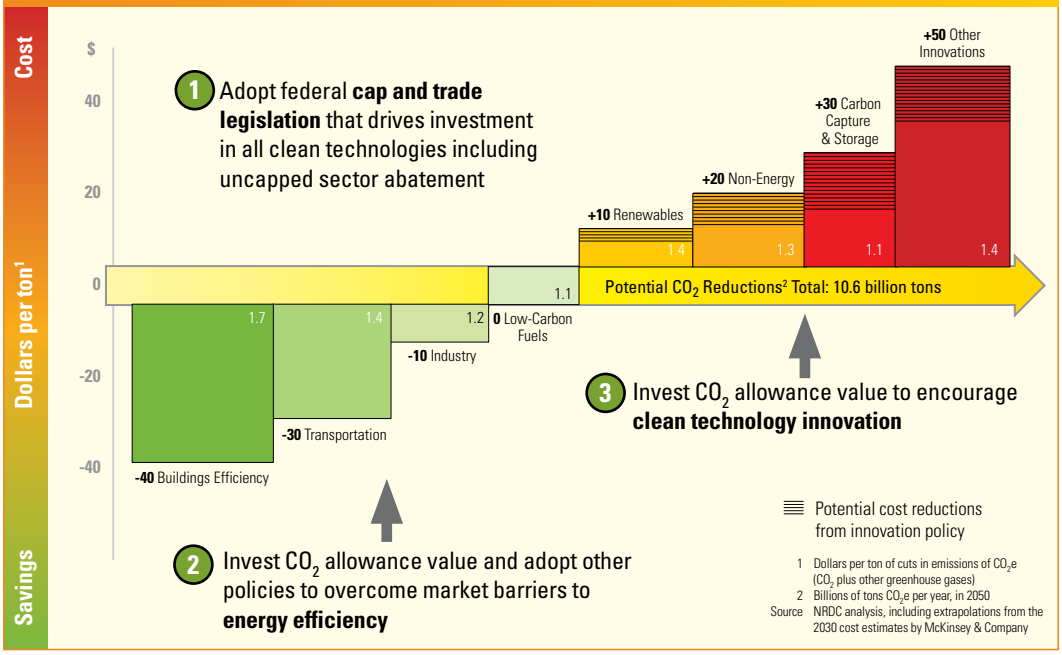
Part of a series on

CAP 2.0

Policy Brief

Figure 1: The Cap 2.0 Solution



Cap 2.0: Policy Solutions for Curbing Global Warming and Building the Clean Energy Economy

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www.nrdc.org/cap2.0

The current economic crisis presents enormous challenges for American workers and virtually every sector of our economy. The crisis, however, also provides a tremendous opportunity to address the threat of global warming in a way that ensures long-term environmental and economic sustainability. In the next 20 years, the United States will invest more than $3 trillion in our energy infrastructure—electric power plants, fuel refineries, and transmission and transportation infrastructure—and trillions more on reducing the energy consumption of buildings, appliances, and vehicles.[1] If we follow the Cap 2.0 policy recommendations, we can avert the growing climate crisis by reducing emissions of global warming pollution and redirect our resources toward cleaner and energy-efficient technologies that will strengthen our position in the global economy, create millions of quality jobs, and bolster our national security by cutting our reliance on fossil fuels.

Avoiding the High Cost of Inaction

Failing to address the dangers of global warming could bring challenges that dwarf our current economic woes. The scientific community long ago reached widespread consensus that we are engaging in a dangerous global warming experiment, with higher average temperatures and increased resource scarcity likely to lead to disease, conflict, and geopolitical instability. If present trends

NRDC
THE EARTH'S BEST DEFENSE

April 2009

continue, by the end of this century the annual cost of global warming for the United States alone may reach 3.6 percent of gross domestic product (GDP), with progressively more severe risks and costs thereafter.[2]

Over the next 40 years, we must deploy technology—on both the demand and supply sides of our energy economy—that reduces global warming pollution by at least 80 percent from current levels. Just as we ramped up and retooled to meet the challenges of World War II, modernizing our 20th century energy infrastructure to meet today's urgent challenges can boost our economy in the years and decades to come.

The economics of solving global warming are more attractive than many people realize, in large part because of the potential to improve the efficiency of our buildings, appliances, and vehicles. According to a 2007 McKinsey & Co. analysis, the savings from such efficiency investments are so great that they would roughly cover the cost of more expensive investments like solar panels and carbon capture and storage.[3] And not only is saving energy a lot cheaper than generating it, but every dollar spent weatherizing homes, retrofitting buildings, or constructing light rail systems is a dollar invested in jobs that cannot be sent overseas. However, the McKinsey study underscores that we must begin making smart decisions right away when investing in new infrastructure. If we continue to build according to outdated and inefficient plans, we will severely increase the long-term cost of reaching our emissions reduction targets.

Adopting Policies to Curb Pollution and Spur Clean Energy Investment

As the Obama administration and Congress grapple with climate, energy, and economic policy this year, they should focus on driving investment that will increase efficiency and reduce global warming pollution at the lowest possible cost. As discussed below, and in more detail in the series of NRDC Cap 2.0 Policy Briefs found at www.nrdc.org/cap2.0, the following policy tools will be needed to curb global warming and secure a clean energy future:[4]

1. a gradually declining mandatory limit or "cap" on pollution.
2. codes and standards that rid the marketplace of the worst-performing products and technologies.
3. performance-based incentives to drive investment in energy efficiency and clean energy solutions (funded through targeted use of the value from pollution permits or allowances).
4. targeted financing support to enable clean infrastructure investment.

Strong American leadership in these areas will not only help strengthen our long-term economic, national, and environmental security, but it will also bolster our position during international negotiations toward reaching a global solution to this global problem.

The Cap 2.0 Climate Solution

A mandatory cap on carbon pollution is the single most important policy that our nation can adopt to move toward a clean energy economy. Capping the emissions from major polluters and implementing this cap with tradable pollution allowances is a proven strategy for achieving a desired level of emissions reductions. The United States pioneered this approach in the early 1990s with its successful program to reduce acid rain, which not only achieved the desired reductions in emissions, but also yielded unanticipated innovations that lowered compliance costs to a quarter of initial projections.[5] Adopting a similar program to address carbon pollution is our best option for curbing global warming.

BOOSTING ENERGY EFFICIENCY

Establishing a price for carbon emissions through a cap-and-trade system will spur innovation in many parts of our economy. Some sectors, however, will not respond sufficiently to an increasing cost of carbon pollution. Increasing the energy efficiency of buildings, industry, and our transportation system already makes economic sense (see the left side of Figure 1), but we have generally not yet made those investments because of incentive problems and a host of other market barriers. This is the reason Congress should put priority on performance-based incentives and standards to

overcome market barriers and boost investment in energy efficiency. We estimate the need to invest roughly one quarter of the value of carbon allowances in consumer and business efficiency investments through 2027.[6]

DEVELOPING CLEAN ENERGY TECHNOLOGIES

A carbon cap alone will not spur innovation quickly enough, nor will it overcome non-price market barriers to bringing new technologies to scale (as shown on the right side of Figure 1). We therefore recommend fully funding energy research and development as well as performance-based incentives for early-stage renewables, carbon capture and storage, low carbon fuels, and advanced vehicles. Similar support is needed to unlock the public benefits from mass-transit-oriented development and other efforts to reduce vehicle miles traveled. We estimate the need to invest roughly 40 percent of allowance value in these clean energy solutions through 2027.

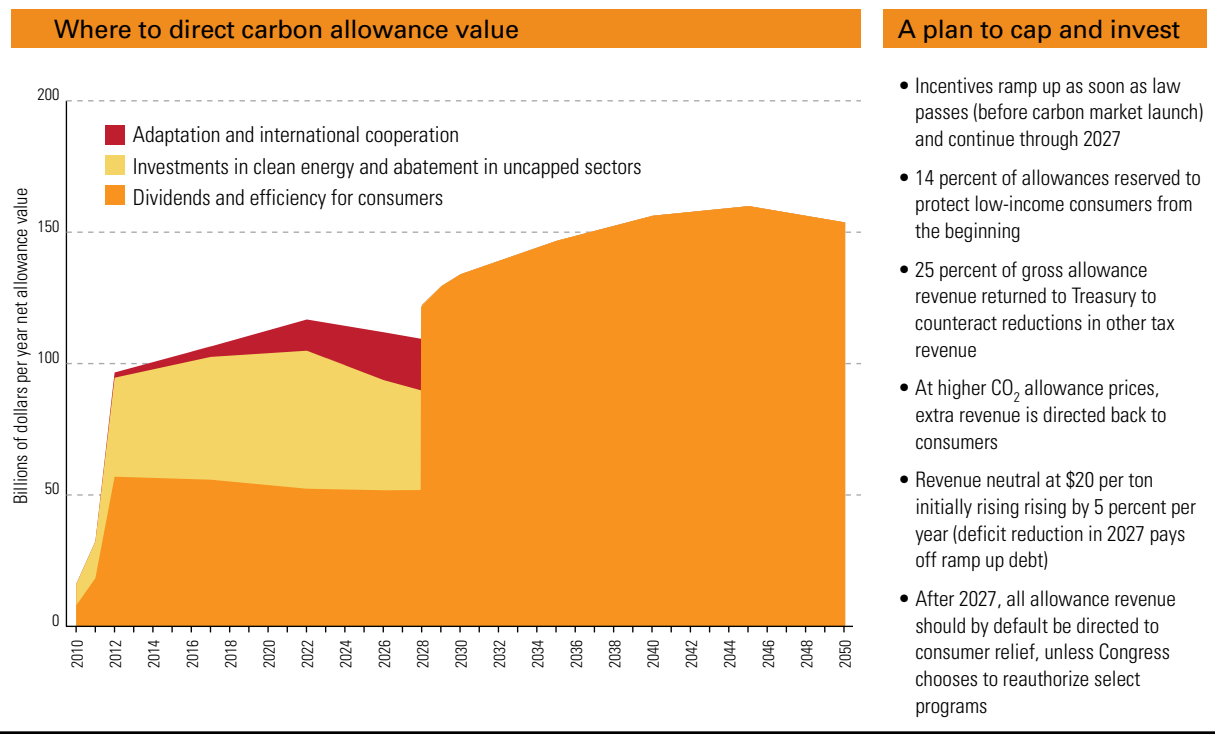
REDUCING POLLUTION BEYOND THE CAP

Congress should also invest a portion of allowance value to reduce pollution in sectors outside the cap (e.g. domestic agriculture and the waste management system) and to enhance carbon "sinks" (e.g. forests and soils domestically and internationally that absorb carbon dioxide out of the atmosphere and store it safely) to help meet overall pollution reduction targets.

ADAPTING TO UNAVOIDABLE IMPACTS OF GLOBAL WARMING

The United States must also invest in adaptation to address the global warming impacts that are already inevitable. Funding should be structured with modest initial expenditures and a ramp-up over time as we better understand adaptation needs and appropriate responses. This strategy will provide for immediate action and allow subsequent and

Figure 2: The Cap 2.0 Allocation Timeline



Source: NRDC Cap 2.0 preliminary proposal based on the policy briefs cited in this overview. These figures are subject to revision based upon stakeholder feedback and ongoing NRDC analysis comparing this proposal with alternative allocations of allowance revenue.

more significant funding to be informed by best practices. Adaptation support is particularly important for the most impoverished developing countries that will bear the brunt of a changing climate despite bearing little responsibility for causing the underlying problem. The United States should allocate this funding based on humanitarian needs, and it should be above and beyond assistance for clean technology deployment and inflows of capital to purchase abatement in the agriculture and forestry sectors in developing countries.

HELPING CONSUMERS TRANSITION TO A CLEAN ENERGY FUTURE

Finally, Congress should return the remaining allowance revenue to consumers. At least 14 percent of the allowance revenue should immediately be set aside to provide financial support to low-income families from day one, through increases in the earned income tax credit and certain other benefits. Any extra revenue generated if early carbon prices prove higher than assumed throughout this analysis ($20 per ton in 2012, rising to just over $40 per ton in 2027) should be sent back to consumers as a dividend.

By 2027, once the transition to a clean economy is on track, Congress can return as a dividend almost all of the allowance revenue directly back to consumers, relying on a steadily increasing allowance price and complementary policies to motivate investors to address a variety of emissions sources. The combined total of consumer efficiency and direct consumer rebates will represent more than 80 percent of the total allowance value through 2050 (see Figure 2).

Why a Carbon Cap is a Better Solution Than a Tax

Among those who agree on the essential importance of putting a price on carbon pollution there is an ongoing debate about the merits of a carbon cap versus a carbon tax. Both a cap and a tax put a price on carbon and other greenhouse gases, providing an incentive to reduce emissions using the most cost-effective solutions. Both approaches require exacting emissions accounting and stringent enforcement to be effective. And both can raise revenue that can be used to kickstart the clean energy economy while protecting consumers from higher prices through efficiency investments, tax reductions, and direct rebates. The principal difference between the two is that a tax fixes the price of carbon emissions but not the quantity, while a cap limits the quantity of carbon emissions while allowing the market price of tradable carbon allowances to vary; it is this key difference that allows a cap to provide several economic and policy benefits that a tax cannot (see *Why Cap and Invest is Better Than a Carbon Tax* Cap 2.0 Policy Brief).

A CAP PROVIDES GREATER CERTAINTY FOR LONG-TERM INVESTMENTS

By establishing clear, long-term emission reduction requirements, a well-designed cap would offer long-term capital investors (e.g. companies deciding whether to scale up new carbon-reducing industries such as carbon capture and storage) greater certainty upon which to build their investment strategies. Once the targets for pollution reduction have been established under the cap, the private sector can estimate the future cost of allowances.

The cap can also build upon the clean energy stimulus investment included in the American Reinvestment and Recovery Act by providing clean energy investors the long-term certainty and additional deployment incentives that will spur further investment (see *Investing in Our Recovery* Cap 2.0 Policy Brief).

A cap would also provide greater environmental certainty for reducing emissions than a tax. The political process of building consensus starts with agreement on the level of the cap and then turns to negotiations on distributing a fixed number of allowances and the revenue from their sale. In contrast, negotiations to define a carbon tax start with reaching agreement on a price—actual emissions results are secondary.

A CARBON CAP ALIGNS INTERESTS ACROSS THE MARKET TO REDUCE POLLUTION AND SAVE MONEY

Once carbon caps are in place, all energy consumers share an interest in promoting policies to reduce emissions, including in sectors where price alone will not generate the needed push for increasing energy efficiency. For example, all energy consumers will benefit immediately from lower carbon allowance prices if demand for energy falls in response to policymakers enacting and enforcing minimum energy efficiency standards in any sector of the economy. A carbon tax would provide incentives for each individual to reduce their own pollution, but there would be less incentive to support policies that reduce the emissions of others since there is no guarantee that the government would automatically lower carbon tax rates in response to lower overall emissions.

A CAP WILL RESPOND TO A GROWING OR SHRINKING ECONOMY

A carbon cap provides a useful economic shock absorber, since allowance prices automatically soften whenever the economy slows down. In principal, carbon taxes could also be adjusted frequently in response to fluctuations in economic activity, but to do this effectively in challenging times would require a level of sophistication, objectivity, and quickness that would be difficult to achieve.

Designing an Effective Carbon Cap

Careful design of the carbon cap and carbon market is necessary to meet the desired emissions reduction targets and to avoid the possibility of market manipulation. In addition to setting clear targets, effective legislation must include regulations that ensure transparency and prevent any single market participant from gaining undue influence over the price of carbon allowances (see *Regulating Trading in the Carbon Market* Cap 2.0 Policy Brief). In designing a carbon cap, U.S. policymakers can benefit from earlier international and domestic efforts to establish cap-and-trade systems.

LEARNING FROM FIRST-GENERATION CAP-AND-TRADE PROGRAMS

As an example of what not to do, when the original European Union Emissions Trading System (ETS) launched in 2005 it allocated allowances free of charge to power producers. This "grandfathering" squandered scarce public resources and allowed generators to reap windfall profits by raising power prices to reflect the resale value of the allowances. Moreover, participating countries set their national targets without first obtaining accurate emissions data. Once better data became available, the emissions limits were revealed to be overly generous and this excess of allowances caused allowance prices to crash. In addition, most of the pollution reductions under the ETS have come from importing Clean Development Mechanism (CDM) credits of uncertain quality.

States in the northeastern United States incorporated lessons learned from the ETS when developing the Regional Greenhouse Gas Initiative (RGGI). Most importantly, the RGGI states decided to auction almost all of the allowances and to use the proceeds to reduce energy costs for consumers by promoting investment in energy efficiency. The states' analysis showed that these steps would lower the average residential customer's energy bill by more than $100 per year while reducing pollution 10 percent below current levels—a much better outcome than giving allowances away for free or rebating auction proceeds to consumers.[7] The states also agreed to specific performance criteria for offsets and adopted strict numerical and geographical limits on their use.

The RGGI experience has reinforced the wisdom of using allowance revenue to accelerate the transformation to a clean and secure economy. This approach helps to avoid windfall profits for polluters and provides a source of revenue to be invested toward two public purposes: (1) driving investment in lowest-cost solutions that face market barriers; and (2) returning some of the value to consumers through tax shifting, debt reduction, rebates, targeted low-income assistance, or some combination of these strategies.

ESTABLISHING CLEAR SHORT- AND LONG-TERM EMISSIONS REDUCTION TARGETS

Scientists have made clear that to avoid the worst impacts of global warming, rich countries must reduce overall emissions at least 80 percent from current levels by 2050 and developing country emissions must peak in the 2020s.

Meeting these targets would allow us to hold expected warming below 2 degrees Celsius—a level of warming that is not ideal, but far safer than current trends. Congress should adopt an overall target that declines to this level gradually, allowing market participants time to scale up investment solutions efficiently. It should also adopt interim targets, including a requirement to reduce emissions 20 percent below 2005 levels by 2020, to ensure early and steady progress toward long-term goals. Failure to achieve these reductions in the near term makes action later much more expensive. In short, a slow start means a crash finish.

IDENTIFYING WHICH POLLUTION SHOULD BE CAPPED AND WHERE

Capping all large industrial sources will cover roughly 85 percent of overall U.S. emissions. We recommend placing the cap at the following regulatory points:

Cap the Carbon Content of Fuels at

- the oil refinery or importer of refined oil for transportation fuels and home heating oil
- the natural gas distribution company, for gas consumed by residential and commercial customers

Cap Direct Carbon Emissions at

- the power plant for electricity
- the industrial plant for industrial combustion of fossil fuels and process emissions

The approximately 15 percent of remaining emissions are generated roughly evenly by the agricultural and waste industries (where measurement challenges often preclude including sources under the cap) and small sources that fall below the minimum emissions threshold for regulation.[8] Despite those regulatory challenges, there are several means for reducing pollution in these uncapped sectors. A separate cap could be set for hydrofluorcarbons (HFCs) and perhaps for the other industrial fluorinated global warming pollutants.

BUILDING EFFECTIVE AND EFFICIENT CARBON MARKETS

A well-designed carbon market should not include a so-called "safety valve"—a mechanism for printing additional allowances any time allowance prices rise above a certain level. A safety valve would break the cap and interfere with the price signal to investors. The best strategy is to drive investment in lowest-cost solutions through direct investment and other efforts to overcome barriers to efficiency and innovation. Trading among capped emitters will further reduce costs by encouraging innovation and emissions reductions by those best positioned to clean up their operations. Finally, careful use of high quality carbon offsets that represent verified, additional, and permanent pollution reductions in uncapped sectors is another important strategy for achieving emissions reductions at the lowest possible cost. (See forthcoming Cap 2.0 Policy Brief on Abatement in Uncapped Sectors).

Policy Brief Forthcoming

A well-designed cap should also include specific provisions to limit allowance price volatility. Caps should be set with a long time horizon and with substantial ability to bank and/or borrow allowances across years. Regulators should also encourage development of well-regulated secondary trading markets to enable firms to hedge against allowance price uncertainty.

The government should also issue fewer allowances if the price falls below a gradually rising floor. This gives companies greater confidence in the value of their clean energy investments and protection against unexpected downward volatility. It also enables making faster reductions in the event that allowance prices prove lower than expected on a sustained basis.

Finally, to ensure that the carbon markets will function in a stable and efficient manner, measures such as trading limits and effective, well-funded governance are needed to limit excessive price volatility and maintain the markets long term integrity and viability.

REDUCING POLLUTION AND INCREASING CARBON SINKS OUTSIDE THE CAP

Achieving substantial emissions reductions beyond carbon offsets in uncapped sectors such as forestry and agriculture—including expansion of carbon sinks such as forests and soils that absorb carbon dioxide from the atmosphere and then store it—can play a significant role in reaching overall pollution reduction targets. (See forthcoming Cap 2.0 Policy Brief on Abatement in Uncapped Sectors). First, Congress should include large industrial agriculture emissions sources, such as manure lagoons, under the cap if they emit more than the annual threshold for covered emitters and if the technology exists to measure emissions levels. Second, state and federal policy makers should explore opportunities to mandate best practices that will reduce pollution and increase sinks in uncapped sectors. Third, Congress should set aside a portion of allowance auction revenue to fund performance-based incentives for sequestration-enhancing practices (e.g. conservation tillage and forestry management) or practices that reduce emissions (e.g. more efficient fertilizer application). Fourth, on the international front, the United States should use a portion of allowance auction revenue to invest in reducing emissions from deforestation and land degradation and to encourage forest regeneration in the tropics.

Overcoming Barriers to Greater Energy Efficiency

Although the net cost savings from efficiency investments can roughly cover the cost of cleaning up emissions from our needed remaining energy sources (see Figure 1), various market barriers stand in the way of realizing this potential. The classic problem of split incentives around energy efficiency typifies such barriers. For example, if the tenant pays the utility bills, the owner of a commercial office building or rental home has little incentive to spend money to increase the energy efficiency of the property. And there are many other barriers. A family might not purchase more efficient appliances if they do not expect to live in that home long enough to recoup their investment through energy savings alone. In the industrial sector, more efficient though more expensive industrial motors can hardly compete in the market when businesses routinely and myopically demand two-year paybacks on capital investments. And finally, a consumer cannot purchase a more fuel efficient version of the vehicle of their choice if the manufacturer does not offer such an option. Simply putting a price on carbon will not address these barriers because they are not grounded solely on price concerns. We can, however, remove these barriers and unlock efficiency through a combination of continuously updated efficiency standards and incentives to firms that substantially exceed the minimum standard. In the case of vehicles, for example, this could mean aggressive greenhouse gas emission standards and incentives for manufacturers to exceed those standards (see *Fueling the Clean Energy Economy* Cap 2.0 Policy Brief).

REALIZING SAVINGS IN AMERICAN HOMES AND OFFICES

For residential and commercial buildings, appliances and equipment, we need a comprehensive approach, including continually updated building codes and appliance standards and performance-based incentives (see *Kick-Starting Building Efficiency* Cap 2.0 Policy Brief). States and local utilities should continue to play a lead role in improving energy efficiency that they have assumed during the last 35 years. Federal standards and incentives for super-efficient appliances and buildings can offer uniformity and reduced compliance and transaction that will help national companies to deliver higher efficiency products to market. Congress should establish a performance-based standard of measurement to reward states that rapidly reduce their overall energy intensity through a combination of building codes, smart utility regulation, and well designed efficiency programs. These efforts would enable the United States to reduce electricity demand by 15 percent by 2020, and gas and fuel oil demand by 10 percent by 2020. In the electricity sector alone this would result in savings (measured in today's dollars) of roughly $717 billion between 2010 and 2050.

SUPPORTING INNOVATION BY FIRMS FACING INTERNATIONAL COMPETITION

For the subset of energy-intensive manufacturers that are also trade-exposed, Congress can use the value of allowances to level the playing field and encourage energy efficiency. Specifically, it should issue allowances to energy-intensive firms

Figure 3: Smart Reinvestment of Allowance Value Can Fund Sustained Growth of the Clean Energy Economy

Category	Investment Area	Billions of dollars (2009) per year 2010	2011	2012	2017	2022	2027	2030-2050
Global Warming Adaptation	Domestic adaptation	-	-	1.0	2.0	6.0	10.0	-
	International adaptation and national security	-	-	1.0	2.0	6.0	10.0	-
Investments	Renewables deployment	1.0	3.0	6.0	7.0	9.0	6.0	-
	Carbon capture deployment	-	1.0	5.0	7.0	8.0	3.0	-
	Energy research	1.0	2.0	4.2	8.0	8.0	8.0	-
	Energy-intensive industry transition	-	-	8.9	8.2	7.1	2.7	-
	Clean transportation deployment	1	2	7.0	9.0	10.0	10.0	-
	Agriculture and forestry (domestic)	0.1	1.0	3.0	3.0	3.0	3.0	-
	International agriculture and forestry	0.1	0.2	2.0	3.0	5.0	5.0	-
	International clean tech	0.0	0.0	2.0	2.0	3.0	2.0	-
	Federal Efficiency Finance Facility (FEEF)	5.0	5	-	-	-	-	-
Consumer Dividends and Efficiency	Consumer dividends	-	-	16.6	19.2	22.4	26.7	All Value
	Consumer rebates through LDCs	-	-	13.5	5.7	-	-	-
	Consumer efficiency through LDCs	5.0	10.0	16.0	18.0	18.0	15.0	-
	Super-efficient Buildings Incentive (SEBI)	2.0	3.0	4.0	5.0	5.0	5.0	-
	Super-efficient Equipment and Appliances Deployment (SEAD)	0.5	1.0	2.0	3.0	3.0	3.0	-
	Weatherization	0.0	4.0	5.0	5.0	4.0	2.0	-

Source: NRDC Cap 2.0 preliminary proposal based on the policy briefs cited in this overview. These figures are subject to revision based upon stakeholder feedback and ongoing NRDC analysis comparing this proposal with alternative allocations of allowance value.

facing international trade competition based on their current output (e.g. tons of steel) multiplied by a continuously tightened carbon intensity benchmark (e.g. starting with industry average tons of CO_2 per ton of steel produced). This protects against carbon leakage—the undesired effect of CO_2 emissions reductions achieved through climate policy in one country leading to increased emissions in another country lacking such a policy—while also discouraging off-shoring of production and providing both funding and a strong incentive to invest in efficiency measures such as combined heat and power (see *Investing in Our Recovery* Cap 2.0 Policy Brief).

IMPROVING ACCESS TO CAPITAL FOR EFFICIENCY INVESTMENTS

Also at the national level, a Federal Energy Efficiency Finance Facility (FEEFF) is needed to make affordable credit available to encourage longer term and lower cost debt financing of efficiency investments, to improve data collection and codification of effective underwriting standards, and to encourage the development of a secondary credit market that will improve access to capital for efficiency projects.

Overcoming Barriers to Low-Carbon Energy Innovation

In addition to advancing energy efficiency technology, we need strong innovation policies to ensure a continuous flow of cost-reducing technology improvements and ultra-low-carbon alternatives for meeting our remaining energy needs in the coming decades (see the right side of Figure 1). Economists have long recognized that private investors under-invest in research and development because they cannot reap all of the value of their hard-won innovations. And public funding is currently insufficient to fill the gap between what companies invest and what is needed. We recommend roughly doubling funding for clean energy research consistent with typical minimum levels recommended by most assessments (see *Developing the Technology of the Future Cap* 2.0 Policy Brief). We also support

allocating a share of carbon allowance value to assist developing countries in scaling up clean technologies essential for meeting global carbon pollution targets.

RALLYING PRIVATE INVESTMENT IN CLEAN ENERGY TECHNOLOGY

Private investors are often reluctant to invest in scaling up emerging clean technologies because hard-won insights from learning-by-doing routinely spill over to their competitors. Companies may be hesitant to invest billions of dollars to build the first full-scale carbon capture and storage facilities if other firms will be able to benefit from their investments made bringing the technology to scale, navigating permitting and utility regulations, and educating the public. Other factors standing in the way of increased renewable deployment include insufficient access to capital because of a lack of information in the marketplace about the value and benefits of renewables; competition from established fossil fuel technologies that continue to receive major subsidies; and outdated energy infrastructure and practices that make it difficult to deliver renewable energy to the grid.

USHERING IN AN ERA OF LOW-CARBON TRANSPORTATION

With respect to transportation, state and federal funding has historically been insufficient to complete ready-to-go transit projects and implement intelligent transportation systems—like real-time tolling systems—that can cut congestion and provide on-going financial support for transit operations and maintenance. Furthermore, low-carbon fuels must overcome nearly 100 years of transportation's dependence on oil, and government research and development for sustainable biofuels and vehicle batteries is critical for bringing them to the mass market (see *Fueling the Clean Energy Economy* Cap 2.0 Policy Brief). Increased funding for development of low-carbon transportation options is long overdue and must be ramped up quickly.

OPENING THE GATES FOR RENEWABLE ENERGY EXPANSION

To ensure rapid deployment of emerging clean technologies, we support clear and stable early-stage support mechanisms for broad technology categories such as wind, concentrating solar, solar photovoltaic power, geothermal, and carbon capture. This support should gradually phase out as each category of technology gains market share, until the carbon price becomes sufficient to serve as the primary driver of further deployment (see *Powering Up Renewable Electricity* Cap 2.0 Policy Brief). As with efficiency, federal support can encourage private financing for investments in clean and renewable energy sources.

Cap 2.0: Climate Solutions for the 21st Century

We must immediately embark on the path toward curbing global warming and building a clean energy economy. The Cap 2.0 policy solutions assembled here can address our current economic crisis while establishing an investment trajectory that will help avoid the worst impacts of global warming and deliver long-term economic, environmental, and national security. Finally, strong action and leadership from the United States will enable progress towards implementing global solutions to this global challenge.

Endnotes

1. World Energy Outlook 2006, International Energy Agency.

2. Ackerman, Frank, and Elizabeth A. Stanton, *The Cost of Climate Change: What We'll Pay if Global Warming Continues Unchecked*, Natural Resources Defense Council, New York, May 2008.

3. McKinsey & Company, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?* (December 2007). Sponsored by DTE Energy, Environmental Defense, Honeywell, National Grid, NRDC, PG&E, and Shell. Available online at www.mckinsey.com/clientservice/ccsi/greenhousegas.asp

4. The Doris Duke Charitable Foundation funded this project and the Energy Foundation provided important supplemental support.

5. www.epa.gov/airmarkets/cap-trade/docs/ctresults.pdf

6. Throughout this analysis we assume an initial allowance value of $20 per ton in 2012, increasing to slightly more than $40 per ton over 15 years.

7. Economic Development Research Group, "REMI Impacts for RGGI Policies Based on the Standard Reference and High Emission Reference," November 17, 2005, http://www.rggi.org/docs/remi_stakeholder_presentation_11_17_05-final.ppt.

8. Forests are generally excluded from overall targets because it is challenging to track forest carbon levels and, in the U.S. context, net forest carbon is increasing as abandoned former agricultural land gradually reverts to mature forest.