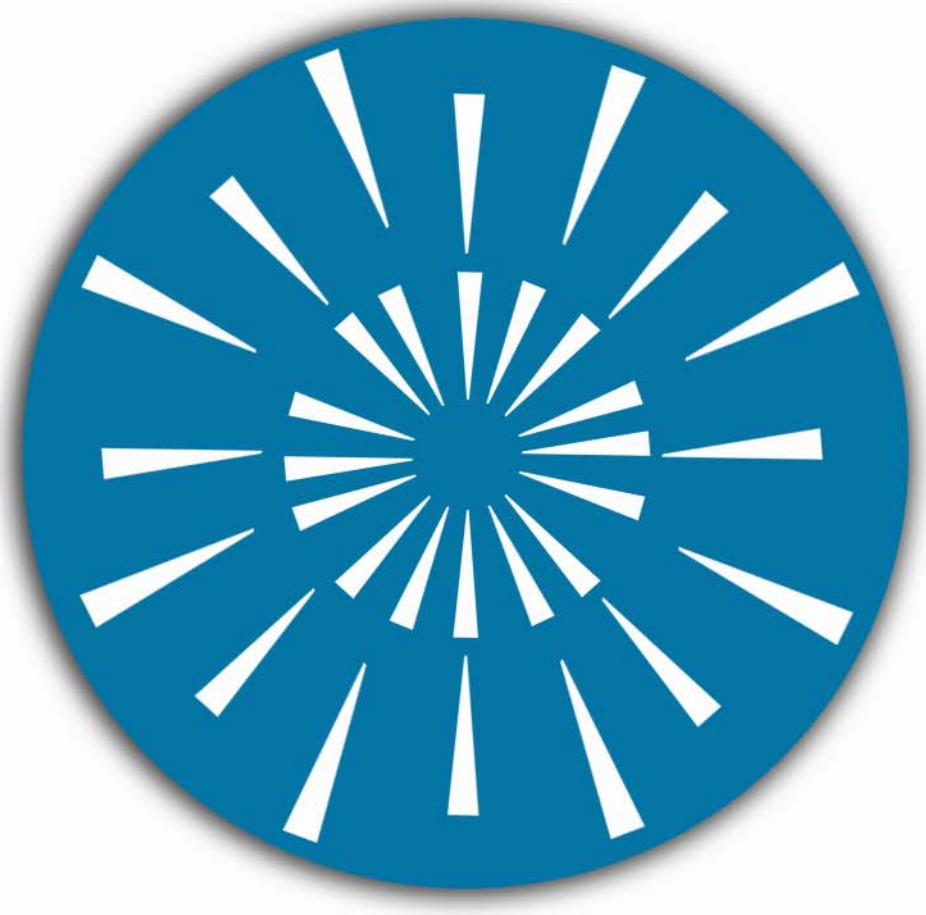
Land of Opportunity

The American Response to Climate Change

Financing the Transition to a Low-Carbon U.S. Economy



THE WILD CENTER, TUPPER LAKE, NY
June 25 & 26, 2008

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FOR REVIEW BY CONFERENCE PARTICIPANTS

A Primer on Financing the Transition to a Low-Carbon U.S. Economy

THE AMERICAN RESPONSE TO CLIMATE CHANGE CONFERENCE

THE WILD CENTER, TUPPER LAKE, NY

June 25 and 26, 2008

Financing the Transition to a Low-Carbon U.S. Economy

A memorandum intended to prompt discussion at *The American Response to Climate Change* Conference[1]

The purpose of the Carbon Finance Working Group is to examine the range of possible financing strategies to facilitate the transition to a low-carbon U.S. economy.

The transition to a low-carbon economy will necessitate the deployment of massive amounts of capital and the creation of a powerful new commodity—carbon allowances. These developments have major implications for the U.S. economy and, by extension, for financial institutions around the world. A successful transition will also require broad public support and market innovation to enable financial markets to provide the capital, liquidity, and risk-transfer solutions the U.S. economy needs in order to make these transformative changes in an efficient and sustainable way.

Industrial restructurings do not come cheap. Major shifts in capital investment will be required. McKinsey estimates that more than $1 trillion in incremental capital investment across all economic sectors will be required through 2030 for the U.S. to make a meaningful transition toward a low-carbon economy, with substantially more investment required in the period between 2030 and 2050. Globally, required shifts in investment flows could demand more than $900 billion of annual investment by 2030.

Current new investment in the low-carbon sector is tiny by comparison. According to New Energy Finance, $117 billion of investment capital flowed into the U.S. clean-energy market in 2007, much of it relatively small, venture-oriented investment or project finance for clean power or biofuel plants. Arguably the single biggest barrier to reaching the scale of investment required is the lack of regulatory clarity from U.S. lawmakers. Unclear regulatory signals create tremendous uncertainty about the long-term future of low-carbon solutions, raising the cost of capital and reducing investment interest from the capital markets. The lack of compliance incentives to bridge the financing gap for greenhouse gas (GHG) emissions abatement lies at the heart of the low-carbon financing conundrum.

This situation is slowly changing. If enacted, legislative proposals to implement a cap-and-trade system in the U.S. will create a powerful new commodity class: the carbon allowance. A national cap-and-trade system would turn carbon emissions into an input factor whose price will powerfully alter the economics of production. Carbon will become a fundamental price in the economy, on a par with fuel prices,

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[1] Prepared by the Carter Bales, Albert Cho and Jamie Russell in consultation with the Carbon Finance Sector Advisory Team: Paul Ezekiel (chair), Matt Arnold, Carter Bales, Albert Cho, Andrew de Pass, Mike Gordon, Ben Lashkari, Colin le Duc, Jason Patrick, Jamie Russell, and Martin Whittaker.

interest rates, and exchange rates, once the "full" cost of energy—its rate cost plus its emissions cost—is priced into all goods. Financial institutions and markets have critical roles to play in helping businesses across the economy manage the impact of carbon prices.

Three types of solutions can help the United States successfully make the transition to a low-carbon economy: (1) unambiguous market regulation, (2) public finance, and (3) private market innovation. The need for major capital investment in a broad range of economic sectors and abatement measures, coupled with creation of a powerful and pervasive new commodity market (one that some speculate could become one of the world's largest), suggest that financial institutions have three essential roles to play: (1) they will need to provide *capital* at a significant scale to support investment; (2) they will need to provide *market liquidity* to enable investors and businesses to freely enter and exit investments and to manage exposure to the price of carbon; and (3) they will need to provide *risk-transfer solutions*, including price hedging and insurance to help participants manage risks involved in large-scale capital investment and manage new carbon market compliance exposure.

Private capital cannot solve the problem alone. Substantial public action is required to create the conditions for financial markets to provide these services. Without public support, many required investments, particularly those at the earliest stages of commercial development, will be unable to attract private capital. Unless public policy measures are stable and sustained, they will not convince the private sector to make the long-term investments needed. Without market innovation, investment opportunities that are attractive but challenging to execute, such as energy efficiency, will remain unexploited. However, once appropriate incentives are in place, existing private sector participants will be better able to respond to new opportunities. Government agencies can then turn their attention to monitoring progress and targeting areas where private action appears insufficient to drive emissions abatement rapidly and at required scale.

This memorandum is intended as a basic primer to introduce readers to the nature of the challenge, identify elements of the solution, and lay the groundwork for discussion. It is organized into five sections:

1. Need for action and the magnitude of the capital gap
2. The roles of financial institutions and markets
3. Financing needs in five key abatement categories
4. Need for liquidity in asset and commodity markets
5. Need for risk-management mechanisms in asset and commodity markets.

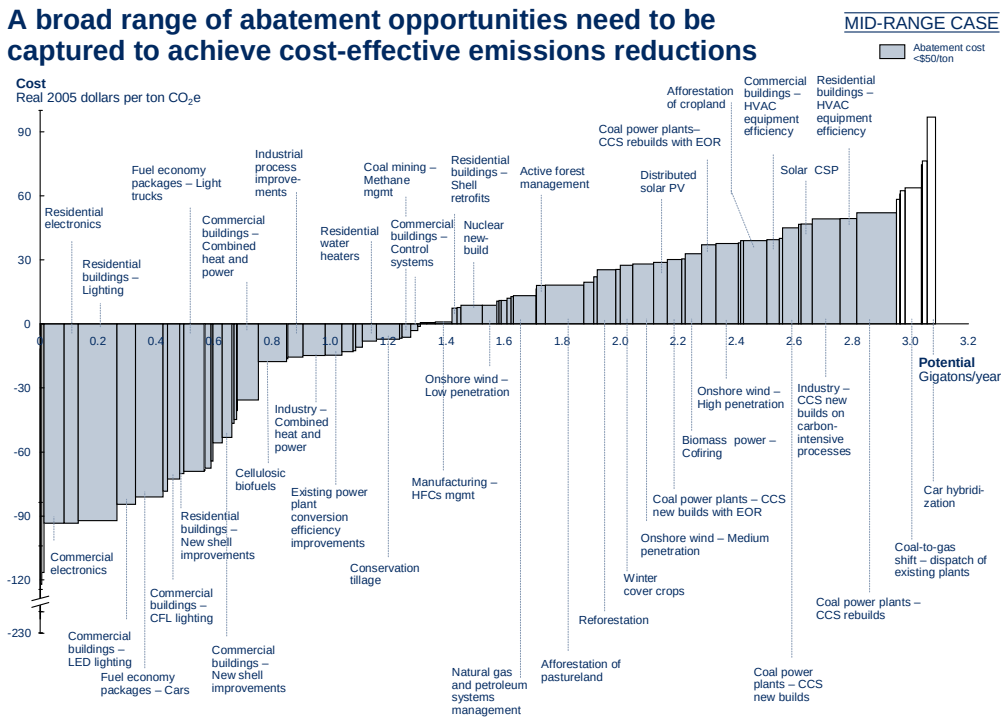
1. NEED FOR ACTION AND MAGNITUDE OF THE CAPITAL GAP

Significant Capital Investment Will Be Required

The U.S. is the world's second-largest carbon emitter and one of the highest emitters on a per-capita basis, which creates a significant opportunity for abatement. A recent report by McKinsey & Company demonstrates that the U.S. could achieve annual reductions in the range of 3.0 to 4.5 gigatons (Gt) in GHG emissions (vs. a baseline forecast of 9.7 Gt in 2030) at a cost of less than $50 per ton. This reduction would require incremental investment of more than $1 trillion and the redirection of more than $3 trillion in investment from traditional technologies (including coal-fired electricity generation) to cleaner technologies between now and 2030. While $1 trillion of incremental investment is no doubt a large sum, it represents merely 1.5% of the forecast $77 trillion to be invested in the U.S. economy through 2030.

The U.S. can make this transition only if companies invest in a broad array of abatement projects, ranging from retrofits of existing buildings to the installation of carbon capture and storage (CCS) at fossil-fuel power plants. These abatement initiatives are extremely diverse and cover all sectors of the economy (Exhibit).[2] Some abatement options—such as energy-efficiency opportunities—are 'negative-cost' and can generate attractive returns as the market for low-carbon technologies forms and matures. Others (such as the switch to more expensive forms of renewable energy) impose a net cost to investors that can only be recouped if financial incentives are provided.

[2] McKinsey & Co., *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?* December, 2007.



Source: McKinsey analysis

2. ROLES OF FINANCIAL INSTITUTIONS AND MARKETS

Financial institutions have three essential roles to play: they need to (1) provide significant amounts of capital, (2) create liquid asset and commodity markets, and (3) develop risk-transfer products to help economic players efficiently manage risks.

Roles for financial institutions

	Description of role	Key actors*
Capital provision	• Supplying debt and equity to finance abatement investments	• Commercial banks • Asset managers • Private equity • Venture capital
Liquidity provision	• Creating 'asset liquidity' by participating in secondary market trading • Creating carbon market liquidity	• Brokers • Exchange platforms • Investment banks • Hedge funds • Private equity
Risk transfer	• Risk transfer for operating risks	• Insurance companies • Re-insurance companies • Hedge funds

*: Not exhaustive

Capital Provision

Of the $1 trillion in incremental investment required by 2030 to achieve carbon-mitigation objectives in the U.S., a significant proportion will require financing from banks and other capital providers. Many abatement opportunities (e.g., retrofitting buildings to enhance energy efficiency) require significant up-front capital expenditure but accrue benefits only over time. Some investment may take place without incremental financing where companies have surplus cash, unused pre-arranged debt capacity, or lines of credit. However, these large-scale, long-term investments are not included in most companies' financing plans and usually require additional financing from outside sources. Without access to external financing, even highly profitable projects will not receive funds, because most economic actors lack the capital required for large up-front investments. By providing capital to companies that could not otherwise make the investments required to abate carbon emissions, private and public financiers play an essential role in the transformation to a low-carbon economy. We discuss the need for capital provision in greater detail in Section 3 below.

Liquidity Provision

Financial institutions play a second important role: creating market liquidity in asset ownership transactions and carbon markets. Liquidity refers to the ability of an asset to be converted quickly to cash without a significant discount. Liquidity matters in all markets, including markets for physical assets and for physical commodities. For markets that involve long-term, large-scale investment in physical assets (e.g., power infrastructure or forestry), liquid markets lower risk by enabling investors to exit investments flexibly without loss of value. For commodity input markets (e.g., carbon allowances), liquid markets enable market efficiency through price discovery and the development of sophisticated risk-management tools. We discuss the need for liquidity provision in greater detail in Section 4 below.

Risk Management

Financial institutions such as banks and insurance/re-insurance companies have an important role to play in enabling investors and firms to transfer significant risks to institutions capable of pooling and redistributing them. The transition to a low-carbon economy will involve major capital investments and the creation of a new commodity class in the U.S. (carbon allowances), and both dimensions will create risks that require management. Financial institutions, including insurance companies, can help investors make larger, longer-term investments by creating opportunities to manage large downside risks. They can also help market participants manage risks in the carbon markets. We discuss the need for risk management in greater detail in Section 5 below.

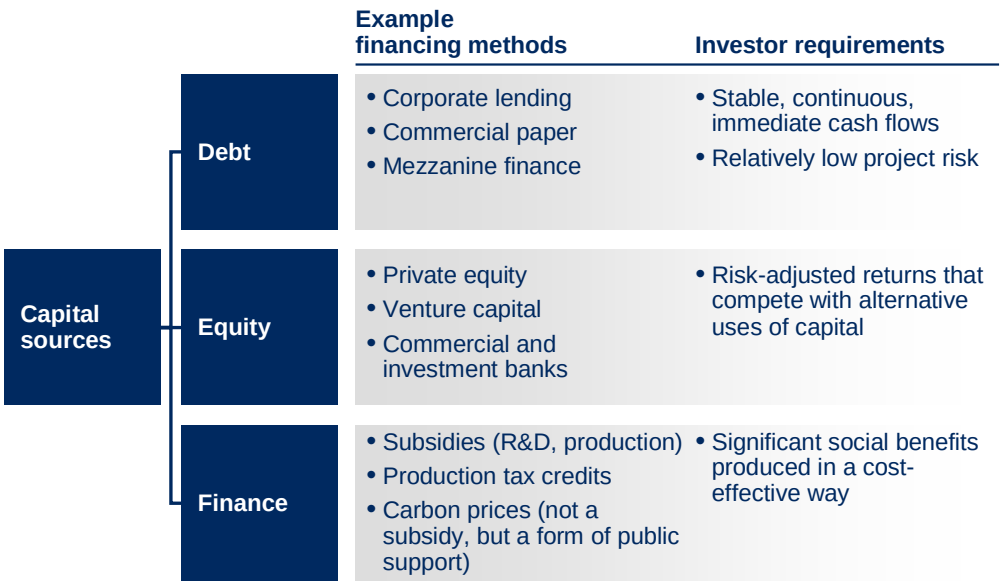
3. FINANCING NEEDS IN FOUR KEY ABATEMENT CATEGORIES

While significant investment in abatement measures is required, a range of market constraints currently prevent capital from flowing at the pace and scale required. This section describes the capital sources available to finance abatement and their core requirements for providing capital. We then describe four core categories of abatement investments that will require financing but where significant barriers are inhibiting the flow of capital. In each area, we describe example investment areas, barriers to financing, and potential solutions. Other investment areas exist but are not the subject of this memorandum.

Sources of finance

The financing required to make the transition to a low-carbon U.S. economy will need to come either from private finance (debt or equity) or from public financing (Exhibit 2). Each of these capital sources has different characteristics and requirements.

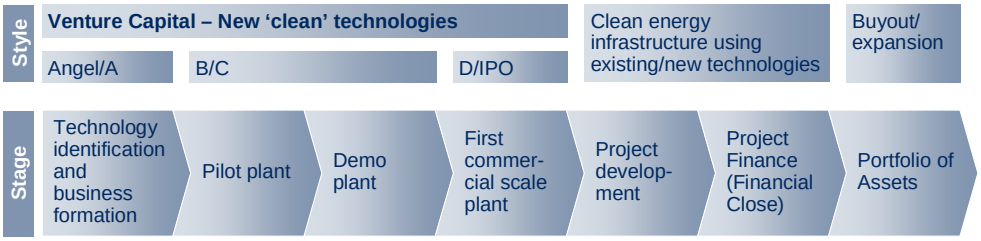
Capital providers have different requirements



1. Private financing. Private sector financing comes in two basic categories, debt and equity, and each category has different investment requirements.[3] Debt providers, such as commercial banks, lend primarily to lower-risk projects that generate stable, recurring cash flows, which begin soon after investments are made and/or where hard collateral exists that can be liquidated in the event of borrower default. Equity providers invest in projects and businesses that offer higher, risk-adjusted returns than competing uses of capital, where threshold return expectations are a function of an investment's expected return and its perceived risk and the risk-adjusted returns available from alternative uses of capital. Equity investors will make capital available only if they perceive that cash flows from low-carbon investments compare favorably on a risk-adjusted basis with potential, alternative investments. Equity investment can take many forms, including venture capital, private equity, and publicly traded equity. Different capital providers have different 'styles' and will be willing to invest at different stages of project and technology development.

[3] Other, more complex financing structures exist, including hybrids between debt and equity (mezzanine finance, convertible debt, preferred stock, etc)

Technologies will appeal to investors with different styles and structures at various stages of development



Source: Sustainable Development Investments, a unit of Citi Alternative Investments

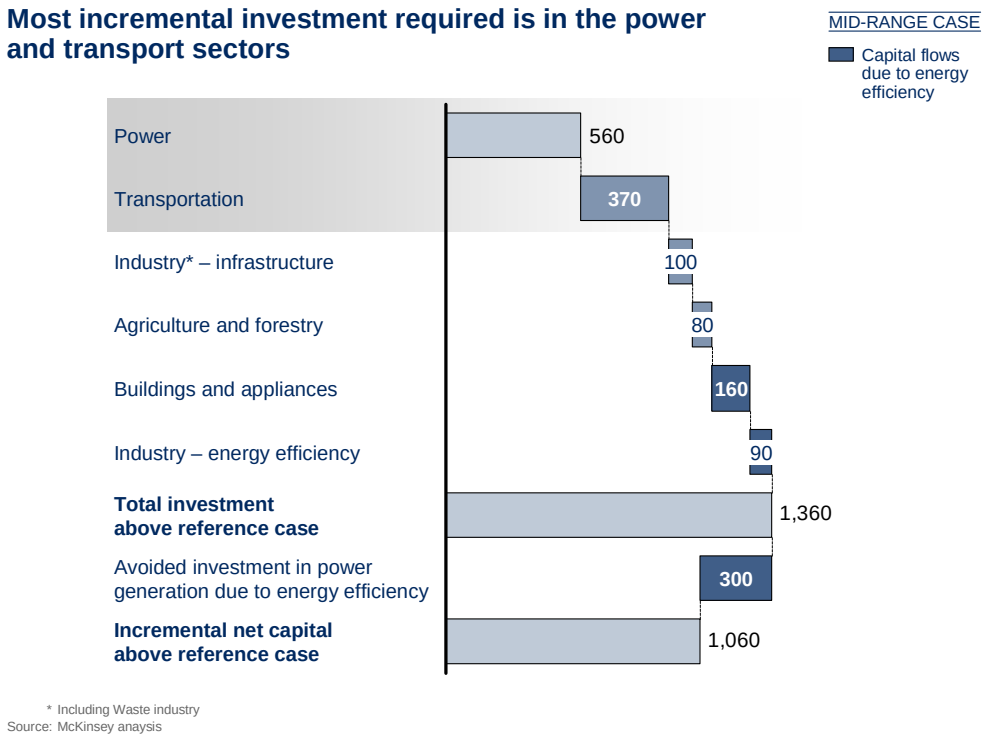
2. Public financing. Public financing can play two roles to increase investment in measures that generate social benefits. Public financing can supply up-front "risk" capital, or it can help investments draw in private capital by improving return expectations or by reducing risk. As a provider of up-front "risk" capital, public financing or subsidies help support new technologies or pilot projects where the risks are too high to attract private-sector investors at the scale required. Examples include R&D subsidies or support for large-scale technology developments such as that required for CCS. In doing so, public financing can help with the early diffusion of new low-carbon solutions into the commercial arena and get them to the point where the private capital can be applied. Public financiers can also attract private capital by enhancing risk-adjusted returns to that private capital through the provision of additional cash flows and other financial benefits. Examples include tax incentives, such as production tax credits, or subsidized output prices, such as feed-in tariffs for renewable energy. At today's power prices, many forms of renewable-power generation would not be competitive at the margin without these subsidies. Finally, public financiers can draw in private investment by lowering perceived risks—and the concomitant cost of capital—through the provision of insurance, performance guarantees, off-take arrangements, or other forms of credit enhancement.

Public subsidies are only efficient where they are used to support critical technologies and services that are not yet cost-effective but could compete given additional RD&D. However, it is difficult to pick winners. Governments have to decide where to establish subsidies and how to disburse them to optimize their impact. For example, solar photovoltaic (PV) technology is rapidly becoming more efficient and less costly.

Governments have to decide when to move dollars from research to deployment given that profitability will only be realized if significant production is ramped up. They also have to decide how to disseminate funds to generate the best outcomes. For example, they could establish public investment funds to promote early stage, venture-type investments, or they could contract outside investment professionals with domain expertise to disburse these funds.

Financing challenges in four key abatement categories

We examine four abatement categories that exhibit a broad range of financing challenges. They are not exhaustive, but they represent nearly 70% of the total abatement options available in 2030 at a cost of less than $50/ton of carbon and nearly 60% of the incremental investment required.

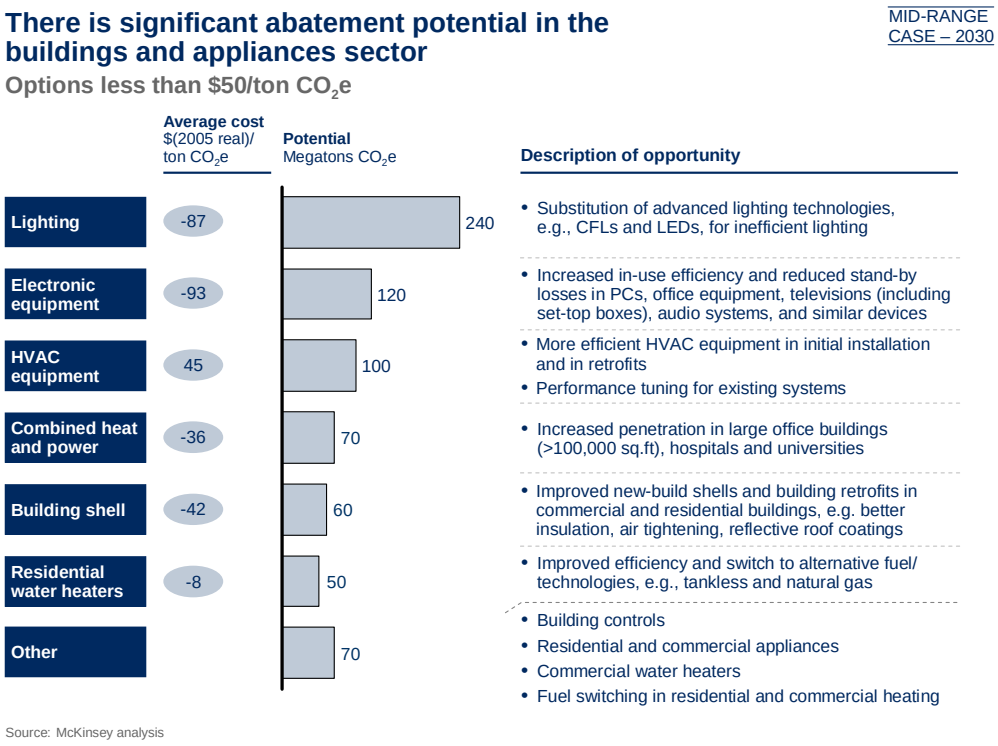


* Including Waste industry
Source: McKinsey anaysis

1. Energy Efficiency

Energy efficiency is a large, "negative-cost" abatement opportunity that can reduce carbon emissions and generate significant cash savings from reduced energy consumption. Many energy-efficiency opportunities have positive NPVs with short payback times, but they remain largely unexploited. The fact that opportunities persist despite the underlying rationale for investment suggests that significant barriers need to be resolved. Private market innovation—in addition to government standards, regulation, and other incentives—will be needed to unlock these opportunities and encourage financing to flow to investments in energy efficiency.

a. Opportunity for abatement. McKinsey's analysis suggests that, in a mid-range case, 710 megatons (Mt) of abatement potential from energy-efficiency improvements are achievable at a cost of under $50/ton. This equates to capital flows of approximately $160 billion through 2030. Nearly all of these investments have a negative abatement cost, which means that the savings from reduced energy expenditure more than offset the up-front investment costs. Energy-efficiency opportunities are found in the built environment, industrial processes, and transportation. This memorandum focuses on energy-efficiency opportunities in the built environment, which accounts for 24% of total abatement potential under $50/ton.



Major "negative-cost" energy-efficiency investment opportunities include lighting, HVAC systems, insulation, appliance/equipment efficiency and management, and cogeneration. Opportunities exist across the built environment, although there are differences between the commercial and residential segments. For example, the scale

of investment required in commercial projects is typically much larger than that required for residential buildings.

b. Barriers to financing. Given the inherent economic attractiveness of investments in energy efficiency, why is the market not already capturing this potential? Three main barriers have made energy efficiency difficult to finance despite the powerful rationale for investment.

First, energy-efficiency investments are typically small, disaggregated, and have not been a priority for most power users. Since energy bills have historically been a minor cost item for most entities (this is changing), many ratepayers have not bothered to make efficiency investments. Second, principal-agent problems and misaligned incentives between owners and occupiers eliminate or weaken the motivation to make investments. For example, where owners have to pay for energy-efficiency measures but occupiers reap the savings in terms of lower bills, investment is less likely to occur. Third, and perhaps most important, it is difficult to secure financing for major energy-efficiency investments (e.g., retrofits) because financial markets currently do not treat energy savings as valid security against debt, making it difficult to obtain up-front capital to invest without placing other assets as collateral.

c. Potential solutions. While a cap-and-trade system could increase energy prices and create stronger financial incentives for energy efficiency, it will not resolve the other barriers to finance noted above. Both market innovation and regulatory innovation will be needed in order to drive abatement.

Market innovation is a critical part of the solution. Given energy savings' stable cash-flow profile, energy-efficiency investments are a good candidate for debt finance. Institutional investors and commercial banks are beginning to take notice; indeed, so-called Energy Savings Performance Contracts (ESPCs) have already channeled more than $1 billion of third-party financing into federal energy-efficiency projects. To scale up the market, two core innovations are required. First, capital providers will have to create debt or insurance instruments that make them comfortable treating energy savings as security against debt. (The reason the federal ESPC market has been so successful is because the efficiency savings are akin to government-backed securities.) Second, they will need to develop transaction structures that aggregate and bundle individual financing opportunities to increase investment scale and diversify risks.

Regulatory innovation will be required to drive greater efficiency, particularly where the scale of energy savings is not large enough to motivate action. Energy legislation passed in 2007, for example, will effectively phase out the use of inefficient incandescent light bulbs in the U.S. New regulations could drive even more significant abatement: for example, public agencies could require new buildings to incorporate highly efficient lighting and heating technologies. To encourage acceptance of these regulations, regulators could compensate losers with public financing, which in turn could be generated from the auctioning or sale of allowances, as was contemplated by the Lieberman-Warner bill.

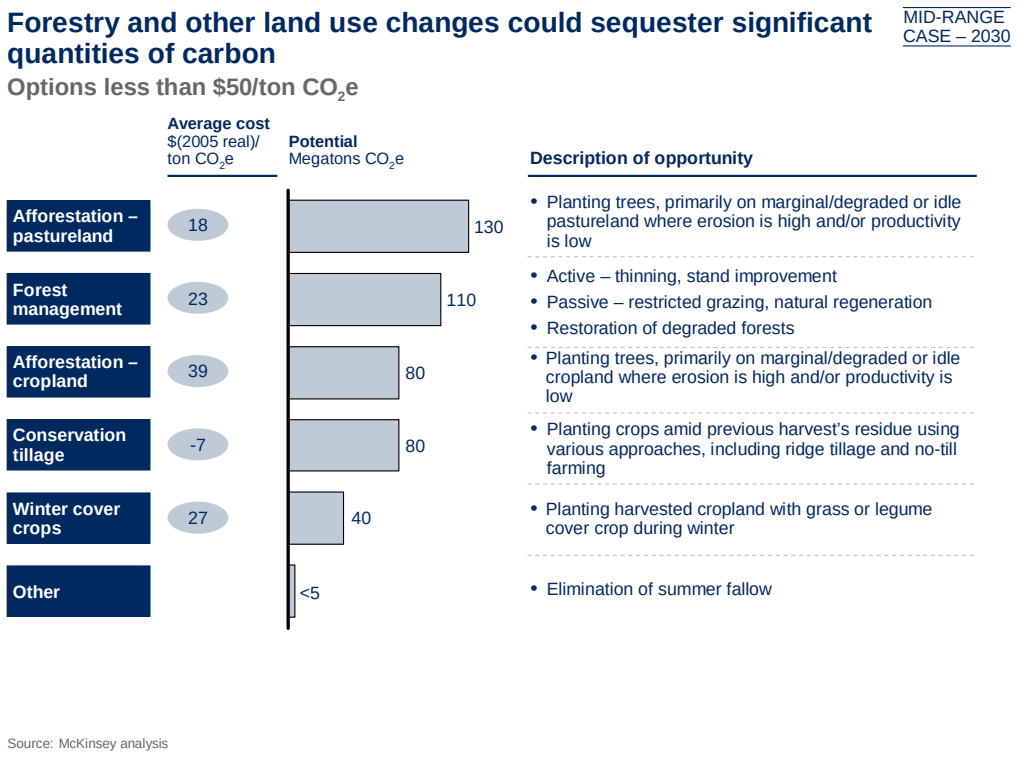
Regulatory changes may also be needed to create innovative contracting relationships. For example, favorable tax status could be granted to facilities that maintain energy-

efficient lease structures for a significant percentage of tenant-occupied square footage. Other regulatory changes can create cash-flow streams from energy-efficiency investment. For example, in New England, the "Other Demand Resources" market, initiated by the Independent System Operator, has enabled energy savers to sell "negaWatts" of energy savings into electricity markets, just as power plants can sell megawatts of energy. Enabling regulatory conditions can create the conditions for market innovation to flourish.

2. Land Use and Forestry

Land-based carbon sequestration offers significant and cost-effective abatement opportunities, but capturing them will require the provision of financial incentives to overcome the additional cost of investment.

a. Opportunity for abatement. Land use and forestry could provide 440 Mt of abatement at a cost of less than $50 per ton in 2030. Afforestation/reforestation is the largest abatement opportunity, accounting for nearly 50% of the total, and is the focus of the discussion below. Other levers include forest management, conservation tillage, winter cover crops, and smaller interventions such as the elimination of summer fallow. Some of these abatement levers can be captured without significant capital expenditure, such as winter cover crops and conservation tillage. However, other levers will require significant up-front capital expenditure and financing as well as public support to make investment economically attractive.



Source: McKinsey analysis

b. Barriers to financing. Investment in land-use abatement has been impaired by two major barriers: unprofitability and long investment horizons. Many land-use

abatement levers have substantial costs and are unprofitable without public assistance or support. In particular, forestation of pastureland or cropland involves costly up-front outlays for labor and materials, which investors will not recoup until the first timber harvest. Furthermore, even when economic returns are generated by timber harvests, these returns typically take at least 6 to 8 years to realize, a profile more favorable to equity investment but with returns that are currently too low to compete with alternative uses of capital.

c. Potential solutions. Two solutions could unlock investment and carbon abatement through forestry and land use. Inclusion of terrestrial carbon offsets in the national carbon market could draw private investment into forestry and land use, as could direct subsidies for terrestrial carbon-sequestration activities.

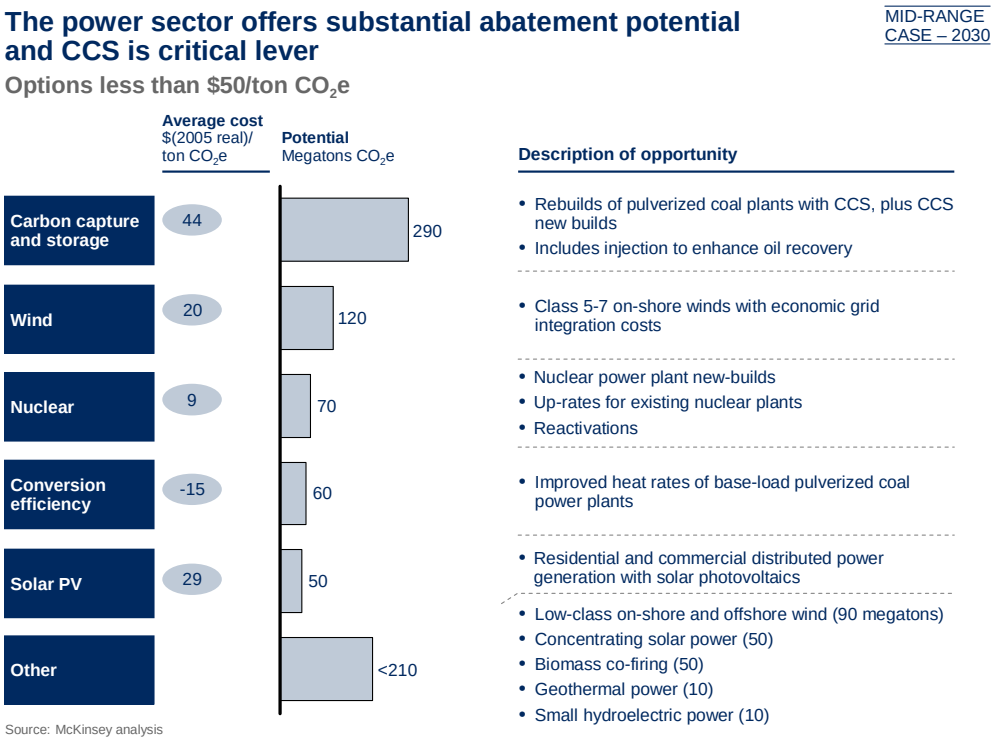
Including terrestrial carbon offsets in a national carbon market—as suggested in Lieberman-Warner and other recent legislative proposals—would incentivize private investment in forestry and land use. This inclusion would create opportunities for landowners to earn carbon revenues from forest sequestration or from avoiding terrestrial emissions. Creating steady and substantial cash flows from offset sales would incentivize private investment by larger landowners and enable equity and/or debt financing. Project development and aggregation by third-party developers could be another solution, particularly for those land holdings too small to warrant the time and expense required to generate carbon credits.

Finally, because not all land-use abatement activities are likely to qualify for offsets, public subsidies can motivate private landowners and farmers to undertake afforestation of cropland or pastureland and other land-use abatement measures. Support could take the form of free seedlings, financial grants, and tax credits for forestation or other land-use abatement efforts. Government agencies, such as the U.S. Forest Service, have a role to play in providing extension services and implementing reforestation and forest management on publicly owned lands.

3. Renewable Energy

Renewable energy includes wind, tidal, solar, hydroelectric, geothermal, biofuels, and other non-fossil-fuel power-generation technologies. At slightly less than 10% of the total power supply in the U.S. today, renewables will require significantly greater investment for this segment to comprise 15% or more of the supply by 2030.

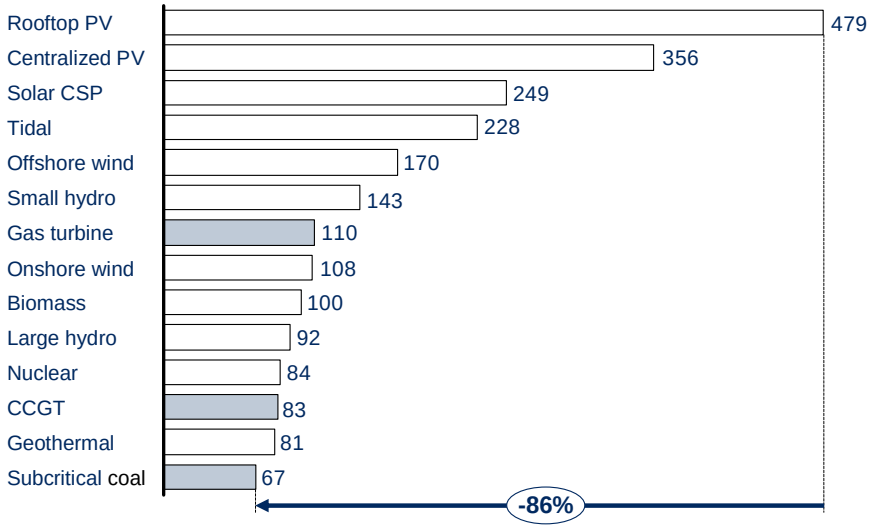
a. Opportunity for abatement. McKinsey's analysis suggests that renewable energy offers at least 450 Mt of potential abatement at a cost of under $50 per ton. Renewable energy has an important role in the future energy supply of the U.S. and also contributes to the objective of achieving domestic energy security.



b. Barriers to financing. Below-market returns have historically been the single most important barrier to financing renewable energy projects, although this is changing as fossil-fuel prices soar. Because most renewable energy technologies have been more costly on a per-kilowatt-hour basis than conventional power generation, investment has depended on public support and subsidy.

Most renewable energy technologies are still more costly than conventional energy generation

Full cost, $/MWh



* Assumes gas prices of $9.5/mmbtu and coal prices of $2/mmbtu
Source: McKinsey analysis

The core barriers to investment in renewable energy technologies are project economics that do not compete with conventional energy. Scale-up of renewable energy will require a mixture of subsidies, technology development, or higher fossil-fuel prices. Given the stable cash-flow profile of most power projects, significant private sources of equity and debt capital will become available if the economics of renewable energy can be made to compete with conventional power generation. Most renewables (e.g., solar, wind, small hydro) assets begin generating stable cash flows within 2 to 3 years and can support debt financing at levels up to a 75% debt-to-capital ratio. Investors also report that relatively underdeveloped or inconsistent business plans have been an additional deterrent to placing capital in some of the newer, entrepreneurial ventures that have been established in recent years.

c. Potential solutions. Three core solutions are required to encourage abatement through deployment of renewable energy technologies: a cap-and-trade system, public financial support, and financial engineering.

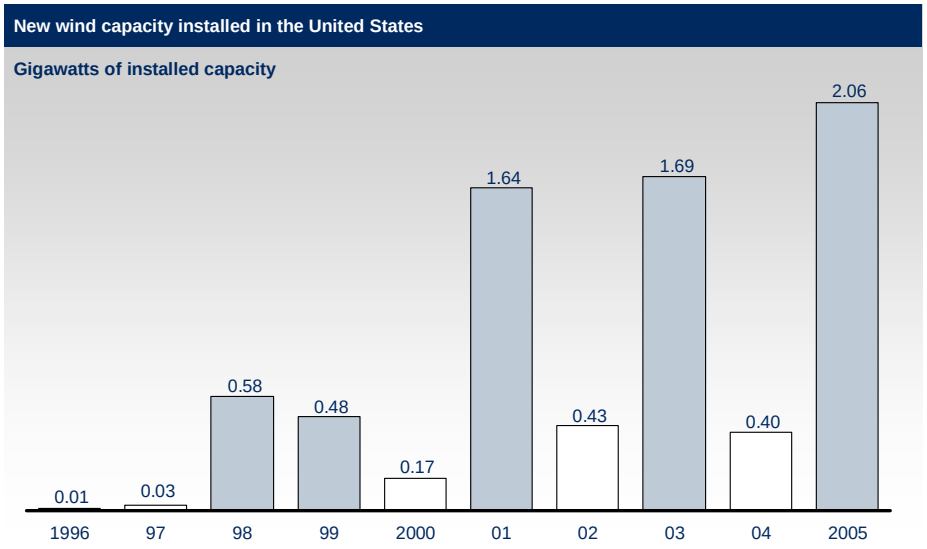
A cap-and-trade system such as that proposed by Lieberman-Warner would strengthen the attractiveness of renewable power, since utilities would not have to purchase allowances for electricity generated from these sources.

However, further public financial assistance for renewable energy is required for three reasons. First, the gap between the economics of most conventional and renewable energy power sources is still significant. Capturing solar PV, concentrated solar power, offshore wind, and biomass co-firing opportunities is likely to require carbon prices higher than those forecast in the short to medium term. Second, conventional power generators may receive significant transition assistance that will dampen the

incentive to invest in renewable sources in the short term. Third, accelerating investment today with public support can help lower the cost of renewable energy technologies as producers "learn by doing."

Public support can take the form of production tax credits, higher feed-in tariffs,[4] renewable portfolio standards, or other obligations. High feed-in tariffs for renewable power in Germany, for example, have led to very high penetration of renewable energy. In the U.S., investment in wind-power generation has been significant in years with production tax credits and negligible in years without them. Meaningful public support can unlock significant flows of private finance and create a virtual circle of investment. As greater volumes of investment drive down production costs, the need for subsidies will decline. Revenues from the sale of allowances, as suggested in Lieberman-Warner, could provide the incentives necessary to take renewable power generation to material scale and make it a meaningful contributor to the U.S. power mix.

Investment in renewable energy installation depends heavily on public support, such as production tax credits



Finally, financial institutions can apply their expertise in financial engineering techniques to generate more innovation in the business models being applied to renewable energy companies. For example, rather than selling solar PV technology and equipment, SunEdison, the country's largest solar independent power producer (IPP), instead sells long-term (20-year) power purchase agreements that allow it to finance growth more effectively and increase margins as the cost of solar power

[4] The price utilities pay for renewable energy generated from private sources.

comes down. Other financial innovations, such as a trading system for production tax credits, could make investment even more attractive.

4. Carbon Capture and Storage

Carbon capture and storage (CCS) is a critical abatement opportunity given the reliance of the U.S. power sector on fossil fuel and, in particular, coal-fired power generation. However, integrated CCS solutions are yet to be deployed at scale, and financing the technology represents a significant challenge. Owing to the fact that CCS incurs significant cost incremental to regular power generation, a mix of public and private financing will be necessary to scale the technology. The current lack of clarity with regard to long-term public funding and regulation has impeded CCS deployment. Public-private cooperation will be required to finance demonstration projects and the longer-term requirements of large-scale deployment. Attracting low-cost finance across the CCS chain of capture, transport, and storage would materially drive down the system cost to industry and society.

a. Opportunity for abatement. CCS captures the CO_2 flue stream from conventional power generation and sequesters it in permanent underground geologic structures, preventing emissions from entering the atmosphere. The U.S. relies heavily on coal-fired plants, which generate 49% of its electric power. Even with high projected investment in alternative-energy platforms, coal's share is projected to rise to 54% by 2030. CCS is therefore a necessary part of a portfolio approach to carbon mitigation, representing the single largest potential abatement lever in the U.S. economy. Furthermore, CCS represents an economic opportunity, as it would ensure the sustainability of the U.S. coal industry in a carbon-regulated world and underpin near- to medium-term security of supply. It also provides significant technology export opportunities for the U.S. to countries such as China and India, whose annual combined energy demand growth is 30 GW/year and is 70% or more coal-based. As a technology developer and provider, the opportunity for U.S. companies is substantial.

b. Barriers to financing. The incremental cost of CCS is significant and comprises both an upfront capital requirement (capture equipment, transport, and storage infrastructure) and a considerable ongoing burden (drop in plant output and efficiency, incremental operations, and maintenance). Deploying CCS therefore requires long-term regulatory frameworks and financing solutions. The flow of private finance is restricted by the lack of material financial incentives. In the short term, private finance will be limited, flowing primarily to technology developers, related pilot projects, and projects based on Enhanced Oil Recovery (EOR).

The absence of clear positive financial incentives is exacerbated by the lack of large-scale models to drive down costs, which are high by virtue of the early-stage, low-scale deployment of the technology. Furthermore, until federal or state bodies accept the long-term liability of sequestered CO_2, industry and private finance will be unwilling or unable to invest in storage projects.

c. Potential solutions. Three key solutions need to be implemented to finance the development and deployment of CCS.

- **Up-front technology development support.** Public agencies need to provide stable and significant financial support for the development of the core technologies necessary to make CCS possible. Significant investment will be required in new technology to enable CCS, but since first movers are unlikely to capture the full value of their innovations, public funding will be essential to drive technology development at socially optimal rates.

- **Inclusion in cap and trade with a meaningful carbon price**. Installation and operation of CCS will be costly. McKinsey's analysis suggests that a carbon price of at least $44/ton will be required to incentivize abatement from CCS installations. To achieve this price, CCS needs to be included in a cap-and-trade scheme that is sufficiently "tight" to generate these carbon prices.

- **Risk transfer.** Given that CCS technology is new and unproven at commercial scale, investors will need mechanisms to transfer risk. Many types of risk-transfer solutions are possible, ranging from a clear legal definition of who bears liability for sequestered carbon to business-interruption insurance. Without an effective set of mechanisms to transfer the potentially sizable risks involved in CCS, investors will not put up the capital required to make CCS a real part of a carbon solution.

Enabling infrastructure

While we have focused on investments that directly reduce or sequester carbon emissions, it is equally important to note that successful scale-up will require a range of enabling investments. These include investments in technology or infrastructure that complement and support abatement measures.

For example, increasing the contribution of renewable energy will entail significant investments in the transmission grid, in part because many sources of renewable energy are located far from load centers. To take wind power as an example, investments are needed in both the "trunk-line" and "backbone" to link wind generators to a grid and transport power over long distances. America's utilities are currently investing approximately $8 billion per year to expand transmission infrastructure, a number that is expected to increase to compensate for decades of underinvestment in the grid. The U.S. Department of Energy (DoE) projects that an additional $3 billion of investment per year could be required to enable wind power to make a meaningful contribution to the U.S. energy supply.

Successful scale-up of abatement infrastructure will require making a broader set of enabling investments. Other examples include the need to invest in a distribution system for cleaner transport fuels, power storage technology to solve intermittence problems in renewable-power generation, and smart metering to allow energy-efficiency investments to bear fruit. The need for enabling investments increases the capital requirements for the transition to a low-carbon economy, and creates even broader opportunities for technology and capital providers to participate in the transition to a low-carbon economy.

NEED FOR LIQUIDITY IN ASSET AND COMMODITY MARKETS

Liquid asset and commodity markets are essential to enable significant capital investment and to create a functioning carbon market that will lower emissions in the U.S. Creation of liquid markets will involve active participation by a broad range of financial institutions.

Liquid Asset Markets

Asset liquidity provides investors with a range of exit options and the ability to sell and purchase assets at various points in their lifecycles. Just as a liquid housing market encourages buyers to make a major investment in a home, a liquid asset market gives investors greater certainty that their assets (e.g., wind farms, energy-efficient buildings) will have value when an exit is desired. In the absence of such a market, large and long-dated projects have difficulty attracting investors.

Low-carbon investments in particular will require liquid asset markets for two reasons. First, many abatement investments such as forestation or wind farms have long lives, and owners may wish to liquidate investments before the end of a project's natural life. By selling to a new buyer, existing owners can receive immediate cash compensation for the discounted value of unrealized future cash flows. The existence of an active secondary market makes long-dated investments much more attractive because it lowers the risk that investors will be stranded with assets they cannot liquidate or that they can liquidate only at a significant discount.

Second, many low-carbon investments are in different stages of technology development with varying degrees of risk. A liquid market enables investors to focus on specific phases where they can add greatest value and assume risks they can most effectively manage. In wind-power development, for example, a secondary market is emerging where early-stage project developers secure permits and develop sites. They can then sell the investment to new owners who can finance construction and development, a stage that involves different skills and risks. These investors can then sell finished assets to power producers, who want low-risk assets with stable cash flows. Secondary market liquidity enables the separation of risks and rewards into discrete phases to appeal to investors with different requirements.

Liquid asset markets will require active participation of players willing to own and/or operate assets at different stages of their life cycle. Private equity players in particular can inject significant liquidity into asset markets. By acting as an interim buyer for assets at various stages of development and aggressively seeking attractive exit opportunities for themselves, they increase market liquidity and facilitate efficient allocation of capital to differentiated phases of investment. Like other actors, intermediaries such as private equity firms seek greater certainty about fundamental market trends, so clarifying policy directions quickly will be fundamental to generating asset market liquidity.

Liquid Commodity Markets

Clear and unambiguous regulation is also essential for the development of liquid carbon markets, which in turn are critical for the efficient transition to a low-carbon economy. Liquid carbon markets enable efficient abatement by creating a current and transparent carbon price and enabling development of sophisticated risk-management tools, such as commodity derivatives and structured risk products. Though we focus here on liquid markets for allowances, the benefits of a liquid market also apply to the market for domestic and international offset credits, should these be included in cap-and-trade legislation.

Liquid markets enable participants to optimize their exposure to the price of carbon, which for many firms will be an input price that needs to be hedged. Liquid markets enable price discovery by incorporating new market information into the price of carbon. As we have seen to great effect in the U.S. SO_2 and NO_X cap-and-trade programs, this benefits market participants, such as power generators, who have to make production decisions based on constantly shifting input and output prices. When fuel prices change, for example, power generators may respond by changing the merit order of production. If gas prices rise significantly, utilities have an incentive to shift to coal, which emits more CO_2. However, they also need to know the carbon price, since coal power generation will require purchasing more carbon allowances.[5] A liquid market is essential to enable them to buy and sell allowances at prices that reflect market conditions.

A deeper and more liquid market will also tend to see evolution of sophisticated risk-management products offered at lower prices. In turn, this evolution enables entities to manage their carbon exposure more economically using tools such as futures, options, and more structured products (e.g., swaps, collars). Several exchanges in Europe now offer basic derivatives for European Union Allowances and Certified Emissions Reductions, and over-the-counter brokers offer products that enable emitters to fix price ceilings on their carbon exposure. The more liquid and competitive the market becomes, the more cheaply covered entities will be able to reduce the risks they face.

A liquid market will require the establishment of a mature market infrastructure, involving clearing, settlement, reporting, scheduling, custody, and other services synonymous with a fully functioning modern-day marketplace. The scale of the challenge should not be underestimated; persistent problems with international carbon allowance registries such as the International Transaction Log have frustrated attempts to execute international trades of Certified Emissions Reductions (CERs). Market infrastructure needs to link seamlessly with market participants' IT platforms and the market authorities' own governance and administration systems, so that participants and authorities alike can execute transactions efficiently and build confidence.

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[5] This slightly oversimplifies the picture; most utilities hedge fuel prices in advance and would likely do the same for carbon; nevertheless the basic argument holds

In the U.S., trading of international carbon allowances has already begun. As in other financial security markets, these are divided between exchanges and over-the-counter brokers. Two exchanges in the U.S. offer commodity contracts for carbon credits. The Green Exchange, run by NYMEX, offers futures and options contracts for Certified Emissions Reductions (CERs) and European Union Allowances (EUAs), while the Chicago Climate Exchange (through its subsidiary, the Chicago Climate Futures Exchange) offers futures contracts for CERs, EUAs, and Carbon Financial Instruments (the CCX "currency"). NYSE-Euronext, the New York Stock Exchange's parent, has also launched its own carbon exchange, "BlueNext," which currently dominates trading in the EUA spot market and now includes futures contracts for EUAs and CERs as well. Over-the-counter brokers include players such as the sales and trading desks of the major investment banks or specialized brokers such as Evolution Markets. The commencement of trading within the Regional Greenhouse Gas Initiative (RGGI), a GHG cap-and-trade program focused on the Northeastern states' utilities, and the prospect of trading under the AB32 in California, is already hastening the demand for domestic liquid trading market solutions.

NEED FOR RISK-MANAGEMENT MECHANISMS IN ASSET AND COMMODITY MARKETS

To date, markets for low-carbon investments and carbon allowance trading have grown rapidly without access to sophisticated risk-transfer mechanisms. However, the maturation of the market will create new opportunities for financial institutions to supply risk-transfer products that enable new investors to make larger, longer-term investments than they would otherwise be unwilling to make. They will also find new opportunities to help carbon market participants control and hedge certain market and project performance risks. Banks and insurance/re-insurance companies have a central role to play in both of these areas of market price and commodity risk management, but the participation of other capital market players, such as hedge funds, brokerages, and exchanges, will deepen the liquidity of markets and improve the efficiency of risk transfer, which in turn will facilitate investment into carbon abatement.

Risk-Transfer Mechanisms for Investments in Operating Assets

Efficient risk-transfer mechanisms help projects attract investment by reducing the volatility of expected cash flows. Risk-transfer products such as insurance and structured derivatives contracts are broadly available for traditional infrastructure and project investment; nearly every construction site, building, power plant, and business in the U.S. has a range of insurance policies to cover risks associated with nearly every aspect of their operations. However, while risk-transfer markets for carbon-abatement projects are growing rapidly, they need to deepen in order to facilitate the very rapid growth required to achieve carbon-mitigation objectives in the U.S.

Many investments in GHG abatement, such as retrofitting building shells, are large and involve significant engineering. Others involve new technologies, such as thin-film solar installations or CCS. Nearly all are susceptible to risks that can disrupt

operations or reduce cash flows. To take solar energy as an example, poor weather can decrease production of electricity; falling debris can crack photovoltaic cells or the concentrating mirror of a solar thermal unit. Because these investments are new, complex, risky, and long-term, efficient markets for risk transfer have not yet developed. This has unfortunately resulted in somewhat of a chicken-and-egg situation, in which longer-term investments seek effective risk-transfer instruments in order to grow, but the creation of such instruments requires the formation of a more stable and mature investment environment.

The potentially significant impact of exogenous and unpredictable events creates demand for risk-transfer solutions that financial institutions must meet. We discuss two examples as illustrations: project insurance for abatement project developers, and weather derivatives.

1. Project Insurance

The large-scale, complex and long-lived infrastructure required to achieve significant abatement will make insurance increasingly important. Insurance requirements include liability insurance, workers' compensation coverage, coverage for equipment loss or damage, business interruption insurance, or even terrorism insurance. Without insurance, projects may have trouble attracting capital, particularly from risk-averse investors such as commercial banks. Indeed insurance companies report that commercial banks have generated strong demand for insurance products in low-carbon markets and increasingly require project developers to possess coverage before they will consider lending.

However, the same factors that make risk transfer attractive to project developers and commercial banks make such propositions challenging to insurers today. Most insurers base premium pricing decisions on actuarial models drawn from long periods of historical data, but in the absence of a long track record for new technologies or infrastructure, some insurance companies have been unwilling or unable to offer policies to mitigate risks facing abatement project developers. Their caution is understandable. According to one industry expert, insurers faced significant difficulties when wind turbines were first introduced at commercial scale in the U.S. These turbines, designed by European manufacturers accustomed to gentle and stable wind speeds, did not stand up well to the 80 mph gusts of California's windy season. As turbines failed, insurance companies had to pay out millions of dollars for claims. Some stopped offering coverage altogether.[6]

Some insurance companies are beginning to create specialist units dedicated to insuring renewable energy projects. However, market development will require further progress in three areas: development of greater technical expertise, innovation, and public insurance to provide coverage in areas where the private sector is not able or willing to assess and absorb risks.

a. Technical expertise is required to properly assess and price risks for specific types of projects. However, technical expertise in many abatement technologies is rare, and

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[6] http://www.xlinsurance.com/xli/share/feature_landing2.jsp?id=117

even rarer within insurance companies. If insurers want to build profitable businesses in emerging climate-related industries, they will have to develop targeted and highly expert domain knowledge to conduct data-driven analysis of project risks.

b. Innovation is required to gain a competitive edge. Draft climate-change legislation and analyses such as McKinsey's abatement cost curve have provided a reasonably comprehensive view of the types of investments (e.g., wind power) that will need to be made in order to achieve national climate objectives. Forward-looking insurance companies will anticipate market growth in key areas and move decisively to capture markets where they are able to price risk efficiently.

c. Public insurance will be needed where the scale or measurability of risk does not yet lend itself to private insurance solutions. One possible example is CCS, an emerging technology that involves risks no market participant yet understands well enough to price. Risks ranging from equipment failure to a breach in underground storage facilities are difficult to quantify with precision given the early stage of technology development. For CCS, the question of long-term liability for CO_2 remains significant. Public agencies may need to offer risk guarantees for this and other similar technologies.

2. Weather Derivatives

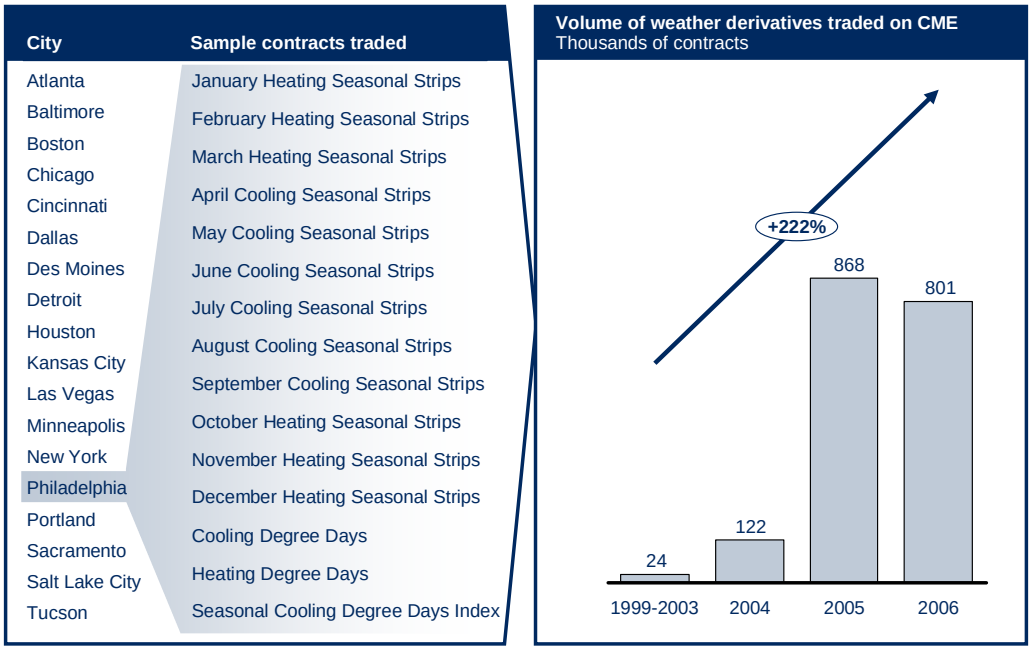
The cash flows from many abatement projects (e.g., wind energy, solar energy) depend on the weather, so natural climatic fluctuations create cash-flow variability that reduces the commercial attractiveness of investment. Weather derivatives can help hedge some of this variability, improving the appeal of investment projects, but market offerings need to grow in breadth and depth. Attracting a broader range of financial players to the market will accelerate product development and lower prices, helping project developers to more effectively manage the risks they face as a consequence of natural climatic variability.

Many abatement measures are affected significantly by changes in the weather. In addition to solar power, wind power depends on wind speeds; hydro power and reforestation depend on rainfall. In other words, fluctuations in weather patterns beyond investor control directly influence returns from many abatement technologies.

A new class of risk-management tools known as weather derivatives has emerged to help investors in a broad array of industries address these risks. These structured contracts offer payments linked to an underlying weather index, such as degree days, snowfall, or rainfall levels. They resemble an option with a payout when the underlying index crosses a strike point (e.g., a payout if the number of heating degree days exceeds the strike) and enable market participants to hedge out volatility of returns.

From the first weather derivative trade in 1996, struck between Koch Energy and Enron with support from Evolution Markets, the market has grown rapidly. The Chicago Mercantile Exchange now offers contracts in eighteen American cities. While volumes have grown, current and prospective market participants argue that weather derivatives do not yet offer protection against the specific risks they face or that they are too expensive.

The market for weather derivatives is small but growing quickly



Greater breadth and depth of weather risk transfer markets will be required to increase coverage and lower costs. In turn, this will require increasing participation from a wider array of financial institutions.

Broadening the market will require new types of contracts to help different asset operators hedge specific types of risk. Contract breadth can expand geographically, to cover more locations, and in the range of indices they cover, such as solar-intensity derivatives. While the market may never reach the level of granularity some participants hope for—there may never be a liquid market for solar derivatives for every small town or farm in the U.S.—the market has room to grow.

Deeper markets will develop with increasing participation from diverse financial institutions. Market participants report at least three major types of direct participants today: asset owners (e.g., farmers, ski resort operators); re-insurance companies (e.g., Swiss RE); and hedge funds and traders. New companies such as Storm Exchange are also increasing the size of the overall market. Over time, rising participation will generate greater liquidity and lower costs, making these hedging products increasingly affordable for asset owners and operators.

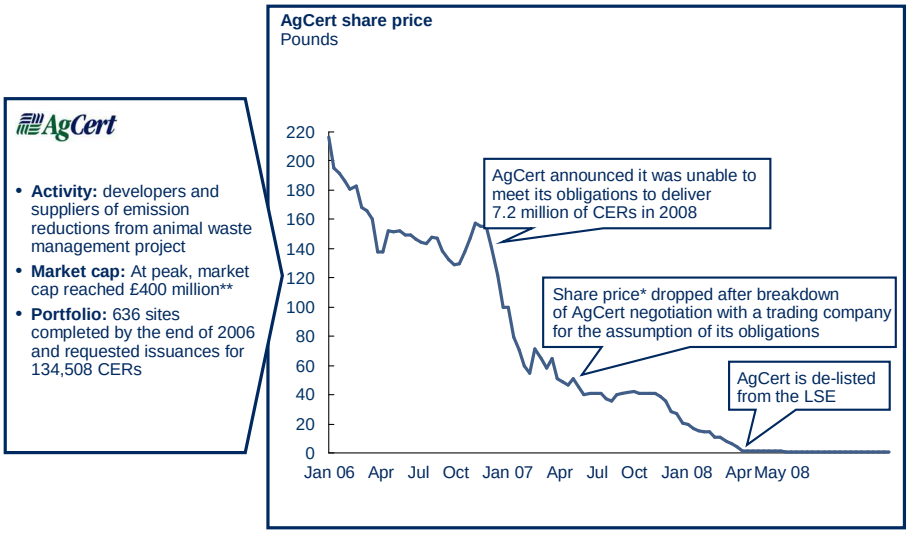
Carbon Market Insurance

A U.S. cap-and-trade system will introduce new risks—beyond simple price exposure—that market participants will need to manage. For the purposes of illustration, we highlight two potential risks: non-delivery risks from offset projects

and permanence risk of forest carbon projects. Banks, insurance companies and other risk intermediaries have an opportunity to address both types of risk.

1. Non-delivery risks. If cap-and-trade legislation allows covered entities to use project offset credits for compliance, they will have to manage uncertainty about the delivery of these credits. Because actual yields of emissions-reduction projects are unknown until verification and issuance of carbon credits are complete, buyers of "primary credits" face delivery risks that they will need to manage. Massive under-delivery of credits from animal waste biogas projects, for example, was a primary driver of the bankruptcy of AgCert, a carbon-credit origination company active in the market for Certified Emissions Reductions (CERs).

Delivery risks caused at least one large company to implode



Much of this risk can be addressed through relatively simple measures. Project developers can develop more conservative risk models for projecting yields and focus on improving project implementation and execution to deliver closer to target. Carbon-credit intermediaries can implement more-effective risk controls to prevent asset and liability mismatches. They can also consider more-sophisticated securitization techniques to transform primary credits into guaranteed credits (as Credit Suisse did in a recent carbon "CDO" with EcoSecurities). The use of this type of securitization technology also helps broaden the demand for carbon allowances beyond that of compliance buyers. There is growing demand from investors globally for exposure to carbon, which many see as an emerging non-correlated asset class. With deepening liquidity in this market, increasing use of traditional risk-transfer technology will be possible.

Insurance companies will have an important role to play in helping project developers or end users manage non-delivery risks. However, because non-delivery or project

underperformance can occur for many reasons, insurance companies will have to be specific about what risks non-delivery coverage actually include. Insurance companies, such as AIG, Carbon RE, Munich RE, Swiss RE and Zurich, are already beginning to offer these services. Some provide highly targeted forms of coverage; others provide comprehensive non-delivery guarantees. Swiss RE, for example, recently wrote coverage for a specific project for a hedge fund, covering registration and issuance risks associated with process delays or suspension of regulations due to changing political agendas. While the offset markets have grown rapidly without significant use of insurance products, insurance companies will see greater opportunities as the markets expand and draw in new sources of capital, such as commercial banks.

2. Reversal/Non-Permanence risks. Carbon credits from sequestration in forests are considered by many cap-and-trade schemes to have a high "permanence risk," since carbon stored in biological sinks can be re-released into the atmosphere when trees die. Under Lieberman-Warner, for example, offsets from forestry must be verified each year to monitor potential reversals of sequestration. The current owner of a forestry offset is liable to replace the credit if reversal of sequestration has occurred, making forestry credits intrinsically less attractive than other offset types, which are assumed to be permanent and not subject to re-verification.

Permanence risk is one of the principal challenges in crediting forest carbon sequestration both in the U.S. and internationally under the Kyoto Protocol's Clean Development Mechanism (CDM). Insurance companies have three critical roles to play in addressing this risk. First, they should dedicate sufficient resources to understand the nature and drivers of permanence risk, as well as the conditions that would be required to make it insurable. Second, they should support policy discussions around forest carbon sequestration in the U.S. and internationally to provide policymakers with the analytical tools necessary to create fungible, permanent forest carbon credits using mechanisms to mitigate permanence risk. Finally, they should develop a suite of insurance products capable of "de-risking" forest carbon credits, potentially through "reversal" insurance products.

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The scale of the transition required is profound, and success will require coordinated public and private action. Failure by U.S. policy makers to face the consequences is not an environmental, financial, or, increasingly, a geopolitical option.

Provided that public agencies create a clear and supportive regulatory framework that prices carbon and provides clear and material incentives to invest in carbon abatement, the existing financial markets have the capabilities required to provide the large quantum of capital, the liquidity, and the risk-management products to transform the U.S. to a low-carbon economy. Public agencies should move to create the broad range of incentives required to unlock private participation. Putting these incentives in place will unleash the full force of American creativity and put it at the service of a sustainable economic future.

If the U.S. successfully mobilizes the policies and resources needed to make this transition to a low-carbon economy, it will create the next wave of expertise and

comparative advantage to allow continued global leadership. These mitigation technologies, both financial and industrial, will become powerful export opportunities and sources of great revenue, trade, and wealth creation. The U.S. became the world's leading economy through its ability to capitalize on innovation and efficiency; its transition to a low-carbon economy can continue to be the cornerstone of that trend for another generation.