engine with electrical motors and a battery that was charged by the gasoline engine or through regenerative braking. Depending on the particular “flavor” of hybrid, the electrical motors would take over at times, providing superior gas mileage. Because of the twin gasoline/electrical system, hybrids were expensive to produce. In 1997, Toyota had begun manufacturing a compact hybrid in Japan, the Prius, but observers noted that the car was subsidized. Pearce contended,

I view hybrids as a very important step towards what I see as the ultimate goal, which is affordable fuel cell technology. But any company whose fleet was entirely hybrids would be out of business because you don’t make any money.

Most people at GM believed that hydrogen fuel cells would be the ultimate end point in the transformation of the automobile. A hydrogen fuel cell produced electricity from the chemical combination of hydrogen and oxygen with some catalyst. Fuel cells differed from batteries in that they consume hydrogen in the reaction and therefore must be replenished. However, fuel cells dispensed far more energy than similar sized batteries and were less prone to wearing out.

GM invested heavily in developing fuel cells. They opened centers in New York and in Europe to improve fuel cell technology and to try to reduce costs (one problem with fuel cells is that one of the best catalysts is platinum, an extremely expensive metal). However, in 1998, commercial manufacture of automotive fuel cells was believed to be many years in the future.

GM senior management would be very deliberate in its introduction of new powertrain technologies. New engines or models were expensive propositions; the upfront costs in setting up production would require billions of dollars. Furthermore GM had had two well-publicized failures in introducing new powertrain systems in the past. In 1981, GM rushed to introduce the V8-6-4 engine for its Cadillac automobiles. The V8-6-4 was a variable displacement engine that would shut off fuel to two or four cylinders in light-load conditions like highway cruising, and then reactivate the cylinders when the driver needed rapid acceleration. The ability to cut the number of cylinders was designed to save fuel. However, the deactivation system didn’t work properly, and most consumers simply turned off the deactivation component.

In the mid-1970s, Oldsmobile had introduced a diesel engine that had an extraordinarily high failure rate, and the company was still trying to live down the fiasco. Even in 2005, an Automotive News columnist wrote,

In North America the specter of the GM diesel disaster clanks around in the auto industry’s attic like a restless ghost that won’t disappear. Responding to the high fuel prices and odd-even rationing of the 1970s, GM rolled out the diesel engines to boost fuel economy of its bigger cars. The defunct Oldsmobile Division produced a 5.7-liter V-8 and two different 4.3-liter diesel engines for mid-sized and large cars that were used by all GM car divisions. GM sold around 1 million vehicles with diesel engines from 1978 to 1985. GM developed the diesels on the cheap. The 350-cubic-inch (5.7-liter) V-8, for instance, was based on a gasoline engine. The diesels were notoriously unreliable. They often suffered catastrophic internal failures curable only by a replacement engine that - made with the same defects - also failed. GM’s engineering reputation took a major bruising. GM diesels stunk up the market so badly that other automakers' diesel sales suffered.

Pearce noted about these engine problems,
These are two good examples of having technology that you know that you want, but because you move too fast, you create this disastrous ill will in the consumer community... We should have known it was going to take time. We took an existing ICE engine and tried to transform it into a diesel and it was a failure. You can’t do an engine program from the ground up in a short time because a powertrain is a very complex beast. Today, some 25 years later, both these technologies have been very successfully executed in many GM products.

Prototypes

Besides working on individual technologies, GM worked on two important prototype programs during the 1990s.

In 1990, GM began work on its first all-electric vehicle, the EV1. The EV1 was the first “purpose-built” electric vehicle; it was designed from the ground up to be an electric vehicle and was not a conversion of an existing vehicle or power train. By 1992, preproduction testing of the vehicle had begun; and in 1997, GM offered 650 EV1s for lease through its Saturn dealerships in Arizona and Southern California (because of limitations on its battery, the EV1 was not suited for operation in colder climates). It was estimated that GM sunk nearly a billion dollars into the development of the automobile.

The EV1 relied on a number of new technologies. Besides the battery-powered electric powertrain, the EV1 was designed to reduce power usage with its lightweight body, superior aerodynamics (the EV1 sported the smallest drag coefficients of any production car ever) and low rolling resistance tires. The EV1 was no golf cart; the car could go from 0-60 MPH in under nine seconds and could exceed 100 MPH (without governing).

In putting the car out on the market, GM was hoping to gauge consumer reaction. While every car was leased, GM believed the market was limited because the car was only a two-seater with limited carrying capacity (nearly half of the car’s weight was in batteries). The car could go only about 90 miles before having to be recharged, and there was some problem with the batteries. However, many of the lessees were quite enthusiastic about the car and reported that driving the EV1 was a joy; the electric motor and the aerodynamics meant that the car operated smoothly and in near silence.

One impetus to the EV1 program was a California law that mandated that car companies offer a zero-emission vehicle to the public by 1998. However, the deadline was extended and GM only manufactured a few hundred more of the vehicle. Despite the limited market, Pearce argued that the EV1 was a necessary first step in developing other alternative vehicles. “We needed to learn how to manufacture electric propulsion and control systems because that was going to be the foundation of every future hybrid and fuel cell car,” he maintained. “Nobody had done that before and put it into the hands of the consumer to see how it worked.”

Another prototype program was launched in 1993 as a collaboration among GM, Ford, Chrysler, eight federal agencies, and the national laboratories. Dubbed the Partnership for a New Generation of Vehicles (PNGV), the collaboration was to bring together engineering thought leaders to build vehicles that would get more than 80 MPG and yet would have the features most consumers expected in a five-passenger sedan. In its conception, PNGV had tremendous risks. It required a substantial commitment of resources, would raise difficult intellectual property concerns and with collaboration among the big three

† The California law was overturned in 2003, and GM ended its lease program by recalling all EV1s. Some of the EV1 lessees wanted to buy the car, but GM did not want to continue to support the vehicle and therefore ordered all of the cars returned. This led some to suspect that GM’s program was a conspiracy to limit the acceptance of electric vehicles, and in 2006, a movie entitled “Who Killed the Electric Car?” proposed that the car was withdrawn due to oil company pressure. GM has denied all of these allegations.

6 GM AND KYOTO (1998)
automakers raised anti-trust problems. In spite of these issues, GM committed to joining. Pearce observed,

> Given the environmental issues and the complexity of the technology, this kind of partnership was inevitable. But there was a great deal of risk, so it was important that the government stepped out and supported the program. We went to our board and presented the program and they gave it their strong support.

Under the NGPV, each company worked on its own prototype vehicle while sharing information on new technologies. In the highly competitive auto industry, this meant that each company was worried about what they were getting out of the collaboration versus what they were giving up in terms of proprietary technology. The collaboration was run by a large steering committee of engineers that helped shape the research and iron out disputes.

NPGV was credited with pioneering a number of new technologies that allowed car manufacturers to reduce the mass of the automobiles, increase the efficiency of fuel cells, clean up diesel exhausts and create a frictionless carbon coating many times slicker than Teflon. As part of its efforts, GM managed to build an 80MPG diesel-electric hybrid dubbed the Precept that was unveiled at the 2000 Detroit Auto Show. Beside the technologies, Pearce noted that the project was important for the collaborations it opened with government. “We gained a lot of information about how government makes a decision. I look back on the project and think despite the high costs that this was a good project. It cemented relationships with the DOE and the federal labs.”

But as exciting as the EV1 and the NPGV were, the prototypes would not be put directly into production because of their high cost of manufacture. Pearce argued,

> Some of the more naïve members of the environmental community think “Okay, now you have made one of these vehicles, so put them into production.” But that was absurd. There was no way you could immediately manufacture these experimental vehicles cost effectively. But the work we did on the materials, the aerodynamic research we did on the body plus the incredible power train technology spawned all kinds of spin-off improvements in our production vehicles.

The problems with other stakeholders

In 1901, Ransom Olds manufactured the first American automobile with an internal combustion engine. In the years since, the automobile had become the center of a massive governmental-industrial complex and replacing this system would not be easy. Modifications to the ICE or wholesale changes to the powertrain would require support from a number of stakeholder groups. Customers would have to change their expectations and adopt new maintenance routines. Energy companies would have to reformulate their products or deliver entirely new products. The government would have to draft new regulations and structure incentives to channel consumers to fuel efficient vehicles.

However, in its efforts to improve the energy efficiency of its vehicles, GM was finding that gaining cooperation of these groups was difficult.

Consumer reactions

GM was insistent that any new cars it introduced meet with consumer support. The company was not interested in subsidizing environmental cars, arguing that such a subsidy was not sustainable over the long run and therefore cars that required a subsidy were not a long-term solution to environmental problems. Like any other vehicle, environmental cars had to justify themselves in the market.
For GM, the experience with the EV1 confirmed that the market for new technology automobiles was small, as long as the new vehicles did not match the performance characteristics of ICE vehicles. Surveys indicated that while consumers were interested in environmental features, they were unwilling to give up any of the performance associated with ICE vehicles or pay a significant premium. Pearce noted,

> Customers in our industry have become pretty spoiled. Consumers want their cars to come in at the right price point; they want all the performance that they are used to, and they never want to bring it in for any maintenance. They want the same interior space and the same range [about 250 miles between refueling] ... There is a small subset of the consumer market who have both the economic resources and the commitment to buy the hybrids, but it is naïve to think that there is a substantial population out there that is willing to invest thousands of dollars into vehicles that don’t produce greenhouse gases.

In 1998, GM was manufacturing the automobile with the best EPA ratings for fuel efficiency, the Chevy Metro. Beginning with its debut in 1988, the Metro was consistently ranked the most fuel-efficient car by the EPA with 53 miles per gallon in the city and 58 miles per gallon for highway driving. City drivers lauded the car for its gas mileage and ability to fit into small parking spaces, but despite its cheap price tag and other benefits, the car’s long-term popularity was stunted. While GM saw strong sales of the Metro in the early 1990s, consumers wanted a car that had more cargo and passenger space (one writer described the car’s cramped backseat as suitable only for children) and more oomph than the Metro’s three-cylinder, 55-horsepower engine could muster. Critics also questioned how well the Metro, which weighed as little as a motorcycle, would hold up in a crash because of its miniscule frame and lightweight construction. GM redesigned the Metro in 1995 to make it sturdier and safer, but it was still a small car, and now it carried a bigger price tag. Sales lagged.

What were selling were GM’s lines of sports utility vehicles (SUVs). SUVs were not classed as automobiles but as light trucks. Their popularity surged during the 1990s (see Exhibit 3). A vehicle that had previously been thought of as a niche vehicle for the dedicated outdoorsman or tradesman was becoming the vehicle of choice for suburban car pools and soccer moms.

Two reasons seemed to be driving SUV sales. First, gasoline prices had dropped to record lows. Since the end of World War II, gasoline prices, in real dollars, had never been lower than they were in 1998 (see Exhibit 4). Therefore, while SUV gas mileage could be half that of standard sedans, U.S. consumers found gas cheap and plentiful. Secondly, SUVs seemed to offer greater safety. They were higher off the ground, providing better sight lines and were roomier than sedans. Pearce observed,

> I think that we had many consumers making a very rational choice. They wanted to sit higher to have better visibility and they wanted to feel safer. We knew that bigger is safer. If you were going to have an accident, you were clearly better off belted in a Suburban. That data was public information. We were being told smaller and smaller, but in terms of passengers and drivers, eventually you run out of room where you can safely decelerate.

The sale of SUVs was proving to be very profitable for GM and other U.S. automakers. While the margins on automobiles had fallen to below five percent on most makes and models (when accounting for extensive dealer incentives offered by the manufacturers), the margins on pick-ups, SUVs and vans was above 15%. In 1998, an industry analyst for Credit Suisse argued,

> The main reason for this [the increased profitability of SUVs and trucks] is that while global overcapacity for passenger cars allows scant profit in the U.S., the demand/supply equation for trucks is much better. While Americans have increased their demand for trucks, most automakers around the world simply do not have enough home-market demand to design and build a wide array of pick-ups, sport-utility vehicles and minivans. For the most part, these are gas-guzzlers to the rest of the world, where gasoline prices are three-to-five times higher than in
the U.S. As a result, in general, only U.S automakers have the truck product that Americans demand, and capacity is still below demand.

Because of the high margins on light trucks and SUVs, these vehicles had become an important part of GM’s financial outlook. GM had stumbled during the recession of 1990s, posting huge losses at the beginning of the decade. As the economy improved and SUV sales took off, GM had once again had become profitable.

However, SUV sales and their lack of fuel efficiency generated a great deal of internal debate at GM. Because of increased SUV sales, GM’s overall fleet MPG had dropped. Pearce noted,

In the end, we all agreed that what we build and sell is going to be determined by the market. The consumer is the person that is going to be making the decisions. If the consumer is driven by environmental concerns, then fuel economy will determine our sales. But if the consumer is driven by other factors, those are the ones that we are going to respond to. We ought to have a product that they want and can buy. For us or the government to deem otherwise is not in keeping with what this company is all about and is at odds with market forces.

Oil companies

No matter what technical path GM and the auto industry ultimately chose in terms of an alternative power train, the oil companies would have to be part of the equation. Pearce observed,

There isn’t a solution to environmental problems that doesn’t involve the oil companies. Whether it’s ethanol, diesel, hydrogen or the grades of gasoline, they have to be on board.

During the 1970s, the oil companies had worked with the auto companies to push one of the more important advances in making automobiles environmentally friendly – the catalytic converter. The catalytic converter required unleaded gasoline and thereby forced the oil companies to rework their refining process in order to provide the fuel. It also required retrofitting the hundreds of thousands of service stations nationwide with additional pumps for the unleaded gas.

During the 1990s, GM had spent $40 million testing various formulations of gasoline and trying to get the oil companies to increase the quality of their product. One particular culprit was sulfur: high sulfur gasoline gummed up emissions control devices as well as putting dangerous gasses in the air. However, the oil companies balked. With the leadership of GM, the auto companies filed a petition with the EPA to force the oil companies to produce the low sulfur gas. Minano observed, “We had to do this, because it doesn’t matter how much you tweak the internal combustion engine if you don’t get the fuel situation right.” Pearce argued,

And there is no natural incentive for the oil companies since it all requires greater costs. The refining capability of this country is right at the limit. While the oil companies are expanding the capacity of some existing refineries, they aren’t building new refineries. And this frustrates me, because these companies are making huge profits.

Gaining co-operation from the oil companies was crucial to setting up a hydrogen fuel infrastructure. Without an infrastructure in place, even a successful hydrogen automobile would have trouble gaining acceptance. Pearce noted,

Let’s face it: we have never had anything except internal combustion engines. We have no history of even thinking about a different way of converting energy. So if we make the mistake of not getting the fuel infrastructure right upfront, there are going to be huge negative consequences.
While initially all the oil companies downplayed the idea of global warming, over the course of the 1990s, differences began to appear. GM found that some of the oil companies were willing to explore alternative fuels. Pearce recounted,

*We could talk to BP and Shell, but not Exxon - they were going to go to war. With Exxon, they said that if global warming is correct, it is going to be the end of our business, so we cannot let this idea gain a toehold."

*We have spent a great deal of time working with BP and Shell and some of the other oil companies. Our pitch to them was that we are absolutely committed to the fact that hydrogen was going to be the fuel of the future. We believe that in time fuel cells will displace internal combustion engines. We understand that you are going to be taking an enormous risk in parallel with us if you invest in this technology… It is a hard thing to convince the oil companies how they should invest their money. They have to believe that you are fully committed to this transformation. And they have to have some understanding of what the time frame is going to be before they think about multi-billion dollar investments.*

**Federal government**

While GM had worked with the federal government and the other US car companies to create research consortium, there were other areas in which GM had tried to influence federal environmental policy to no avail.

In 1992, GM along with Ford and Chrysler approached the incoming Clinton administration with a proposal for a 50 cent per gallon increase in the gasoline tax (gas was selling at about $1.00 a gallon at time with about 18 cents in federal taxes). The automakers believed that such a sizable increase in the gas tax would drive consumers to more gas efficient vehicles. Pearce noted,

*We convinced ourselves that the only way that you were going to change the fundamental environmental dynamic was by raising the price of gasoline… Europe is a shining example of this dynamic and is the reason that European vehicles get higher fuel efficiency than vehicles in this country. Natural market forces drove that vehicle development priority in Europe.*

Minano observed, "Every economist and their team said that you guys are absolutely right. This is the right policy direction."

While the proposal received some consideration, congressmen began scaling back the proposal. In lieu of a gas tax, some law makers, much to the approval of GM and the other automakers, began to study the possibility of a carbon tax. Basically, this would have taxed all energy sources on the basis of how much carbon was burned. Pearce recalled,

*We had quite a discussion at the Board concerning the carbon tax because it forced industries to go head to head depending on whose ox was being gored. If you could cut across all the industries and impose a tax on hydrocarbons, that seemed to make sense to us. The complexity of US industries however, would have made that impossible to implement, even though, I think that would have been the best solution to our problem.*

The carbon tax idea did not pick up enough support in Congress. Eventually Congress passed a modest 4.3 cent per gallon increase in the gas tax as part of President Clinton’s deficit reduction package. However, the idea of a significant increase was deemed politically infeasible.

Another point of controversy between GM and the government was over regulations governing diesel engines. The new generation of diesels that GM and other manufacturers had developed was 20-30 percent more efficient than similarly-powered ICEs. In Europe, diesels had become a popular alternative
to ICE cars. While diesels would require making a substantial investment, GM was willing to build the production facilities.

However, diesels also produced more particulates and NOX gases than EPA regulations allowed. So the EPA ruled that GMs diesel engines would not be allowed on American roads, despite the substantial decrease in greenhouse gases diesels would have delivered.

**Political Dimensions**

**The Road to Kyoto**

Even before NASA’s James Hagen testified to Congress that he was 99 percent certain that global warming was underway, the World Meteorological Organization (WMO) recognized the need for an objective, balanced, and internationally coordinated scientific assessment of the effects of increasing concentrations of greenhouse gases on the earth’s climate. In 1989, the WMO and the United Nations Environment Program established the Intergovernmental Panel on Climate Change (IPCC). While the IPCC would not directly sponsor research or establish monitoring posts, the organization would bring together climate scientists (broadly conceived to include meteorologists, chemists, engineers and even environmental economists) to assess:

- The state of knowledge of the science of climate and climatic change;
- Programs and studies on the social and economic impact of climate change;
- Possible response strategies to delay, limit, or mitigate the impact of adverse climate change.

Over time, the IPCC relied on the work of more than 2500 scientific expert reviewers and published the work of 850 different authors representing over 100 different countries.

The IPCC issued its first report for policymakers in 1990. The report affirmed that there was a natural greenhouse effect. The scientists argued that the evidence showed that emissions resulting from human activities were substantially increasing the atmospheric concentrations of the greenhouse gases and would result in the unprecedented warming of the earth’s surface. This warming, in turn, would cause an increase in global sea levels and other climatic disruption. The panel noted that owing to the complexity of the climate, it was difficult either to estimate a timetable for global warming or to state unequivocally that the warming was the result of human activity.

The IPCC report fed growing concerns and led to the scheduling of a meeting of global leaders. On June 3, 1992, in Rio de Janeiro, Brazil, representatives of 178 nations met in an historic summit on climate change, known as the United Nations Conference on Environment and Development, commonly referred to as the Earth Summit. Over the course of 12 days, the parties drafted the first-ever global plan for sustainable development.

In terms of global warming, the treaty that promoted the greatest impact was the United Nations Framework Convention on Climate Change (UNFCCC). The 154 nations that ratified the UNFCCC pledged a reduction of greenhouse gases to 1990 levels by the year 2000. The UNFCCC put forth the principle of “common, but differentiated responsibilities,” in which developed/industrialized countries agreed to greater responsibilities in reducing greenhouse gas emissions than underdeveloped nations. While many environmental activists had called for binding emissions standards, the Rio treaty’s obligations were voluntary with only the promise of mandatory controls in the future. In the fall of 1992 under the Bush Administration, the United States signed the UNFCCC treaty. By 1994, fifty countries
had agreed to participate in the convention, facilitating the first UNFCCC Conference of the Parties (COP) in Berlin.

The Berlin meeting took place in the spring of 1995. The conference focused on complaints surrounding mandatory emission reduction levels, with many nations citing the need to set expectations on an individual basis. To address this issue, the U.N. drafted the “Berlin Mandate,” declaring that a two-year Analytical and Assessment Phase (AAP) would be undertaken to determine the carbon dioxide per capita emissions reduction level expected of each country. Although the largest greenhouse gas producers in the succeeding fifteen years were expected to be developing nations such as China and India, the Berlin Mandate eliminated expectations of greenhouse reductions from these countries.

The free pass on emissions standards proved controversial, especially in the United States. Developing countries like China and India, whose aggregate CO2 levels were high and expected to grow, nonetheless had relatively low per capita CO2 levels (see Exhibit 5). To stimulate their economies, developing countries argued that they needed to industrialize without CO2 restrictions. These developing countries maintained that the greenhouse problem had been brought on by the industrialized world, and therefore the industrialized world should take the first steps to solve the situation. Both at Berlin and later at Kyoto, representatives of the developing world held firm to this position. “This is a matter of human rights,” the leader of the Chinese delegation proclaimed at Kyoto.

However, the U.S. (joined to a lesser extent by Japan and Australia) insisted that the developing nations commit to some form of CO2 reduction. Without their participation, the U.S. maintained any accord would be both substantively flawed and politically unpalatable to domestic audiences. Meanwhile, European countries were resigned to the position of the developing countries and yet were willing to bind themselves to making CO2 cutbacks. To add to urgency, the IPCC issued its second report to policymakers in 1995. The panel reported that scientists had become more certain that global warming was underway and that man-made emissions were the leading cause of the greenhouse effect. These positions set the stage for the talks in Kyoto.

On December 1997, the UNFCCC met in Kyoto, Japan. For eleven contentious days, the nations of the world held marathon bargaining sessions trying to hammer out a compromise between very divergent positions. During the initial bargaining sessions, each side held firm to their positions. The United States tried in vain to get the developing world to at least make some symbolic concessions to reducing CO2 levels in their jurisdictions. Mid-conference, U.S. Vice President Al Gore flew to Kyoto to urge some flexibility. While the developing countries still refused to budge on their own emissions, Gore got their agreement to allow developed counties to fulfill their emissions quotas by doing reforestation and the promise of an emissions trading scheme where developed countries could get credits by reducing emissions anywhere on the planet. In return, the developed countries agreed to mandatory cuts to lower greenhouse gas emissions between six to eight percent below 1990 levels during the first emissions budget period of 2008 to 2012 (The United States was obligated to reduce emissions by seven percent below 1990 levels by 2012). The developing countries were exempted from any emissions cuts.

Without the binding targets on the developing world, Republican members of the Kyoto delegation were quick to declare the treaty dead on arrival. Rather than submit the treaty to Congress where it would face certain defeat, the Clinton administration signed the treaty but left it unratified as of the end of 1998.

For its part, GM sent delegations to each of the international meetings, from Rio onward. One purpose of attendance was to gain information on the positions of the various delegations and the potential regulations that might come of those positions. In addition GM was interested in presenting its own work and opinions to the delegates. Minano noted,

We even took the risk of presenting what we were working on, a decision that wasn’t always popular. But we took the position that that was what American business needs to convey on a world stage. We wanted to be involved with the thought leaders. We entered those settings in
two ways: First we talked about technology. Whether you believed or don’t believe in global warming or are only semi-committed, it is technology that is going to have to drive this. The second thing we talked about was responsibility to the customer and our shareholders.

The Global Climate Coalition

At Kyoto conference, Friends of the Earth, an environmentalist group, polled delegates as to which organization was the worst of those organizations opposed to the climate accord. The winner of the “scorched earth” title was the Global Climate Coalition (GCC), outpacing even Exxon as an opponent of climate change regulation.

The GCC was created in 1989, shortly after global warming sprang into public consciousness. Besides General Motors, the group’s founding members included BP, the American Forest & Paper Association, American Petroleum Institute, Chevron, Chrysler, Exxon, Ford, Shell, Texaco, and the United States Chamber of Commerce. At its height, the GCC claimed to represent over 230,000 businesses (numbers buoyed because the coalition included umbrella organizations such as the Chamber of Commerce).

Despite its “green-sounding” name, the GCC soon became known as a vigorous and unrelenting critic of efforts to curb greenhouse gasses. The GCC, from 1989 on, opposed every legislative and diplomatic initiative aimed at capping or curbing CO2 emissions by direct lobbying, sponsoring scientists it found congenial to its views and appealing directly to the public through advertisements, solicited op-eds, and glossy publications. The coalition promoted a two-pronged message. First, spokespeople for the organization argued that efforts to cap CO2 would greatly harm the economy. In the aftermath of Kyoto, the GCC sponsored a study that argued that the CO2 curbs proposed in the treaty would cost the U.S. economy $350 billion a year and result in the loss of 2.5 million jobs.

Secondly, the GCC attacked the science behind global warming, claiming that scientific models and studies were wrong or that the evidence for the phenomena was inconclusive. The GCC identified global warming skeptics and placed articles by these scientists in prominent publications. But the GCC went beyond promoting the work of scientists to producing its own reports and studies. For example, it distributed a video to hundreds of journalists at the Earth Summit in Rio claiming that increased levels of carbon dioxide would increase crop production and help feed the hungry people of the world.

At times, the GCC’s tactics recalled those used by politicians in tight political races. For example, the GCC alleged that the 1995 IPCC report arguing a definitive link between the burning of fossil fuels, the increase in atmospheric CO2 and climate change had been altered to suppress the scientific uncertainty behind this claim. To bolster its allegation, the GCC showed that there were changes in one chapter between the agreed upon draft of the report and the final version. Even though the chapter’s author said that the changes were done for stylistic reasons and the IPCC did not in any way change the substance of the report, the GCC continued to maintain that the entire report was tainted.

One columnist for the Financial Times labeled the GCC as “a relentless purveyor of confusion.” As the scientific support for global warming mounted, the GCC would find skeptics, some with fairly dubious credentials (a list of global warming skeptics produced by the GCC included a few TV weathermen), to counter any study so that the press would report that science concerning global warming was still controversial. Many commentators drew parallels between the GCC’s activities and those of the Tobacco Institute, which used similar tactics to deny the link between cigarette smoking and cancer.

Whatever the morality of its tactics, the GCC was proving to be extremely effective in moving U.S. public opinion and policy. The GCC had been influential in insuring that the Rio Earth Summit did not end with binding or mandatory commitments in the reduction of CO2 emissions. One prominent German publication noted that the GCC’s goal at Rio had been to “ensure that climate protection negotiations end in the never-never land of vague declarations.” In Washington, the GCC led the charge against both the
gasoline and carbon tax, scuttling both initiatives. In the aftermath of Kyoto, the GCC produced television commercials against the accord and managed to get 95 senators to oppose the treaty.

The GCC’s positions and tactics were not just infuriating to environmentalists, but were a cause for concern among some of the coalition’s members. In 1995, Du Pont quietly quit the group. Then in 1996, BP made its exit from the coalition in a very public fashion. In a speech at Stanford, BP’s chairman Lord Browne announced that BP had come to see the scientific research on global warming as compelling and would dedicate its efforts to becoming a “green company.” As part of those efforts, Lord Browne announced that BP would not oppose efforts to curb greenhouse gasses and would quit the GCC. In early 1998, Royal Dutch Shell pulled out of the coalition, citing its support for Kyoto. In addition, the company had commissioned a poll that showed that people felt it was uncaring about the environment. “We looked in the mirror and we didn’t like what we saw,” a company spokesman told a London newspaper.

Responding to the Kyoto Accord

Overall, GM was opposed to the Kyoto accord. The company felt the accord’s greatest drawback was its exemption of developing countries from the CO2 limitations that were imposed on the developed world. In Pearce’s view that meant the accord would do little to actually tackle the problem of global warming. He noted,

My concern was that Kyoto could hide the reality of what could happen globally. Let’s assume that everybody signed up. Well, even that wouldn’t be enough. We all knew that China and India were putting up a couple of coal-fired power plants a month and to not look at the CO2 consequences of that and make them a part of the solution would swamp anything that could be accomplished in Europe and the United States. The Kyoto accords were fatally flawed in that the reality of international politics was that you were not going to impose the standards that you were imposing on Europe the US and Japan on the developing countries. My view was that we needed a much broader discussion on the issues. Just arbitrarily setting limits and ignoring what was going to become 75 percent of the CO2 production down the road just didn’t make any sense. It was going to cause people to become complacent and feel the problem had been addressed when it had not been addressed at all.

An accord that included the developing countries would give those rapidly industrializing regions an incentive to develop along a more environmentally friendly technical path. Pearce argued,

I really felt that for countries like China there was a tremendous opportunity for countries like the United States and companies like GM to give them leapfrogging technologies. For example, we had discussions with the Chinese about giving them our fuel cell technology for stationary power generation so that you could use fuels cells for distributed power generation instead of building all of these coal fired generating plants and they were very excited about that. And that made more sense to me, rather than hashing out an international treaty that took the focus off what was important.

Besides voicing its opposition to the accord, GM felt it needed to understand the accord and its impact on the automobile industry. Within GM there was a great deal of trepidation about the agreement. The head of GM’s truck division looked at the text of the agreement and argued that it could put the company out of business. Minano said that GM’s top management decided that it was important not to be fearful of the accord, but to engage various groups, not just to inform them of GM’s position but also to find out the implications of the accord. He noted,

After Kyoto was signed, we took part in every forum about the topic. We assigned not just our best technologists, but also our top economists to the question, because you had to understand the economics of the situation. We surrounded our public policy center with GM employees who could help us make sense of both the technology and economics.
While the United States would not ratify the accord, other developed nations where GM did business were backing the agreement. The company launched a major effort to discover how the agreement would impact their products and operations. Minano noted,

> We certainly needed to understand the way that Kyoto would be implemented, government-by-government, in the 150 countries in which GM was present. Is this going to require a changed regulatory structure? Is this all about getting to a specific number? Is this about creating more cities with no vehicle zones? Is it about creating demonstration vehicles? Our board wanted to know what these countries were thinking and how they were going to implement this concern.

As a global company, GM operated in countries such as Germany, where the government embraced the Kyoto agreements. The reality, Pearce observed, was

> We couldn’t create a master position in the US and expect all of our subs to fall into line. That was totally unrealistic… You have to respect the policies of the countries in which you operate. You can’t articulate this overarching position at the top that is supposed to reflect the soul of the entire company. You can say that we don’t fully understand the science and agree that there may be an impact from CO2 on the environment. But when it gets down to actual requirements, there is no way you are going to take what Opel complied with in Germany and simply export it to China or the US.

**Cause for Concern**

The post-Kyoto discussion on global warming had become increasingly polarized. For its part, GM executives were trying to advance what they thought was a carefully considered moderate position acknowledging global warming as a problem that could be attacked through the deliberate application of new technology. But this position was not resonating with the public and the press. Pearce noted,

> The debate had gotten very shrill...What worried me at the time was that the strongest voices were at either end of the spectrum, as opposed to the thoughtful centrist who thinks “Yes, there is some risk. But let’s not overreact because we can destroy whole economies if we don’t put this into context.”

While steadfastly opposed to the Kyoto Accord, GM executives were breaking with other manufacturing companies and crediting the increasing scientific evidence of the greenhouse effect. In 1997, GM Chairman Jack Smith first noted that GM believed that greenhouse gases and global warming was a “cause for concern.” In a speech to the Automotive News World Congress in January, 1998, Pearce echoed these sentiments:

> Despite uncertainty about global climate science, General Motors has concluded that there is enough evidence linking global climate change to man-made greenhouse gases to have a cause for concern, and we’ve said so. And having said so, we accept certain responsibilities with respect to our products and manufacturing process.

As part of its efforts, GM also renewed its call for a 50-cent-a-gallon gasoline tax. In addition, GM joined with BP, Monsanto, and the World Resources Institute (a Washington DC environmental group) to produce a report “Safe Climate, Sound Business” that called for “durable policy pathways” that would maximize both environmental protection and economic development.

GM was receiving a lot of negative comment from other manufacturing and energy companies. Oil companies railed against the 50 cent gas tax. An editorial in the *Oil and Gas Journal* wondered,

> What got into executives of General Motors Corp. last week? At a news conference in Tokyo, top officials of the world’s largest automaker joined the worldwide whine about global warming and said the U.S. should raise gasoline prices by 50 cents/gal. The oil industry and gasoline
consumers, some of whom drive GM products, should not welcome their observations… Calls by companies for higher taxes on individuals, especially taxes designed to limit popular choice, do not represent shining moments of corporate citizenship. Besides, recommendations by companies that customers surrender growing shares of their money to official treasuries just don’t seem like smart business.¹⁰

Industry lobbyists felt GM was breaking the united front they had tried to erect to counter not just the Kyoto accords but also any regulation of greenhouse gases. They believed that any concession that global warming was the result of human activity would give government the cover for passing regulations. GM’s efforts to improve its environmental position seemed like poor politics. “GM is trying to have it both ways,” one lobbyist told the Automotive News.¹¹

Despite its stands on global warming, GM was still being associated in the popular mind with the oil and energy companies. Pearce noted, “It was always troublesome to me to see GM get lumped in with other companies by the press as if we had no sensitivity or concern and that simply wasn’t the case.” GM executives noted that the press did not report on its incremental improvements to ICE vehicles or its leadership in new technologies. Therefore, for many, GM’s position was no different than that of those companies who insisted that global warming was not happening. For example, University of Washington students urged its board of regents to divest stock in the “Egregious Eight” corporate contributors to global warming, including GM, Allegheny Energy (a coal company), Chevron, Exxon, Ford, Mobil, Southern (a coal company) and Texaco.¹²

There were some who were urging GM to come out and make a blanket statement that they were a “green company” like BP. Minano noted that “Every environmental group and every policy leader said to us that we were the only company that could stand up and say I am green, because you have the data.” But Minano argued that making such a declaration was not in keeping with GM’s long term goals;

Yes, you could say “We’re green” but then you have to answer the second and third question. What does that mean to your company? What are you doing and why? It is hard to be a high integrity company. While saying you are green might be a nice statement, how you answer the other questions are key to how you govern your company responsibly. The leadership of the company and the board was always thinking of the larger framework rather than the short-term PR win.

There was a great deal of discussion within GM about continuing to stay within the GCC. Pearce noted that the denial of global warming among some members of the GCC was “almost a religious” commitment. This led to statements by GCC members that GM found to be excessively one-sided. Pearce noted,

The statements from the GCC were moving out to the edge of the discussion. GM has never been comfortable with taking extreme views. We knew from the early days that this was an exceedingly complex issue from a scientific point of view. We knew we didn’t know enough; hence we were not comfortable taking a position that was always negative. We wanted to find a constructive middle ground and endeavor to keep current with the science.

However, the GCC had adopted a position on Kyoto that was consistent with GM, that the treaty was flawed because it did not include the developing countries. Pearce said of GM’s continued participation in the organization,

When you are within an organization that you feel is going the wrong direction, your first inclination is to stay and try to redirect the organization. So we were not eager to leave the GCC. In fairness to the organization, there were a number of points of view within the coalition… It was typical of GM to move with a lot of deliberation; maybe that is just the nature of a large organization.
The place of GM within the GCC, the company’s advocacy work on environmental issues and the direction of GM’s development program were interrelated questions. Pearce noted, “This is not about who is right and who is wrong. What we needed to determine was given the role and stance of our company, how do we want to be debating this issue?”

In 1998, there remained a great deal of uncertainty around the issue. Within GM, there were those who felt that regulations on greenhouse gases could significantly hurt the company. Furthermore, the company felt that the science of global warming was not yet a settled issue. In this context, many at GM believed that the best role for the company to play was that of a “constructive critic;” pointing out alternative solutions (such as diesels) to environmental problems as well as reminding the public of the significant costs and commitment required to implement new technologies. Minano argued,

There is an environmental component to the story, but you have to be cognizant of how you were going to position your company so that in 20 years people will want you to still be around. The environmentalists were saying that you have to change the technology of the internal combustion engine and all the technologies surrounding it. This meant that you had to change the fundamental model of your business, and that is a big thing to do in short time. The public had to realize that when you talk about climate and the environment you have to talk about massive technical innovation, a new business model and the long-term obligation of a company to its customers, employees and investors.

17 GM AND KYOTO (1998)


12 “University of Washington Students Urge Board of Regents to Divest of ‘Egregious Eight’ Contributors to Global Warming” Business Wire, May 19, 1999.

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Source: Compustat

Source: Center for Research in Securities Prices (CRSP) dataset
### Exhibit 3: Truck vs. Automobile Sales for General Motors, Ford, & Chrysler

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<td>GM Trucks</td>
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<td>18.4%</td>
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Exhibit 4: Real Gasoline Prices (in Constant U.S. $ per Gallon) 1949 - 1998

NOTE: From 1949 to 1977, fuel prices are for regular leaded gasoline, after 1977 the price is for regular unleaded gasoline

Source: Energy Information Administration, *Retail Motor Gasoline and On-Highway Diesel Fuel Prices, 1949-2006*
### Exhibit 5: Carbon Dioxide Emissions from Select Countries 1998

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<th>Per Capita**</th>
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<tr>
<td>Saudi Arabia</td>
<td>256.82</td>
<td>11.73</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>116.09</td>
<td>50.59</td>
</tr>
</tbody>
</table>

* Million Metric Tons of Carbon Dioxide  
** Metric Tons of Carbon Dioxide