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The New Energy Economy

Putting America on the Path to Solving Global Warming

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Executive Summary

America and the world face serious and urgent challenges rooted in the way we fuel and power our economies. How we respond to global warming and our growing demand for energy—and whether we respond in time—will determine what kind of planet we have for generations to come. The scale of the challenge will require an unprecedented response, one that transforms U.S. and global energy markets from archaic, dirty technologies to clean, sustainable solutions. Fortunately, many of the technologies and policy tools we need to make this transformation already exist, and we can deploy them without harming the economy. The next step is decisive U.S. government action to facilitate these investments and reduce our global warming pollution the necessary 80 percent from current levels by the year 2050.

In just the next 20 years, the United States is expected to invest more than $3 trillion in expanding and retooling its energy infrastructure—electric power plants, fuel refineries, transmission and transportation infrastructure—as well as trillions more on energy-consuming buildings, appliances, and vehicles.[1] Redirecting these resources toward cleaner, energy-efficient technologies is critical if we are to meet the global warming challenge in time. Moreover, developing these technologies offers the United States an enormous export opportunity since the rest of the world will need to make a similar transition to cleaner energy.

A December 2007 study by the business consulting firm McKinsey & Company, cosponsored by NRDC, examines the cost and market potential of more than 250 greenhouse gas abatement technologies and concludes that the United States can do its part to stabilize the climate at little to no net cost to the economy, considering energy-efficiency savings.[2] In sharp contrast, estimates of the annual benefits from stopping global warming, and avoiding the myriad associated economic and non-economic harms, typically range from 5 percent to 20 percent of total global economic output. Moreover, the transition to a cleaner and more efficient energy economy will improve air and water quality, protect public health, and increase our energy security and productivity, all while we continue to improve our standard of living, decade after decade.

We Must Act Now to Stop Global Warming

The Nobel Prize–winning Intergovernmental Panel on Climate Change (IPCC) confirmed in its latest report that "warming of the climate system is unequivocal," and places the blame squarely on anthropogenic emissions of CO_2 and other global warming pollution.[3] Global average surface temperature has increased by almost 1 degree Celsius since 1900, and scientists who have studied the problem for decades are surprised to see how quickly the ice caps and glaciers are melting, mountain snowpack is shrinking, and natural systems are beginning to break down. We are already seeing significant environmental and economic impacts including more intense heat waves, increasing droughts as well as heavy rainfall events, sea-level rise, ocean warming and acidification from CO_2 absorption, and more intense tropical cyclones.

Scientists are increasingly concerned that if global temperatures rise further by more than roughly 1 degree Celsius, very dangerous impacts may become inevitable.[4] According to the IPCC, ecological impacts include increased risk of extinction for 20 percent to 30 percent of plant and animal species, widespread coral bleaching, and a growing risk that degraded ecosystems will become a net source of CO_2 emissions rather than helping to absorb carbon.

Human impacts from global warming of roughly 2 degrees Celsius include:

- increased risk of starvation from lost crop productivity in lower latitudes;
- annual coastal flooding that would affect millions;
- increased water stress for hundreds of millions of people; and
- health impacts including "increases in malnutrition; increased deaths, diseases and injury due to extreme weather events; increased burden of diarrhoeal diseases…and the altered spatial distribution of some infectious diseases."[5]

Unfortunately, under a scenario resembling current rapid fossil fuel growth trends, the IPCC projects that temperature increases will range from 2.4 to 6.4 degrees Celsius by 2100.[6] Even in the IPCC's most optimistic scenario, which assumes "rapid change in economic structures toward a service and information economy…and the introduction of clean and resource-efficient technologies," temperatures increase 1.1 to 2.9 degrees Celsius by 2100.[7]

The bottom line is that we need to change course now to avoid locking ourselves and future generations into a dangerously disrupted climate. The emerging consensus is that industrialized nations need to reduce global warming pollution 80 percent from current levels by mid-century, assuming that developing-country emissions peak between 2020 and 2025 and then also begin declining.[8] The scenario would allow us to stabilize at 450 parts per million (ppm) CO_2 equivalent, thereby limiting expected warming to 2 degrees Celsius. The European Union and a few other countries have already begun to act, but the world will not reach the necessary targets unless the United States quickly enacts mandatory limits and moves aggressively to reduce its pollution by shifting investments to low-carbon, high-efficiency fuels and technologies. This will also allow the United States to export advanced energy technologies to developing countries, enabling them to grow without following our highly polluting development path. It will also give us the credibility to negotiate a post-2012 global emissions control agreement to replace the Kyoto Protocol, including long-term provisions to begin addressing emissions in developing countries.

Six Big Opportunities to Transform the U.S. Energy Sector

Reducing global warming pollution 80 percent by mid-century will require the United States to substantially transform its energy economy. NRDC examined multiple strategies to reduce global warming pollution on both the demand (energy consuming) side and the supply (energy producing) side of the equation and pinpointed six major groups of energy sector opportunities that will put America on the path to significantly reducing the pace and magnitude of global warming.[9]

Figure 1: Six Opportunities for Reducing U.S. Fossil Fuel Emissions

		Carbon Pollution Avoided by 2050	Percent of Total Needed by 2050
1	Building efficiency to reduce heating and electricity needs.	1.7 billion tons	16%
2	Vehicle efficiency and smart growth communities to help cars go farther on less fuel and reduce vehicle travel.	1.4 billion tons	13%
3	Industrial efficiency such as combined heat and power to reduce industrial energy use.	1.2 billion tons	11%
4	Renewable electricity from sources such as wind, geothermal, and solar power, which have the potential to supply 40 percent of our energy needs.	1.4 billion tons	13%
5	Low-carbon transportation fuels such as biofuels made from crop waste and switchgrass to replace imported oil.	1.1 billion tons	10%
6	Carbon capture and storage of CO_2 emissions from coal-fired power plants in geologic structures deep in the earth, where it is gradually absorbed.	1.1 billion tons	10%
		TOTAL: 7.9 billion tons of carbon pollution avoided	**TOTAL: 73% of total emissions reductions needed**

NRDC Policy Recommendations to Contain Global Warming

To move markets to deploy these solutions, we need comprehensive and effective policy action within the United States. Three essential steps, also illustrated in Figure 11 on page 28, will put us on a path to curbing global warming:

1. **Enact comprehensive mandatory limits on global warming pollution to stimulate investment in all sectors and guarantee that we meet emission targets.** A mandatory cap will ensure that the cost of pollution is reflected in decisions across the economy. A well-designed program can achieve emission reductions at the lowest possible net cost for consumers and businesses, in part by generating funds through the distribution or auction of pollution allowances that can support energy efficiency and emerging technologies.

2. **Overcome barriers to investment in energy efficiency to lower abatement cost starting now**. Relying on price signals from a CO_2 cap to drive investment is not enough because other, non-price barriers significantly constrain energy efficiency, such as limited consumer information and split incentives between landlords who may purchase the cheapest, least-efficient appliances and renters who pay utility bills. State and federal policies are also needed to promote building, appliance, industrial, and transportation efficiency at lowest cost, for example, by adopting energy performance standards and reforming irrational regulations and utility rate structures to allow energy efficiency to compete on a level playing field against additional electricity and gas supply.

3. **Accelerate the development and deployment of emerging clean-energy technologies to lower long-term abatement costs.** As with efficiency, price signals from a CO_2 cap alone are insufficient because investors are reluctant to invest in new solutions when their competitors can capture the associated learning-by-doing benefits. For example, a carbon capture and storage pioneer must work with suppliers, regulators, and the general public to figure out how to build and successfully permit the first full-scale facilities—and most of the associated learnings will subsequently be available to their competitors. To overcome this disincentive to innovation, government must promote rapid development and deployment of emerging technologies such as low-carbon fuels, renewable electricity, and carbon capture and storage. Key measures include research and development funding; deployment mandates including renewable energy standards, low-carbon fuel standards, and low-carbon generation obligations; performance-based commercialization support in the form of tax incentives or feed-in tariffs that pay a fixed fee per unit of delivered clean energy; and direct government procurement.

In addition to national action, we must simultaneously move to adopt an effective international system to control global warming pollution, ultimately including caps on emissions from all countries. The cost of inaction—to our health, our environment, our culture, and our economy—is a price that we cannot afford to pay. We must act now, and act decisively, to prevent the dangerous impacts of global warming and to drive investment in the next generation of buildings, vehicles, fuels, and power production.

CHAPTER 1

The Rising Tide for Global Warming Solutions

Momentum for U.S. action on global warming is accelerating. From international scientific consensus to legal victories, strategic repositioning, and state and local government action, we have made progress. Now it is time for decisive nationwide action to push back against global warming.

The decision to award the 2007 Nobel Peace Prize to the IPCC marks a general recognition that global warming science is clear. There is no debate that the level of CO_2 in the atmosphere has already risen to well over 380 parts per million (ppm), up from pre-industrial levels of about 280 ppm and far exceeding the natural range of 180 to 300 ppm over the last 650,000 years.[10] Moreover, atmospheric CO_2 concentrations are rising at an accelerating pace that has now reached nearly 2 ppm per year. By the end of this century the IPCC projects warming of 2.4 to 6.4 degrees Celsius in a fossil fuel–intensive emissions scenario, or 1.1 to 2.9 degrees Celsius in the IPCC's most optimistic emissions scenario that does not include specific policies to curb global warming pollution. The picture looks roughly the same if we include the offsetting cooling effects of aerosol emissions and land use changes plus the warming from ethanol, N_2O, and other non-CO_2 greenhouse gases. Thus, the current net CO_2-equivalent (CO_2e) warming effect is roughly equal to the effect of CO_2 on its own.[11]

The courts have played an important role in moving the private sector toward action to address this threat. Among several important court rulings, on April 2, 2007, in a case brought by NRDC and others, the U.S. Supreme Court issued a landmark ruling that CO_2 is subject to regulation under the Clean Air Act, providing critical legal backstops for state actions and strengthening momentum for federal legislation. Increasingly, however, business leaders are seeing economic opportunities rather than litigation risks in the fight against global warming. Twenty-seven major U.S. corporations—including industry giants such as General Electric, General Motors, DuPont, AIG, Caterpillar, and Shell—have joined NRDC and other nonprofit organizations to form the U.S. Climate Action Partnership (USCAP) to advocate for federal legislation to cut emissions by 60 to 80 percent by 2050. Moreover, USCAP working groups are actively developing proposals to deal with some of the more complex details in proposed cap-and-trade legislation. And in the last five years, more than 60 conventional coal-fired plants have either been cancelled or significantly delayed due to concerns about escalating construction costs, uncertainty regarding the cost of future carbon dioxide regulations, and the economic and environmental benefits of cleaner energy sources.[12]

Finally, state and local action has played an essential role in moving the federal government toward decisive global warming legislation. States, led by California, enacted the first appliance efficiency standards, and set the stage for federal standards. Several states have adopted policy reforms in the utility sector designed to make delivering energy efficiency at least as

The Growing Trend Against Coal-Fired Power Plants

Since March 2006, plans for more than 25 coal-fired power plants around the country have either been rejected or significantly delayed.

Rejected

Orlando Utility Commission's Stanton Energy Center IGCC (Florida)
Seminole Electric Power Cooperative's Seminole 3 Generating Station (Florida)
Tampa Electric's Polk County IGCC (Florida)
Florida Power & Light's Glades Power Plant (Florida)
Florida Municipal Power Agency's Taylor Energy Center (Florida)
Sunflower Electric Power Corporation (Kansas)
Southwestern Power Group's Bowie Power Station (Arizona)
TXU Corporation; eight plants rejected (Texas)
Great Northern Power Development's South Heart Power Project (North Dakota)
Westmoreland Inc. (North Dakota)
PacifiCorp's Intermountain Power Project Unit 3 (Utah)
PacifiCorp's Jim Bridger Project (Wyoming)
Sempra Energy (Nevada and Idaho)
Idaho Power (Idaho)

Rejected (Cont.)

Xcel Energy (Colorado)
Tenaska's Sallisaw Electric Generating Plant (Oklahoma)
Bull Mountain's Power Project (Montana)
Indeck Energy Service's Elwood Energy Center (Illinois)
Twin River's Twin River Energy Center (Maine)
Associated Electric Cooperative Inc. (Missouri)
Peabody Coal Company's Thoroughbred Generating Station (Kentucky)

Delayed

Energy Northwest's Pacific Mountain Energy Facility (Washington)
Matanuska Electric Association's Palmer project (Alaska)
Associated Electric Cooperative Inc. (Kansas)
Westar Energy's Coal Plant Project (Kansas)
American Electric Power and Oklahoma Gas & Electric's Red Rock Generating Station (Oklahoma)
Duke Energy Carolinas (North Carolina)

profitable as investments in new supplies. More than 20 states have enacted renewable electricity requirements, mandating that a certain portion of the delivered electricity come from clean, renewable sources and creating momentum for a similar federal standard. And states have now set the stage for federal greenhouse gas emission limits. Beginning in 2002 with the passage of California's landmark law limiting global warming pollution from new vehicles, state and local leadership has created a drumbeat of climate policy actions and momentum for delivering global warming solutions at the federal level:

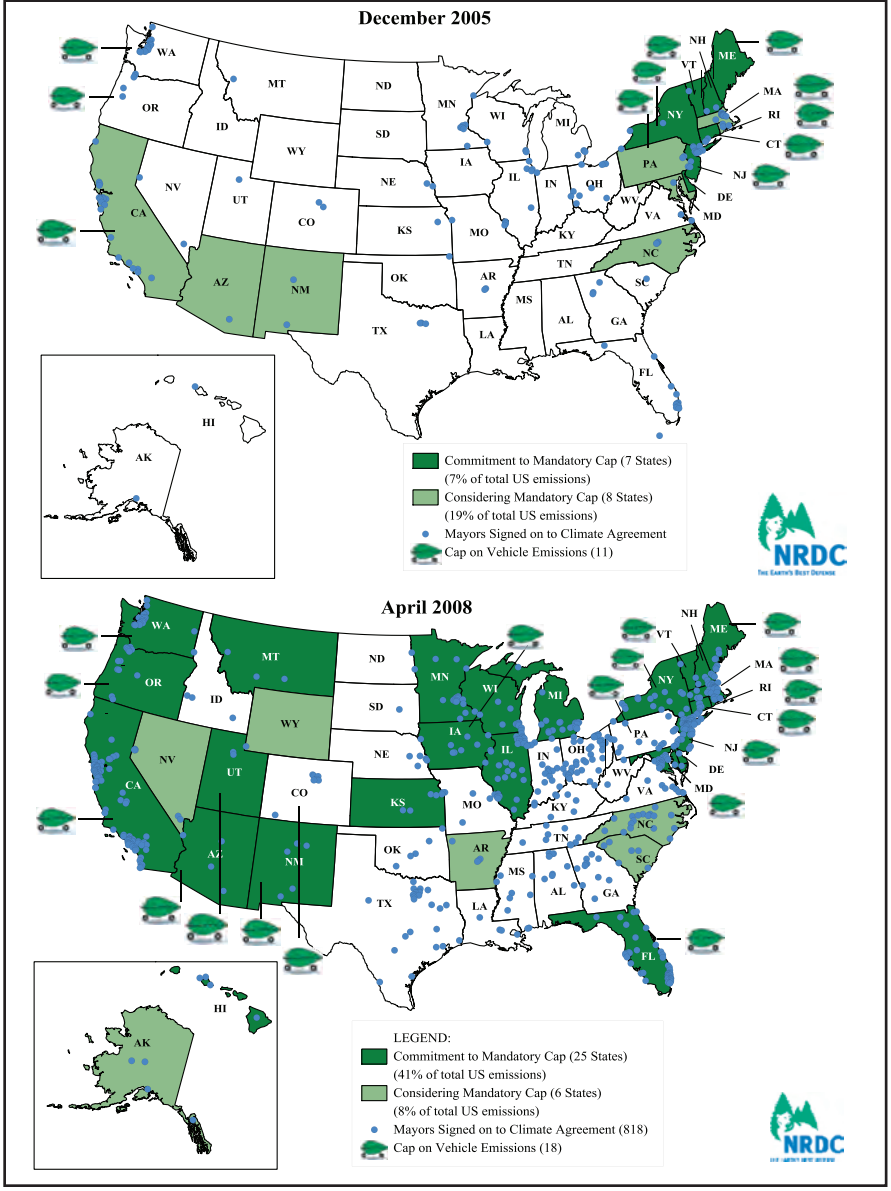
- 15 states have adopted California's clean car standards, accounting for 40 percent of the U.S. car market. (While these standards have been upheld against industry challenges in several states, the U.S. EPA recently blocked them from going into effect; California and other states and environmental groups have challenged this EPA action in court.)
- 17 states representing 45 percent of the U.S. population have committed to greenhouse gas emissions reduction targets.[13]
- More than 700 cities have pledged to cut emissions and called for federal legislation to do the same.

Governors and mayors have undertaken economic analyses that show these efforts will deliver economic benefits. California currently spends more than $30 billion a year to import fossil fuel. By keeping more of that money in state and investing it in efficiency and clean technologies, the state will realize billions in net economic benefits and create more than 80,000 new jobs.[14] The 10 Northeast states in the Regional Greenhouse Gas Initiative (RGGI) discovered that by promoting energy efficiency at the same time that they implemented a cap on power plant emissions, they should be able to actually reduce the average residential customer's energy bill by more than $100 per year.[15] To capture this opportunity these Northeast states have decided to auction almost all of their pollution allowances and use the proceeds to promote energy efficiency.[16] Meanwhile, the Western Climate Initiative has grown to include seven states and three Canadian provinces, and the midwestern states are also moving forward under the Midwestern Regional Greenhouse Gas Reduction Accord.

In part as a result of this progress at the state and local levels, Congress is beginning to respond. In December 2007, Congress passed essential energy legislation that will boost building and lighting efficiency through performance-based standards, increase mileage standards for cars and SUVs, and support the development of low-carbon biofuels. NRDC estimates that these measures will unlock roughly 10 percent of the emissions reductions needed through 2030, while putting money in consumers' pockets. Earlier proposals that included a federal mandate for increasing the portion of electricity coming from renewable sources failed to pass after a threatened veto, but Congress should continue to press for this.

Meanwhile, a bipartisan majority of the Senate demonstrated support for advancing climate legislation, and similar proposals have been introduced in the House.[17] The bills propose creating a cap-and-trade system, where a regulatory cap limits overall emissions while trading of emission allowances provides flexibility and market incentives to invest broadly in cost-effective opportunities to reduce emissions. The United States is finally poised to take decisive nationwide steps down the path to a cleaner and more secure energy future. It is past time we got moving on implementing a suite of policies that shift our energy investments toward clean, cost-effective energy solutions and away from inefficient, polluting technologies and fuels.

Figure 2: The Rising Tide for Global Warming Solutions, December 2005 Compared With April 2008



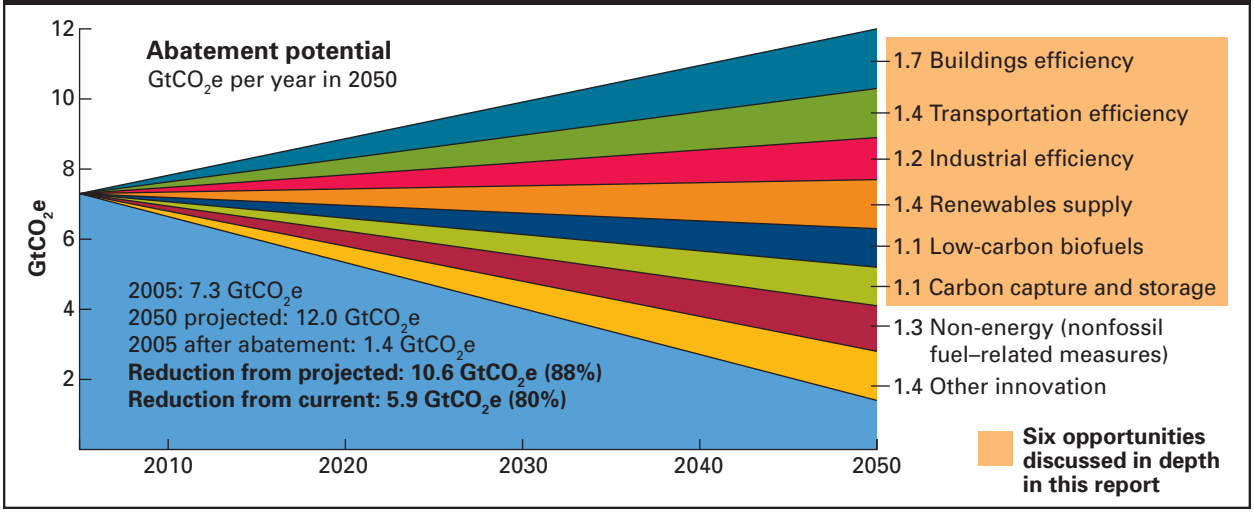
CHAPTER 2

NRDC Strategies to Cut U.S. Global Warming Pollution 80 Percent by 2050

No "silver bullet" will radically reduce our global warming pollution. We need a suite of solutions to get the job done. NRDC has developed an integrated analysis of eight categories of action that together could cut annual U.S. emissions by 10.6 billion tons by 2050, which would enable us to reduce pollution 80 percent from current levels—nearly 90 percent below business-as-usual projections of 12 billion tons by 2050.[18]

This level of emissions cuts, if matched by other developed nations and accompanied by developing nation reductions starting after 2020, would allow the atmospheric concentration of CO_2e to stabilize at about 450 ppm. At this concentration, experts expect average global warming of about 2 degrees Celsius and a roughly two-thirds chance of holding warming below 3 degrees Celsius.[19] This would at least significantly mitigate our risks, though we would still be running a massive and largely irreversible global experiment. Some recent research suggests that a more prudent target would be to reduce CO_2e concentrations to 350 ppm, which would require a much more rapid phase-out of all greenhouse gas

Figure 3: The Path Forward for Global Warming Emissions Reductions



emissions and a reversal of deforestation.[20] This evolving debate underscores the importance of moving aggressively in order to retain the option of achieving lower concentration targets as necessary in response to developing science.

NRDC identified eight areas of opportunity that would put America on the path to solving global warming. We focus here on the six key categories that either improve energy efficiency or decrease the carbon intensity of our energy supply because fossil fuels account for more than 80 percent of global warming pollution in the United States.[21] Moreover, CO_2 is a very long-lived greenhouse gas, and it will take decades to transform our energy infrastructure—so it is imperative that we move as quickly as possible to redirect capital from polluting conventional power plants to clean alternatives. Taken in aggregate, these six clean energy solutions are cost effective even without considering significant ancillary societal benefits, such as cleaner air and improved national security from reduced dependence on imported fossil fuels.

For each opportunity discussed below, we present the total number of gigatons (billions of tons) of CO_2 equivalent avoided as compared with what would be emitted if the United States continues on its present course with its current policies (as modeled by the U.S. Department of Energy "business as usual" scenario), as well as the percent of the 10.6 Gt of abatement needed for the United States to do its part to keep global CO_2 concentrations below 450 ppm. (For comparison, Germany emitted about one gigaton of CO_2e in 2005.) Collectively, these major energy-sector options account for almost three-quarters of needed abatement. Beyond these opportunities, to reach 2050 targets we also need 1.3 billion tons per year of reductions in non-CO_2 greenhouse gases and forest and soil carbon and 1.4 billion tons per year of additional innovations, particularly to address thousands of smaller sources not considered in most assessments of abatement potential.

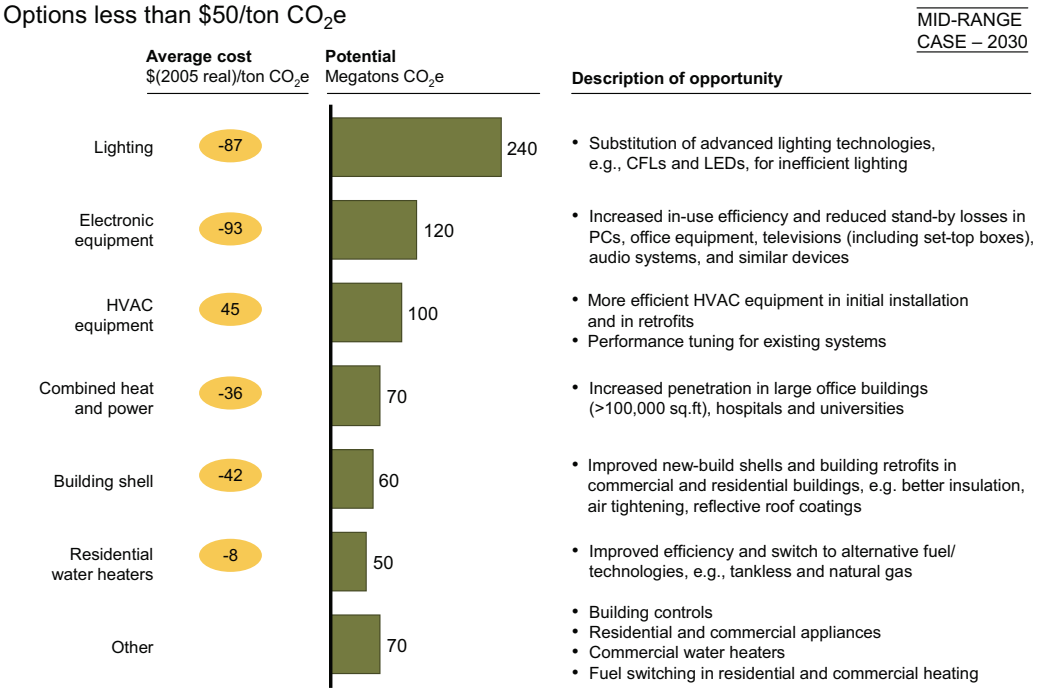
Six Big Opportunities to Transform Our Energy Infrastructure

OPPORTUNITY #1: BUILDING EFFICIENCY	
Global Warming Pollution Avoided	**Percent of 10.6 Gt in U.S. Emission Reductions Needed by 2050**
1.7 Gt CO_2	**16%**

Heating fuel (oil and gas) and electricity use in buildings are the largest sources of global warming pollution in the United States, and they continue to grow as rapidly as transportation emissions. The buildings sector is expected to account for 37 percent of total U.S. greenhouse gases in 2030.[22] We already have the technology in hand to radically reduce energy use in buildings at tremendous savings to consumers, but unreasonable regulatory systems and other market failures—some as simple as the fact that landlords and developers make capital investments without sufficient regard for the economic interest of building occupants who pay energy bills—have prevented us from unlocking this potential. As shown in Figure 4, McKinsey identified 0.7 Gt of building sector abatement by 2030 in their medium-range case and 0.9 Gt in the high-range case, more than 90 percent of which is based on technologies that are fully available today and all of which is highly likely to become available. Most strikingly, nearly all of these measures come at a negative cost per ton because the ongoing benefit of reduced energy bills (discounted at 7 percent real, 10 percent nominal interest rate) more than justify the extra up-front cost of measures such as more efficient lighting.

Electricity accounts for only about half the total energy used in buildings, but it accounts for three-quarters of the CO_2 emissions from this sector because electricity from our coal-heavy grid is far more carbon intensive than the natural gas or oil used directly for heating. Through cost-effective energy-efficiency measures, we can cut overall CO_2 emissions from buildings in half by 2050. Areas to target include building architecture; insulation, heating, ventilation, and air-conditioning (HVAC) equipment; major appliances and electronics; lighting; and systematic maintenance. Renewable generation technologies integrated into buildings can contribute additional cost-effective reductions in CO_2 emissions from buildings. For example, solar hot water systems are already cost-competitive in almost all parts of the country.[23] Moreover, small-scale combined heat and power systems are becoming available, and industry analysts expect unsubsidized solar photovoltaics to become competitive with retail electricity rates in most parts of the United States by 2020. Ground source heat pumps will also become increasingly effective carbon abatement technologies as we reduce the carbon intensity of the electricity needed to power these heating and cooling systems.

Figure 4: Abatement Options — Buildings-and-applicances Cluster



Source: McKinsey analysis

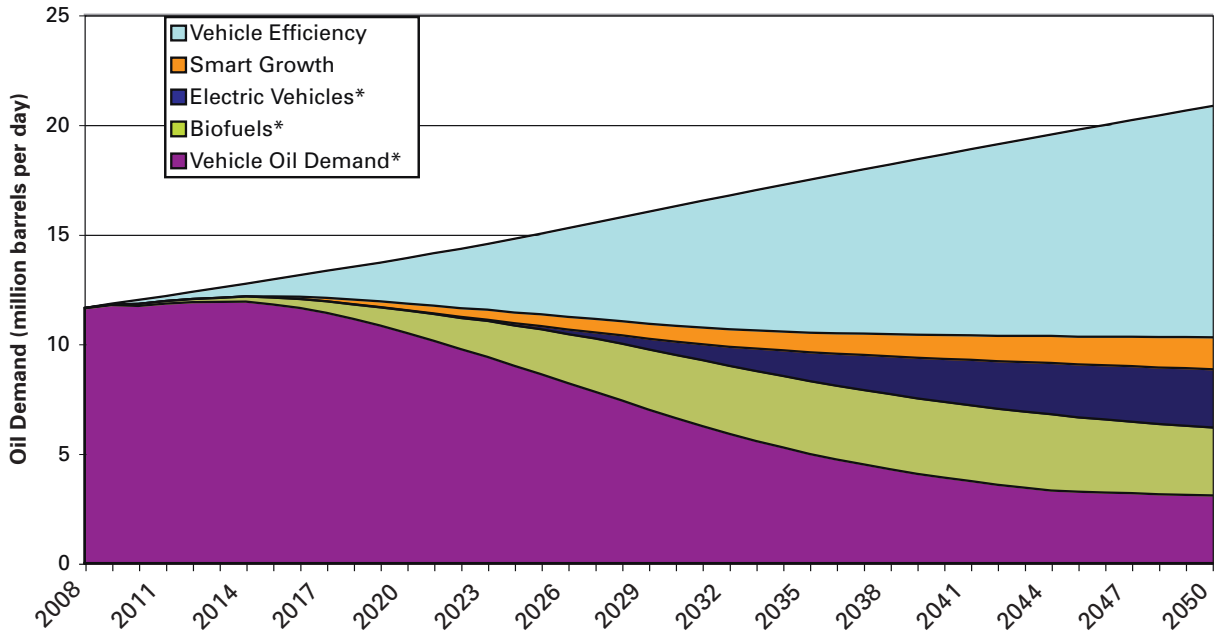
Market Opportunities in Building Efficiency

Because most energy efficiency investments deliver a profitable return, a wide range of stakeholders, including building owners, corporate tenants, and efficiency providers, stand to benefit from increased adoption of building efficiency measures.[24] There are also tremendous growth opportunities for firms that market and sell energy efficiency services and products, such as building managers, energy service companies, manufacturers, and retailers. Already, the U.S. market for energy efficiency in buildings is estimated at $236 billion in revenues, and it has the potential to more than triple to $756 billion in revenues by 2030; the worldwide market could be roughly five times as large.[25]

OPPORTUNITY #2: SMART TRANSPORTATION: VEHICLE EFFICIENCY AND SMART GROWTH	
Global Warming Pollution Avoided	**Percent of 10.6 Gt in U.S. Emission Reductions Needed by 2050**
1.4 billion tons CO_2	**13%**

The transportation sector is expected to account for 29 percent of total U.S. greenhouse gases in 2030.[26] Today's passenger vehicles are both inefficient and fueled almost exclusively by oil, making vehicles the second-largest source of global warming pollution in the United States and around the world. Improving fuel economy standards is the fastest, cheapest way to reduce transportation-sector global warming pollution and oil consumption. The recently enacted Energy Bill, which will increase fuel economy to 35 mpg by 2020, is a step in the right direction, but much more can be done. Using today's technology, we can at least double the fuel efficiency of new conventional gasoline vehicles; with advanced hybrid designs, we can triple vehicle efficiency. By 2050 vehicle efficiency measures could reduce the carbon emissions from the on-road fleet of cars and light trucks by more than 50 percent, with similar gains possible for heavy vehicles as well.

Figure 5: Oil Demand Reduction From Smart Transportation Solutions



* Addressed in the section about opportunity number 5.

The greenhouse gas reductions made possible by more efficient vehicles, however, may be largely counteracted by an increase in vehicle miles traveled (VMT). Over the past decades, VMT has increased by more than 3 percent per year, now totaling more than 3.5 trillion miles in the United States alone. The Department of Transportation expects that number to increase to 7.5 trillion by 2050.

The rise of VMT has been relentless and virtually ubiquitous. However, for the first time in recent history, VMT on U.S. public roads has actually declined since 2006, largely as a result of the rapid increase in gasoline prices.[27] A major effort is needed to reduce VMT by being smarter about how we design and build communities. There is a strong correlation between household density, availability of public transit, and VMT. Moreover, compact transit-oriented "smart growth" is highly cost effective. The Sacramento region recently adopted a growth strategy focused on smart growth principles. In addition to reducing household VMT by 26 percent over the base case, the region projects savings of $16 billion in unnecessary infrastructure costs by 2050, simply by channeling growth into appropriate transit-oriented locations.[28] Sacramento's experience echoes New Jersey's, where local officials estimate that every smart growth unit they build saves $25,000 in public dollars over a sprawl unit.[29]

Similarly, smart growth zoning reforms allow developers to meet the growing demand for conveniently located homes in walkable neighborhoods. Residents of compact, walkable, transit-served communities drive 20 to 40 percent less than residents of sprawl development.[30] Considering that two-thirds of the development that will exist in 2050 has not yet been built, there is substantial opportunity to reduce vehicle miles traveled and global warming pollution—while providing highly desirable and less traffic-plagued communities—simply by encouraging smarter land use in new developments.[31]

Market Opportunities in Smart Transportation

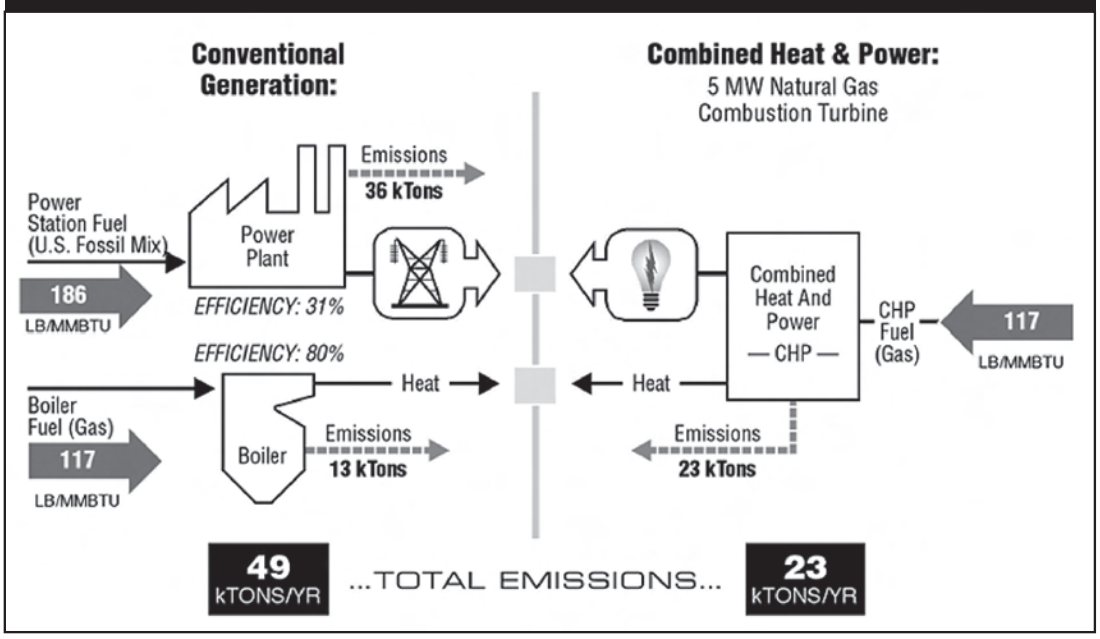
Studies of the auto industry show that federal fuel economy standards can help make U.S.-based manufacturers more competitive.[32] Revenues for GM, Ford, and Chrysler currently are highly dependent on sales of gas-guzzling trucks, but with today's high fuel prices consumers are buying the more efficient alternatives offered by foreign automakers. Higher standards would spur domestic companies to produce more of the models that consumers increasingly demand. Studies also show that more community-friendly (and energy efficient) developments sell faster and retain their value better than traditional sprawl developments.[33]

OPPORTUNITY #3: INDUSTRIAL EFFICIENCY	
Global Warming Pollution Avoided	**Percent of 10.6 Gt in U.S. Emission Reductions Needed by 2050**
1.2 billion tons CO_2	**11%**

The U.S. industrial sector (oil, steel, cement, fertilizer, etc.) emits approximately 2.2 billion tons of global warming pollution annually, representing 26 percent of U.S. annual emissions by 2030.[34] Improvements in industrial processes could result in a 50 percent decrease in global warming emissions from this sector.

Combined heat and power (CHP) is an essential opportunity for industry. These systems generate electricity while burning fuel for process heat, sharply reducing or eliminating the need to purchase electricity from power plants—cost-effectively reducing CO_2 emissions by half or more. Also, more efficient motors, transformers, pumps, and other industrial machinery can decrease energy waste by 15 to 20 percent using today's off-the-shelf technologies.[35] Finally, advanced industry-specific processes, including greater recycling of materials and product reformulations, can yield substantial cost-effective efficiencies.

Figure 6: Combined Heat and Power Is a Key Strategy for Cutting Global Warming Pollution From Industrial Sources



Source: www.eps.gov/chp/basic/environmental.html

Market Opportunities in Industrial Efficiency

Despite the fact that many industrial facilities actively manage their energy consumption to improve their margins, competing demands on sometimes limited capital and other market barriers, including lack of reliable information about alternative technologies, prevent investments in energy efficiency improvements that could save U.S. businesses billions annually by 2030.[36] Again, technologies developed and perfected in the United States would also find large and expanding markets abroad.

OPPORTUNITY #4: RENEWABLE ELECTRICITY	
Global Warming Pollution Avoided	**Percent of 10.6 Gt in U.S. Emission Reductions Needed by 2050**
1.4 billion tons CO_2	**13%**

Non-hydro renewables currently provide about 2 percent of our electricity. However, these technologies—including wind power, concentrating solar power, biomass power, geothermal electricity, and solar photovoltaics—have the potential to provide roughly as much electricity as nuclear by 2030 and more than 40 percent of our electricity needs by 2050.[37] For example, solar photovoltaic power today provides less than 1 percent of total energy use. If prices continue to drop as anticipated, photovoltaic power could compete with retail rates by 2015 and become a significant generating technology throughout the country, with the potential to supply at least 20 percent of our electricity needs by 2050. Wind alone could provide an additional 20 percent, and other high-potential sources include geothermal and biomass. Finally, concentrating solar power, based on rows of parabolic mirrors installed in desert conditions in one leading configuration, is becoming competitive in a carbon-constrained world. For example, PG&E has announced plans to procure 1,000 MW from this source over the next five years.[38]

While some renewable resources provide intermittent power, some, such as geothermal and biomass, can provide on-demand electricity, and concentrating solar power can include thermal storage that enables production well through evening peak demand or potentially all day and all night using energy molten salt technologies. Moreover, renewable systems that are diversified across different technologies and terrain, enabled by a more robust transmission system, will have higher overall reliability. New energy storage systems, such as compressed-air energy storage, are under development. Conventional fossil resources such as peaking gas turbines can provide backup for intermittent renewables. These grid backup costs are typically modest until the penetration of intermittent renewables exceeds at least 20 percent of peak output.[39] Finally, new "smart" grid technology can help increase the reliability and efficiency of grid distribution overall and thus better handle the distributed and intermittent generation of renewables.

Despite their long-term cost advantages, renewables face multiple barriers. Most important, innovators are often reluctant to invest in scaling up renewables manufacturing and installation capacity since government support is often unsteady (e.g., the production tax credit for wind is perpetually at risk of expiring) and much of the associated "learning by doing" spills over to their competitors. Moreover, renewable energy systems face financing difficulties because virtually all their costs are up-front capital investment, with almost no fuel costs, and volatility in energy markets has made such financing difficult. Furthermore, much of our renewable energy potential is located in rural, less populated areas of the country. Bringing this energy to market will require extensive expansion of our transmission system, and the associated investments, if not fairly apportioned and abruptly realized, will be a barrier to renewables. Finally, many utilities impose unduly burdensome interconnection standards, consumers and developers sometimes lack information on renewable system reliability and durability (and real long-term profitability), and the technologies themselves are not readily available to most consumers.

The growth of renewable energy and the mix of specific renewable technologies therefore depends not only on technology developments and the speed with which costs decline, but also on the development of state and federal energy policies that will overcome these market barriers.

Market Opportunities in Renewable Electricity

Global investment in new renewable energy installations totaled $100 billion in 2007, up from $15 billion in 2000.[40] Renewable energy resources are spread across the United States, making renewables profitable throughout the country. Solar photovoltaic power is widely available, geothermal is likely to play a significant role in the West, solar thermal in the Southwest, and biomass in the Midwest and Southeast.[41] In addition to the clean technology, or "clean tech," industry that is growing in many cities, renewable energy technologies will benefit rural and agricultural economies that have the good fortune to be located where the wind blows, the sun shines, and biomass grows well. Wind provides a particularly exciting example. Farmers can enhance their revenues by planting both crops and renewable energy on their land. Clean tech companies will face foreign competitors, some of which have a head start due to strong innovation support in the European Union and Japan, but they could see significant export opportunities over time.

OPPORTUNITY #5: LOW-CARBON TRANSPORTATION FUELS	
Global Warming Pollution Avoided	**Percent of 10.6 Gt in U.S. Emission Reductions Needed by 2050**
1.1 billion tons CO_2	**10%**

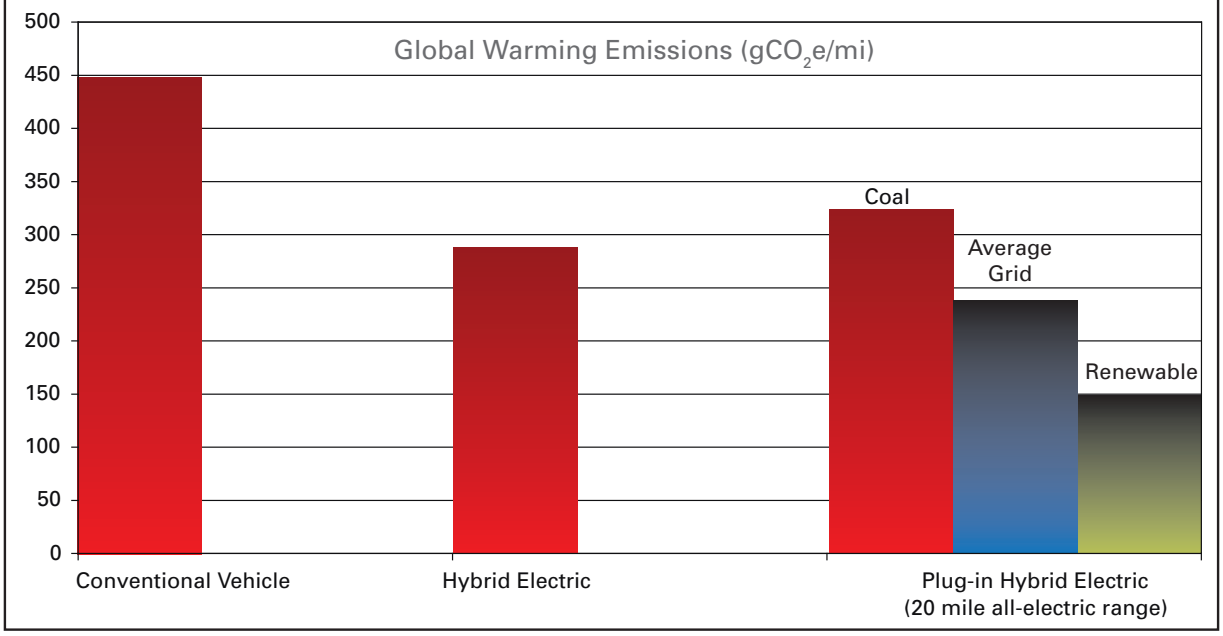
Low-carbon transportation fuels such as biofuels and electricity can help wean America off its addiction to oil. Advances in how biofuels are made—from high-energy sugarcane to new methods that convert switchgrass, agriculture wastes, and other forms of non-food biomass into fuel—will enable us to dramatically boost the volume of biofuels we can produce in the United States to more than 60 billion gallons per year by 2050, while reducing the fossil energy needed to produce them. Together with improved vehicle performance and reduced VMT, this would enable us to cut oil consumption by 85 percent from today's levels.

But not all biofuels are created equal. Done wrong, biofuels could trade one set of environmental problems for a host of others, ruining wildlands and wildlife habitat, drawing down water reserves, and spreading chemical pollution. Some could even make global warming worse by directly or indirectly promoting conversion of forested land to agricultural land.

Fortunately, there are multiple ways to reduce lifecycle carbon emissions from biofuels. In particular, new cellulose-based biofuel refineries along with careful biomass sourcing practices can ensure lifecycle carbon emissions per gallon are 80 percent lower relative to conventional crude oil fuels. We need strong safeguards on where and how biofuels are sourced and produced to ensure that we reap biofuels' potential safely.

With the emergence of plug-in hybrids, which combine a battery that owners can charge from a household outlet and a gasoline, diesel, or biofuel engine that kicks in when the battery charge is depleted or more power is needed, electricity can become another source of transportation fuel. Electricity is far less expensive than gasoline and would become increasingly low-carbon as renewable electricity and carbon capture and storage reduce power plant emissions. However, innovation support to advance battery performance is urgently needed.

Figure 7: Global Warming Emissions of Plug-in Hybrids Compared With Other Midsize Cars



Taken together, by 2050 a combination of biofuels and electricity consumption in plug-in vehicles has the potential to reduce global warming pollution by more than a billion tons of CO_2 each year while radically reducing our reliance on volatile crude oil supplies.

Market Opportunities in Low-Carbon Transportation Fuels

Shifting our transportation energy dollars away from oil and toward low-carbon fuels that we can produce in the United States will create jobs, revitalize our rural communities, and end our oil dependence. Today we import more than 3.7 billion barrels of oil each year. At $100 per barrel, this is nearly $400 billion per year, or more than $1,000 per person leaving our country to pay for oil that could instead be reinvested here at home.

OPPORTUNITY #6: CARBON CAPTURE AND STORAGE	
Global Warming Pollution Avoided	**Percent of 10.6 Gt in U.S. Emission Reductions Needed by 2050**
1.1 billion tons CO_2	**10%**

Coal-fired power plants, which provide more than half of our country's electricity, are by far the largest sources of carbon pollution and account for more than one-quarter of all greenhouse gas emissions in the United States. A single 1,000-megawatt coal plant can emit more than 7 million tons of CO_2 in a year, and continue to do so for 60 years or more. As coal is the cheapest and most abundant of fossil fuels, coal-rich countries such as the United States, China, and India are unlikely to stop using it for the foreseeable future.

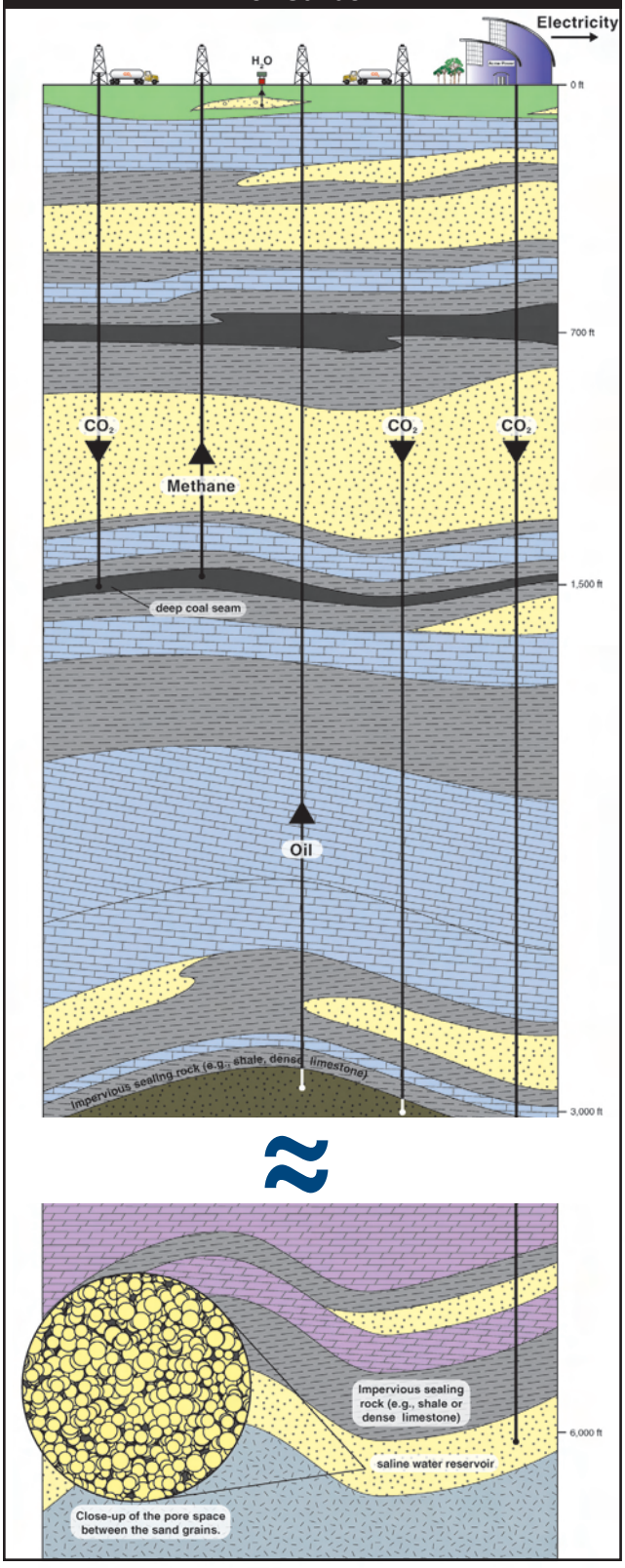
Yet technology is commercially available that can separate and capture 80 percent to 90 percent or more of the CO_2 from power plants and other industrial sources, and the oil and gas industry has decades of experience safely compressing CO_2 into liquid form, then transporting it by pipeline and injecting it into depleted oil fields to boost crude production.

The United States is fortunate to have major additional enhanced oil recovery (EOR) potential as well as sedimentary basins underlying vast areas of the country that geologists believe are well suited for permanent geologic disposal of CO_2. These formations typically lie several thousand feet below multiple layers of clay and cap rock, where they can absorb huge quantities of CO_2 emissions and prevent their release to the atmosphere. The United States is estimated to have enough geologic capacity nationwide to dispose of more than 3 trillion tons of CO_2—more than enough to accommodate several hundred years of total U.S. emissions, if we were able to capture it all.[42]

Given this geologic potential and the availability of carbon capture technology—General Electric, Shell, and Conoco Phillips each offer fully integrated systems—NRDC believes no new coal plant should be built without the ability to capture and safely dispose of its CO_2 pollution. If the United States meets the energy efficiency and renewable energy goals set forth above, NRDC estimates that we will still need to deploy carbon capture systems on approximately 100,000 megawatts of coal-generating capacity and other sources including industrial facilities to prevent more than 1 billion tons from being emitted per year by 2050.

Indeed, carbon capture and storage is a critical "insurance" technology that can be scaled up further in case the United States, or, more likely, other developing countries fall short on reducing energy demand and expanding renewable energy sources. It is therefore essential to develop this technology in order to address emissions in China, India, and other large coal-consuming economies. It is even possible to develop a "negative emissions" power supply by gasifying a combination of biomass and coal and sequestering the CO_2 emissions from both—a critical option we may need later in the century once relatively easy large abatement options have been tapped. Any sustained use of coal, however, must also include serious reforms of coal mining, including ending the most destructive practices, such as mountaintop removal.

Figure 8: Geologic Injection and Storage of Carbon



Market Opportunities in Carbon Capture and Storage

In addition to coal-fired power plants, many other industries emit large volumes of CO_2 that could be readily captured for geologic disposal, which would enable these businesses to cost-effectively adapt to economy-wide emission limits. Some industrial processes, such as fertilizer and ethanol production and petroleum refining, produce pure waste streams of CO_2 that are relatively inexpensive to capture. Geologic disposal of emissions from these sources will enable these firms to reduce the carbon emissions from transportation fuels and the agriculture sector. There is also a substantial demand for CO_2 for enhanced oil recovery, providing a market opportunity for early CO_2 capture projects until this demand is saturated, while boosting the energy security benefits of an effective global warming pollution abatement policy. We estimate that total additional domestic oil production from CO_2-based EOR could reach roughly 50 billion barrels through 2050, the equivalent of displacing 13 years worth of oil imports at our current rate of 3.7 billion barrels per year.[43]

Source: Illinois Geological Survey and Midwest Geological Sequestration Consortium

CHAPTER 3

McKinsey's Roadmap for Transforming Our Energy Economy

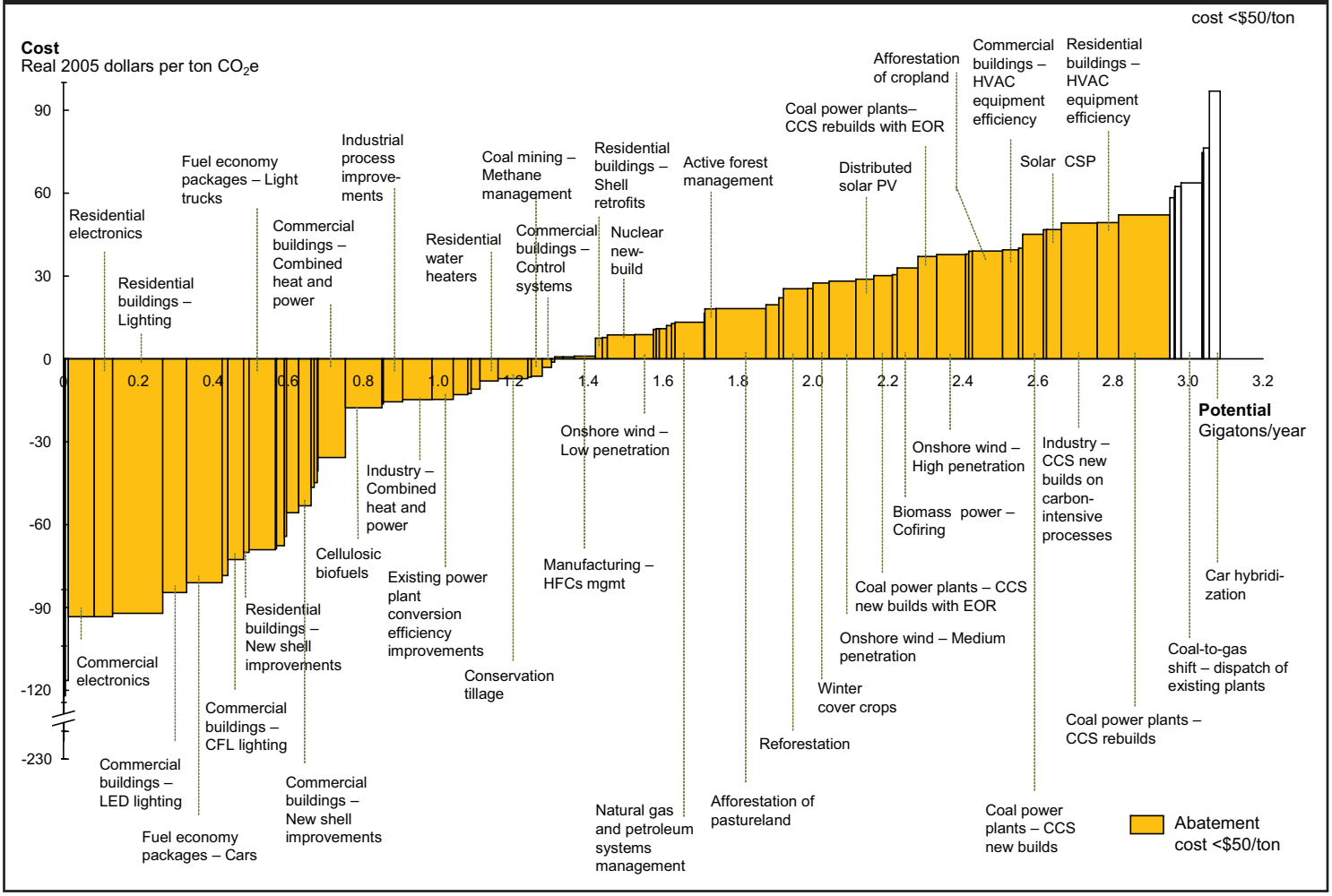
NRDC and a host of academic and government analyses have concluded that many readily available global warming solutions make economic sense and that a wholesale shift away from inefficient, polluting technologies and fuels toward cleaner energy will bring net economic benefits.[44] A recent report from McKinsey & Company, an internationally renowned business consulting firm, bolsters this growing consensus. The report was sponsored by a diverse group able to contribute substantial expertise: NRDC, Environmental Defense Fund, PG&E, DTE Energy, Shell, National Grid, and Honeywell.

McKinsey assessed more than 250 options in the buildings, electric power, transportation, industry, and agriculture sectors in order to evaluate the technical potential and economic feasibility of significantly reducing U.S. global warming emissions. Meeting the global warming challenge is scientifically necessary. Moreover, according to McKinsey, the economic benefits of energy efficiency can roughly pay for cleaning up our remaining energy supply needs.[45]

The study shows that by 2030—only 22 years from now—we can cut domestic global warming emissions by nearly 30 percent from current levels using proven technologies. This would put the United States on a clear path toward the 80 percent reductions needed by 2050 for our country to do its share to prevent potentially catastrophic global warming.

As shown in Figure 9, the study demonstrates that reducing U.S. emissions below current levels would yield cost savings from energy efficiency (below the line) that roughly match the investments needed for the more expensive but essential clean supply options (above the line). If we move quickly, before locking in additional polluting infrastructure—such as conventional coal plants that often last for more than 60 years—we could begin reducing emissions by increasing total U.S. capital expenditures by only 1 to 2 percent per year. This increase would be more than offset by all the economic, productivity, health, and infrastructure benefits that would follow from reduced energy demand and a reduction in the magnitude of global warming.

Figure 9: McKinsey's "Mid-Range Case" U.S. Supply Curve

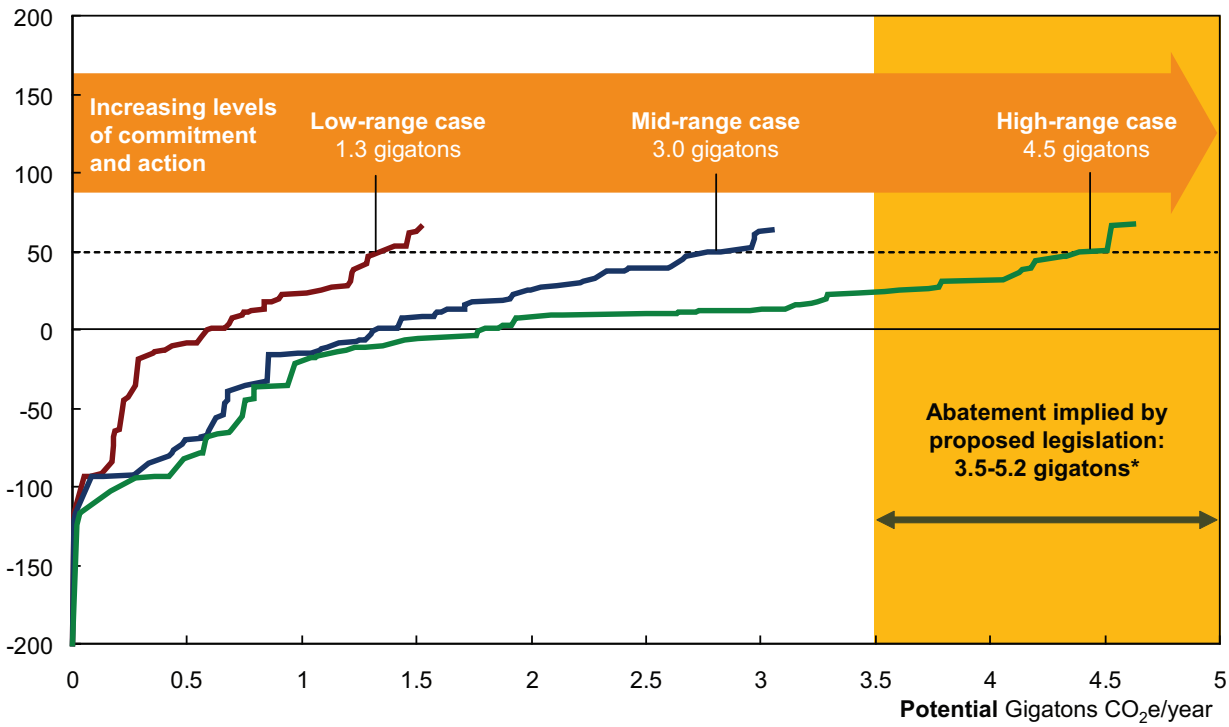


Source: McKinsey analysis

Note: The McKinsey report examines scenarios only through 2030. NRDC recommends a goal of 80 percent emissions reductions by 2050.

As we tackle the more aggressive actions needed to fully address global warming (the high-range case in Figure 10) the overall cost rises modestly, but the net cost to the U.S. economy remains roughly zero as long as we unlock the full potential of energy-efficiency measures that more than pay for themselves. While the net cost to the U.S. economy will be close to zero, there will be winners and losers—sectors that stand to gain from a transition to clean and efficient energy and those that may need to redirect their strategy. Policies can and should be designed to ease the transition for workers, businesses, and communities, but such changes cannot provide an excuse for inaction. The McKinsey study emphasizes that we must start now to adopt policies that will redirect capital flows toward clean solutions in order to solve this challenge at the lowest cost.

Figure 10: McKinsey's Three Cases of Abatement Contingent on Level of Policy Action



Source: McKinsey analysis

*Based on bills introduced in Congress that address climate change and/or GHG emissions on an economy-wide basis and have quantifiable targets; targets calculated off the 2030 U.S. GHG emissions of 9.7 gigatons CO_2e/year (reference case).

The study also demonstrates why we need a portfolio of well-designed policies beyond an overall limit and price on carbon pollution. On the demand side, efficiency improvements are already profitable but face well-known barriers in the market that require technology-specific performance standards and incentives to overcome. On the supply side, emerging technologies, such as carbon capture and storage, will also need targeted policy support to encourage or require early deployment and drive down costs.

Early action to address domestic emissions will position the U.S. economy to make sharper, cost-effective cuts in later decades as needed. In particular, early action creates the economic and infrastructure momentum needed to roll out large-scale solutions quickly starting in later years, and it encourages development and deployment of completely new emissions reduction alternatives. Moreover, the energy sector moves more slowly than any other corner of the economy. It can take decades to bring new technologies from the lab to full scale. We will have fundamentally greater policy flexibility once we have developed the capacity to rapidly expand low-carbon infrastructure (e.g., scaled-up capacity to manufacture and install solar panels; a CO_2 transportation and storage network; a "smart" electricity grid capable of handling more distributed and intermittent generation sources).

The McKinsey Study Is Inherently Conservative so the Likely Benefits Are Even Greater

The McKinsey analysis, like earlier but less comprehensive ones, demonstrates that the greenhouse gas emission cuts necessary to stabilize atmospheric CO_2e at 450 ppm by 2050 are not harmful, and indeed may be beneficial, to our economy. However, this study was intentionally conservative, so the economic reality of the transition to clean and efficient energy may be even more positive. Because the McKinsey team limited its analysis to currently available technology, it did not account for the dynamic effects of specific policy measures, which historically have led to swifter progress and lower costs. There are two major emissions reduction opportunities that were beyond the scope of the McKinsey study:

1. **Unforeseen innovations as investors respond to new incentives to contain emissions**.
   The profit potential from developing and deploying new solutions will increase as the country moves to control global warming pollution. As with prior regulatory efforts, this will likely stimulate a wide range of innovative solutions. For example, U.S. acid rain cap-and-trade regulations initiated in 1990 prompted power generators to switch to low-sulfur coal and develop new scrubber technologies, substantially reducing compliance costs relative to initial expectations. Similarly, the mandate to eliminate lead from gasoline led to innovation that dramatically cut compliance costs. Broad regulation of global warming emissions will create incentives for entrepreneurs to develop new technologies ranging from super-efficient solar cells to CO_2-eating algae that produce biodiesel. Some options may even enable "negative emissions," such as advanced biomass gasification facilities that use carbon capture and storage.

2. **Energy consumption reductions in response to a CO_2 price, as well as possible policy innovations such as smart growth and congestion pricing.**
   The McKinsey study intentionally avoids prescribing any particular policies to unlock emissions reductions, and it does not model changes in behavior in response to pricing CO_2 emissions. Consequently, energy demand reductions resulting from CO_2 price effects represent significant emissions reduction potential not included in the study. For example, a price of $50 per ton of CO_2 would imply a gasoline price increase of roughly $0.50 per gallon. For $3 per gallon of gasoline, this would suggest a 17 percent price increase and a 3 percent reduction from reduced driving assuming a price elasticity of demand of 0.2. Sustained higher gasoline prices also encourage purchase of smaller, more fuel-efficient vehicles, as seen in the past year in a trend that a Ford Motor Company analyst called "easily the most dramatic segment shift I have witnessed in my 31 years here."[46] Similarly, the study does not address possible policy-driven reductions in projected vehicle mileage growth, such as revised zoning rules, stormwater runoff programs, or financing standards for new developments. Internalizing the costs of transportation investments—both dollars and pollution—by instituting new pricing policies could provide substantial environmental benefits. A recent analysis commissioned by NRDC found that if we institute congestion pricing in central business districts across the country, vehicle mileage could be cut by 20 percent from projected levels by 2030.[47] Similarly, reforming automobile insurance so charges vary based on miles driven would reduce VMT by nearly 10 percent.

CHAPTER 4

Economic Benefits of Taking Action Now to Contain Climate Change

In 2006 the British government released a report prepared by Sir Nicholas Stern, former chief economist at the World Bank, concluding that if global warming continues unabated, long-term damages from global warming could reach the equivalent of 5 percent to 20 percent of global economic output.[48] The lower bound of 5 percent includes only direct financial losses, while the 20 percent figure includes an estimate for all costs other than national security risks. The cost of inaction on climate change dwarfs the cost of addressing the problem. Indeed, a 5 percent loss of global GDP due to continued inaction is roughly an order of magnitude greater than the worldwide cost of action to stabilize atmospheric CO_2 levels.[49] Many other studies come to similar conclusions.

A recent report by economists at Tufts University, sponsored by NRDC, showed that if present trends continue, the total cost of global warming for the United States will be as high as 3.6 percent of gross domestic product (GDP). Four global warming impacts alone—hurricane damages, real estate losses, energy costs, and water costs—will come with a price tag of 1.8 percent of U.S. GDP, or almost $1.9 trillion annually (in today's dollars) by 2100.[50] And most analysts expect costs to be more severe in developing countries due to potential impacts such as severe flooding in Bangladesh and drought in sub-saharan Africa.[51]

> *"Global warming could cost the United States more than $1.9 trillion each year in hurricane damages, real estate losses, energy costs, and water costs by 2100."*
>
> *Cost of Climate Change: What We'll Pay if Global Warming Continues Unchecked*, NRDC, May 2008

Failing to act now means there will be severe impacts on our economy, health, and environment, including:

Direct financial losses. The Stern Review estimates 5 percent global GDP loss solely from the direct economic damages caused by unabated global warming. Similarly, a recent University of Maryland study concludes that global warming could have a specific and direct effect on the U.S. economy and "place immense strains on public sector budgets."[52] Another study estimates that climate-induced decreases in tourism, losses to coastal residential property from sea level rise, intensified hurricane damages, and increased electricity costs for air conditioning will reduce Florida's gross state product by 5 percent by the end of the century.[53] And a Massachusetts Institute of Technology study released this year found that U.S. agricultural yields will likely decline significantly as the climate changes.[54]

Extreme weather events attributable to global warming will also inflict significant economic damage. A recent Union of Concerned Scientists (UCS) report found, among other impacts, that if emissions are not curtailed the extreme coastal flooding that now occurs only once a century could strike New York City an average of once every decade.[55] Other UCS studies examining impacts in California and in the Northeast found similar and other likely damage. And the University of Maryland study mentioned above found that climate change in the Great Plains and Midwest would result in "increased frequency and severity of flooding and drought events, causing billions of dollars in damages to crops and property." A recent White House report confirms these likely weather-related harms, noting that "[i]n the 21st century, precipitation over North America is projected to be less frequent but more intense. This increase in storminess is projected to be accompanied by greater extreme wave heights along the coasts."[56]

Increased illness and mortality. Likely impacts of global warming include increased disease incidence, such as the spread of malaria beyond its historical range, and increased human mortality from heat waves and other extreme weather events.[57] The United Nations Development Program, Harvard Medical School, and insurance company Swiss Re issued a report that argues warming will exacerbate diseases such as malaria, which currently kills 3,000 African children a day, and West Nile virus, which cost the United States $500 million in 1999 alone.[58] In the eastern United States, global warming will exacerbate air quality challenges, requiring more difficult and costly reductions in emissions of smog-forming pollutants if increases in asthma attacks and other respiratory problems are to be avoided.[59]

Ecosystem deterioration. Our environment is a public good with a value in its own right, and the economic impacts of environmental degradation are complex and wide-ranging, affecting everything from agricultural productivity to water quality to species survival. For example, the IPCC estimates that expected climate change by 2100 under current trends may put 30 percent of plant and animal species at risk if warming is in the 1 to 3 degree Celsius range, or lead to extinctions of 40 percent of all species by 2100 at higher levels of warming.[60] Adverse impacts could entail the shifting or shrinking of habitats or the loss of entire ecosystems such as coastal wetlands.[61] Global warming emissions are also causing our oceans to heat up and acidify, seriously threatening coral reefs and fisheries.[62]

Catastrophic risks. As global warming worsens, the risk of truly catastrophic climate change increases. Abrupt, irreversible climate impacts could take many forms. For example, the complete disintegration of the Greenland or West Antarctic ice sheets would cause sea levels to rise by 20 feet or more, causing devastation of coastal cities and regions where a large portion of the American population lives.[63] No one can say for certain at what temperature this will occur, or at what pace, but these catastrophic impacts become more likely as the world warms. Similarly, as the IPCC notes, large areas of the planet could shift from semi-arid to desert ecosystems, rendering them unfit for human habitation and forcing the migration of tens of millions of people. The Stern Review found that including expected losses from possible catastrophic impacts along with direct financial, human health, and ecosystem costs resulted in global economic losses as high as 20 percent of per capita consumption.

National security risks. The combined effect of such varied adverse impacts is likely to also cause upheaval in human societies. In 2007 a leading military think tank released a study authored by 11 retired high-ranking generals and

admirals that called global warming a "threat multiplier" that poses severe risks to America's national security and to international security by adding new hostile and stressing factors through sustained natural and humanitarian disasters on a scale far beyond those we see today.[64] In the same vein, while making no attempt to quantify these costs, the Stern Review notes that climate change "is the greatest and widest-ranging market failure ever seen" and goes on to say that "our actions over the coming few decades could create risks of major disruption to economic and social activity, later in this century and in the next, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century. And it will be difficult or impossible to reverse these changes."[65]

By implementing the six strategies outlined in Chapter 2 (plus other measures to address forestry, and non-CO_2 emissions), the United States can address global warming while ensuring a role for U.S. companies in the growing market for advanced energy technologies. In addition to the important benefit of avoiding climate change itself, these investments also will result in a range of societal and economic benefits above and beyond those just described.

Improved community health. A low-carbon energy economy would substantially improve environmental quality within the United States, and therefore improve public health. Energy efficiency and most low-carbon energy technologies also reduce emissions of a range of pollutants caused by traditional energy sources, including particulate matter, smog, acid rain, carbon monoxide, arsenic, mercury, and lead. Cutting air pollution from power plants could avoid many of the roughly 20,000 premature deaths that occur annually in the United States as a result of fine particulate pollution, much of which comes from dirty coal plants.[66] This translates to $175 billion per year using standard EPA estimates for the value of avoided morbidity and mortality.[67] A cleaner, more efficient energy supply will also reduce ecological harms such as acid rain, which is killing lakes and forests; mercury contamination, which is poisoning fish throughout the Northeast; eutrophication of coastal waters, which leaves many estuaries almost devoid of fish and shellfish; and pollution from mining operations and oil spills. All of these benefits would be multiplied many times over when technologies developed or perfected in the United States were widely adopted abroad. For example, the World Health Organization estimates that there are more than 650,000 deaths per year in China from indoor and outdoor air pollution, most of it related to coal combustion.[68]

Economic opportunity. Unlocking cost-effective energy efficiency in vehicles and buildings will directly benefit consumers by reducing their energy bills. In addition, efficiency reduces peak power demand, putting downward pressure on prices and reducing the cost of maintaining the electric grid, as well as delaying or avoiding the need for new capital investments in generation, transmission, and distribution capacity. Moreover, making the transition to a clean energy infrastructure means launching whole new industries—efficiency, solar photovoltaics, biofuels—all of which provide more American jobs than importing and burning fossil fuel. One study estimated that every MW of solar power we install generates 33 local jobs.[69] Renewable energy technologies such as wind and biomass will particularly benefit rural and agricultural communities.

Increased national security. America's dependence on oil for 97 percent of our transportation needs makes the country vulnerable to price shocks due to conflicts in unstable oil-producing regions and the actions of national oil companies, which own about 90 percent of remaining world reserves. Tripling light-duty and doubling heavy-duty new vehicle efficiency, in conjunction with replacing gasoline and diesel with biofuels and electricity, will cut our oil use by 85 percent relative to projected 2050 levels. Moreover, enhanced oil recovery using CO_2 captured from power plants has the potential to cut emissions and substantially boost domestic oil production from existing oil wells, eliminating the equivalent of roughly 13 years of oil imports through 2050. This would dramatically reduce upward pressure on global oil prices and our exposure to oil price volatility. Similarly, energy efficiency in the buildings and industrial sectors means less demand for natural gas compared with business as usual, resulting in lower and less volatile natural gas prices.

CHAPTER 5

NRDC Policy Recommendations to Unlock Global Warming Solutions and Grow the Economy

A host of market barriers and irrational incentives currently block investment in cost-effective global warming solutions. To unlock the potential that these technologies offer, we need a comprehensive package of policies to transform the capital-intensive and slow-moving energy sectors. Well-designed policies can promote investment in global warming solutions while improving the competitiveness of U.S. businesses and minimizing costs for residential, commercial, and industrial energy consumers.[70]

To capitalize on the opportunities described in Chapter 2, the federal government must take three essential steps:

1. Enact comprehensive mandatory limits on global warming pollution to stimulate investment in all sectors and guarantee that we meet emission targets, both by putting a price on pollution and by reinvesting value from pollution rights to encourage efficiency, innovation, and abatement outside capped sectors.
2. Overcome barriers to investment in energy efficiency to lower abatement cost starting now.
3. Accelerate the development and deployment of emerging clean energy technologies to lower long-term abatement costs.

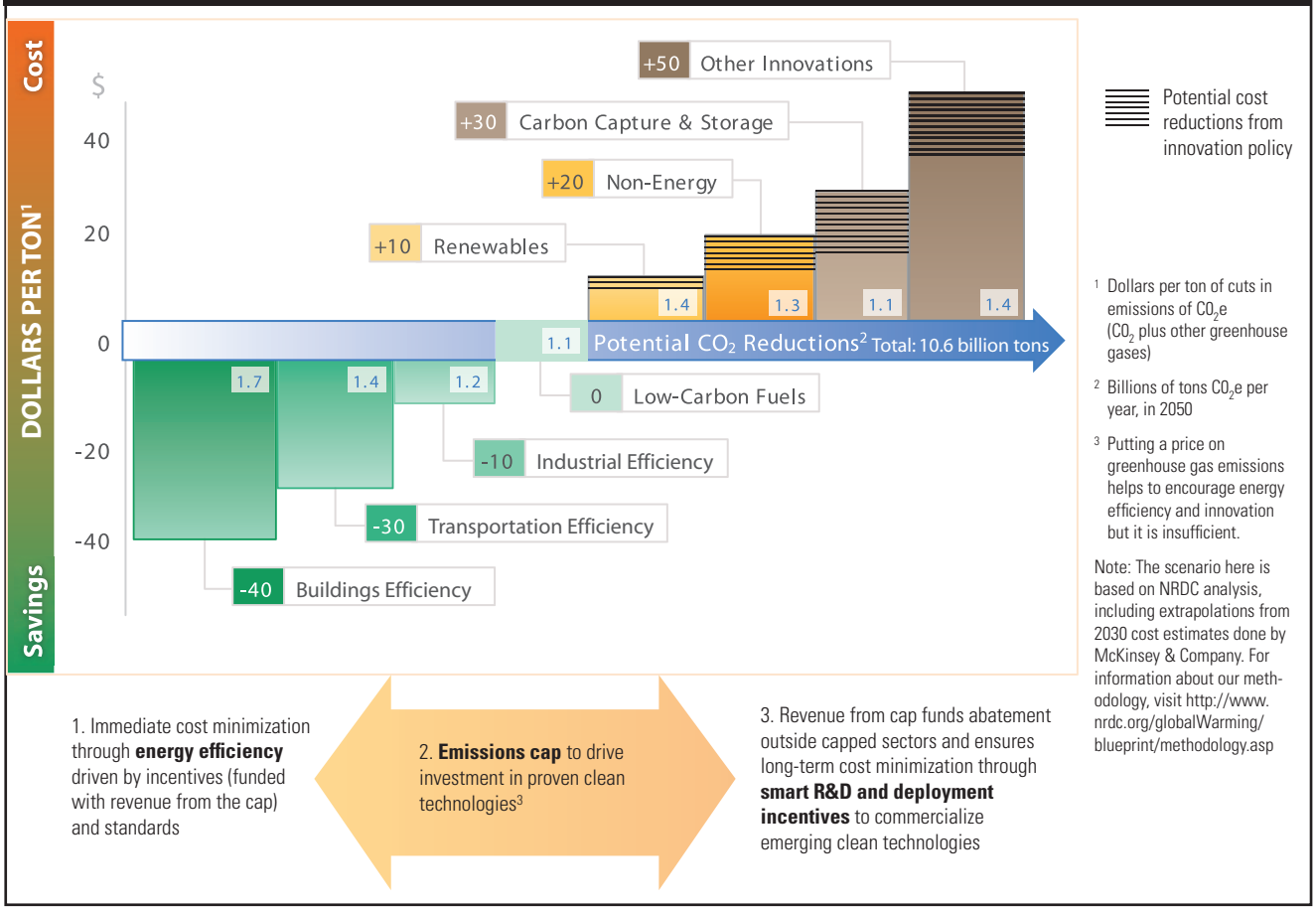
Enact Mandatory Limits on Global Warming Pollution

A mandatory cap will guarantee that we meet emissions targets in covered sectors and will drive investment toward the least costly reduction strategies. If properly designed to support efficiency and innovation, such a program can actually reduce energy bills for many consumers and businesses.

The following design elements are essential to achieving these results:

- **Long-term Declining Cap**—A federal program should cap emissions of carbon dioxide and other heat-trapping pollutants at current levels and steadily reduce the cap to 80 percent below current levels by 2050. This will deliver the reductions that scientists currently believe are the minimum necessary and provide businesses with the certainty and market signals they need to make large capital investments in clean solutions.

Figure 11: Cutting U.S. Global Warming Pollution 80% by 2050: Cost and Payoff by Sector



▸ **Comprehensive Coverage**—At a minimum, a federal emissions cap should cover heat-trapping pollutants from all large stationary sources (power plants, factories, etc.) and the carbon content of transportation and heating fuels at the point of wholesale distribution (oil refineries and natural gas distribution companies). If the program covers these sectors, it would address more than 80 percent of global warming pollution sources in the United States, with the remaining sources targeted through carefully devised programs and projects as described below.

▸ **Use Allowance Value in the Public Interest**—As with other public goods such as broadcast spectrum, pollution allowances should be auctioned directly or through consumer trustees, and the annual revenues—potentially hundreds of billions of dollars—should be used to achieve additional emission reductions from uncapped sources as well as to reduce costs for residential, commercial, and industrial energy users by promoting end-use energy efficiency and supporting investments in emerging low-carbon technologies. It is also appropriate to use a portion of the value of allowances to provide new opportunities for adversely affected workers and low-income families, and for helping communities adapt to the impacts of global warming that can no longer be avoided.

▸ **Allowance Trading**—Regardless of how allowances are initially distributed, companies should be allowed to buy and sell allowances on the secondary market in order to true-up their holdings to reflect actual emissions and ensure that the overall costs of compliance are held to a minimum. Provisions for banking and borrowing credits across trading years are also needed to ensure a stable CO_2 price signal to facilitate long-term investment in global warming solutions.

Why a Cap-and-Trade System Is Better Than a Carbon Tax

A carbon tax that taxes pollution emitters is another option for creating a broad, economy-wide incentive to reduce greenhouse gas emissions. Proponents of this approach suggest that it has advantages over a cap-and-trade system, including administrative simplicity and investor certainty.

On close inspection, however, a cap has clear advantages over a tax. Just as with a cap, administering a carbon tax requires careful monitoring and verification. While an upstream tax on the carbon content of fossil fuels sounds simple in theory, in practice, implementing such a system involves the same political and administrative complexities faced by a cap (e.g., treatment of fossil fuel carbon "sequestered" in long-lived products, such as plastics; point of collection for natural gas; and coverage of gases other than CO2). Moreover, long-term carbon prices under a tax approach are not necessarily more predictable than under a cap, since politicians may decide to substantially reduce or increase tax levels depending on how closely the nation is tracking toward abatement targets, evolving science, and political factors.

Most important, a cap on carbon provides more fundamental environmental certainty than a tax—both because it is, by definition, a fixed limit on emissions and because the political process to define a cap is less likely to result in emissions loopholes. In particular, the political horse-trading in defining a cap centers on distributing a fixed number of total allowances—with equity and economic productivity implications but no impact on future emissions levels. In contrast, negotiations to define a carbon tax might result in exemptions for certain sectors, which would allow higher emissions levels.

- **Limited Use of Offsets**—Offsets are credits generated by specific projects outside the capped portion of the economy, i.e., non-capped sectors within the United States or potential projects in developing countries. Any offsets provision must include standards to ensure that reductions are real, surplus, verifiable, and permanent. A numerical limit on the use of offsets is also necessary to ensure faithful implementation of the offset quality rules and to guarantee that the program drives transformative investments in the U.S. electricity and transportation sectors.

Overcome Barriers to Energy Efficiency

Multiple market failures cause individuals and businesses to underinvest in cost-effective energy efficiency and emerging low-carbon technologies. Price signals alone will not adequately drive these investments, which are already profitable at current energy prices. Therefore, while a mandatory cap on emissions is essential (and the associated allowance value can substantially fund efficiency), many of the opportunities identified in this report require additional federal, state, and/or local policy to overcome barriers to investments that are already cost effective even without a price on greenhouse gas emissions.

- **Building, Industry, and Appliance Efficiency**
  - *Codes, standards, and incentives*: Minimum efficiency codes and standards for buildings, appliances, and equipment are essential for driving the market to more efficient products that can also save the consumer money.[71] Refrigerators today are bigger, less expensive, and use less than one-third the energy of those 35 years ago—because appliance standards have changed the market. A whole suite of appliances from lighting to air-conditioning have already become more efficient because of smarter energy policy. Moreover, creating nationally consistent incentives for manufacturers to develop super-efficient technologies, for retailers to market super-efficient products, and for building owners to perform whole building retrofits that dramatically improve energy performance will further accelerate market adoption of efficiency and help reduce consumer energy bills. In addition, improved product and building efficiency labeling requirements will provide consumers with the information needed to shift market demand toward more efficient products and buildings.
  - *Federal-level regulatory reform:* In addition to setting a cap on global warming emissions, federal climate legislation holds tremendous potential to establish

strong market incentives specifically targeted to accelerate the adoption of cost-effective energy efficiency. Today, few states put energy efficiency on a level playing field with new energy supply, much less require utilities to invest in efficiency whenever doing so is cheaper than purchasing electricity or gas. In addition, many states lag behind in adopting strong residential and commercial building codes and otherwise advancing increased efficiency.

A federal cap-and-trade system for global warming emissions could distribute allowance value to states based on demonstrated improvements in the energy intensity of buildings within that state. Compared to a baseline for each state, such a cap-and-trade system would drive state policies and incentives to rapidly scale up and enable energy efficiency solutions. A similar allowance value distribution applied to utilities based on aggregate-level improvements in efficiency across their service territory would create a strong incentive for utilities to invest in end-user energy efficiency. This system of rewarding states and utilities for achieved reductions in aggregate energy intensity of their end-users, potentially combined with minimum federal targets for energy efficiency procurement, would help to overcome structural barriers to energy efficiency.

- *State-level regulatory reform*: In most states current regulation ties utility profitability to sales, a powerful disincentive to utility support for energy efficiency or clean distributed generation such as solar PVs or combined heat and power. We need to reform utility regulation with measures like "decoupling" profits from sales plus incentives for delivering efficiency so that helping customers save energy becomes the most profitable thing utilities can do. It is also critical to ensure that utility regulators use appropriate standards (e.g., the total resource cost test) when assessing ratepayer impacts from efficiency investments.

- **Smart Transportation: Advanced Vehicles and Smart Growth**
  - *Performance standards*: While the 2007 Energy Bill made important progress, the federal government should further increase automobile fuel economy standards or set global warming pollution standards to promote the production of hybrid vehicles, high-efficiency internal combustion engines, and other advanced vehicles across all vehicle models and classes, with the goal of helping consumers reduce fuel use and lower overall transportation costs.
  - *Financial and regulatory incentives*: To minimize vehicle miles traveled, federal, state, and local government must establish policies that encourage investment in transportation, housing, and neighborhood design to reduce sprawl and improve convenience. Key measures include congestion pricing as well as pay-as-you-drive insurance to ensure that drivers pay the full cost to society for each mile.
  - *Support for local governments*: Federal transportation and other policies should support state and local governments that invest in smart growth planning, public transit, and transit-oriented development, and that promote green building strategies that reduce global warming pollution.

Promote Emerging Low-Carbon Solutions

To accelerate the "learning by doing" needed to develop an affordable low-carbon energy supply, we must support rapid development and deployment of renewable electricity, low-carbon fuels, and carbon capture and storage, including channeling a substantial share of CO_2 allowance value from a federal emissions cap towards innovation.

- **Renewable Electricity**
  - *Renewable electricity standards*: Twenty-five states require utilities to provide a minimum percentage of their electricity from renewable sources. The federal government should establish a national standard to ensure steady expansion of the renewable electricity market.
  - *Infrastructure upgrades*: Energy regulators must support transmission capacity upgrades to enable increased use of intermittent renewables, subject to careful environmental review. Much of the upgrade is in controls more than new wires, sometimes called a "smart grid."
  - *Financial incentives*: Many states already provide long-term, performance-based incentives to support the continued growth of promising technologies, such as solar photovoltaics. A federal program would dramatically expedite the growth of these technologies and drive down costs even more quickly.

- **Low-Carbon Transportation Fuels**
  - *Performance standards*: California has already developed a technology-neutral performance standard that requires lower carbon content in our transportation fuels over time to ensure investment in advanced, sustainable biofuels without picking industry winners. A federal low-carbon fuel standard would dramatically expedite the nation's shift to advanced fuels.
- **Carbon Capture and Storage**
  - *No new dirty coal plants*: Several states have determined that without carbon capture and storage, new coal plants are a bad investment for consumers and the environment. As the Clean Air Act requires for other air pollutants, the federal government should prevent the construction of any such power plants by establishing a CO_2 performance standard that would require carbon capture and storage as the best available technology.
  - *Geologic sequestration standards*: State and federal governments must develop an effective regulatory framework for site selection, operation, and monitoring for carbon capture and geologic storage systems.
  - *Regulatory and financial incentives*: Installing and operating carbon capture and storage technology is not currently cost effective and may not become so during the early years of a mandatory emission limit. State and federal electric incentives are needed to overcome this cost barrier and ensure that any new plant that uses coal captures and safely disposes of its carbon pollution.

Conclusion

The United States is finally starting to move toward addressing the threat of global warming. This paper shows that we have the solutions at hand to solve the problem while continuing to grow our economy. Starting now will build the momentum the market needs to generate even more technological advances. And acting now means we stop wasting money on old polluting infrastructure and start leading the global economy to a clean energy future. Failure to act will result in unacceptable economic and environmental risks from global warming—with trillions in investment in the health of our planet at stake. The time is now for political leadership both at home and abroad.

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