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Chapter 5: Local Action Plan **Reducing the Impact of Continuing Emissions**

DOCUMENT CONTENTS

Carbon Offsets

In the summer of 2006, Ballard, Washington announced its goal to become the United States' first "Climate Neutral City," producing net zero greenhouse gas (GHG) emissions .The cities plan includes both reducing emissions as much as it can and then 'offsetting' the remainder.

The city's program to eliminate its carbon footprint includes encouraging citizens and businesses to reduce their emissions and, as well as purchasing carbon offsets from the state chartered non-profit The Climate Trust. The city's efforts follow in the 'low carbon' footprints of numerous businesses and organizations.

For example, both the Republican and Democratic 2004 Conventions in New York City offset the emissions that their meetings caused, and were declared carbon neutral. The National Football League offset the 2006 Super Bowl in Detroit. Nike has a partnership with Delta Airlines to ensure that carbon credits are purchased for all employee flights.[1] Likewise numerous cities, including Vail, Colorado; Chicago, Illinois; and Berkley, California, have used carbon credits or renewable energy credits to offset some of their emissions.

The Carbon Offset Concept

A carbon offset is designed to 'cancel out' emissions of one

[1] Hamilton, Katherine (2006) "Navigating a Nebula: Inistitutional use of the U.S. Volunatay Carbon Market," Master's Thesis. Yale School of Forestry and Environmental Studies. Archived at: www.climatemanual.org/Cities/Chapter5/ReducingImpact/Hamilton_USVoluntaryMarket.pdf, 5 December 2006.

activity by causing equivalent GHG reductions from another activity. The unit of trade is a 'carbon credit,' which represents the equivalent of one metric ton of carbon dioxide (CO_2). Various GHGs' global warming potentials are used as conversion factors. For example, methane is estimated to have a global warming potential (GWP) 23 times higher than CO_2. Thus one ton of methane equals about 23 carbon credits.[2]

Carbon offsets can be created through "project-based transactions" or "allowance-based transactions."

Project based transactions create credits through projects to reduce GHG emissions. These projects are financed by funds from offset purchases. For example, when students at the Yale School of Forestry and Environmental Studies decided to offset some of the emissions resulting from their graduation, they purchased two different types of project based credits: forestry-based offset credits from a native tree-planting project in the Mississippi River Valley and credits generated from the replacement of diesel generators with solar panels in a Nigerian village. By purchasing third party verified credits from these project developers the school claimed the offsets and the projects received additional funding.

Allowance-based transactions involve credits created through 'cap and trade' regimes. Most cap and trade regimes around the world are created by government regulations, which "cap" the quantity of emissions that participants are permitted to emit. The government then issues tradable allowances, which allow participants who have not been able to meet the caps to buy the allowances. These allowances can be bought and sold between participants with the goal of cost effectively reducing net emissions. The largest carbon trading scheme is the European Union Greenhouse Gas Emission Trading Scheme.

The most significant exception to this approach is the Chicago Climate Exchange (CCX, see below). It is a trading system in which members voluntary agree to what then become for them a legally binding commitments to reduce emissions. Members are then able to trade reductions that exceed their reductions obligations. All voluntary offset purchases, with the exception of CCX transactions, and credits permanently retired from a regulatory market, are based on project- based transactions.[3] Institutions claiming to have offset their GHG emissions must retire credits purchased.

Institutions and cities voluntarily purchasing credits often set their own operations reductions goals, such as matching Kyoto Protocol goals. They frequently use offsets to help reach these goals.

Others choose to offset the GHG emissions from a particular activity, such as an event or transportation. For example, Chicago's Bike Chicago festival and Boulevard Lakefront Tour, a partnership with the Metropolitan Mayors Caucus initiative, the non- profit Clean Air Counts, and the company CLIF BAR, Inc. was declared a 'carbon neutral event' because they used a zero carbon bike transportation system and because CLIF BAR, Inc donated Renewable Energy Credits (RECs) to offset energy use. (For more information on RECs see below).

Carbon offset credits allow actors to indirectly reduce emissions that cannot practically be reduced at the moment. Buyers of carbon offset credits should always first investigate means of directly reducing their own emissions before investing in other project's emission reductions.

The Regulatory Context

Since the U.S. does not have national climate change regulation, the majority of U.S. based purchases of carbon offsets are voluntary. However, it is important to note that several state level initiatives have created regulated cap and trade systems that are currently in place or will be operating soon. For example, in 1997, Oregon created the first regulated CO_2 market in the U.S. by capping the

[2] Source: Bayon, R., Hawn, A., and K. Hamilton (December 2006) Voluntary Carbon Markets: An International Business Guide to What they are and How they Work, Earthscan.

[3] Hamilton, Katherine (2006) "Navigating a Nebula: Inistitutional use of the U.S. Volunatay Carbon Market," Master's Thesis. Yale School of Forestry and Environmental Studies. Archived at: www.climatemanual.org/Cities/Chapter5/ReducingImpact/Hamilton_USVoluntaryMarket.pdf, 5 December 2006.

emissions of new power plants. Oregon plants that do not meet this cap may propose their own carbon offset projects or purchase carbon credits from The Climate Trust.

A larger greenhouse gas market is being created by the Regional Greenhouse Gas Initiative. This agreement between Maine, New Hampshire, Vermont, Connecticut, New Jersey, New York, Delaware, and most recently, Massachusetts will utilize a cap and trade program to regulate the CO_2 emissions of power plants. Credits will be created via allowance based and project based transactions.[4]

In addition to this carbon dioxide regulation in the Northeast and Mid-Atlantic states, it is probable that a cap and trade system will also develop in the West. California recently set the target of reducing emissions to 1990 emissions levels by 2020. The "AB 32: Global Warming Solutions Act" bill mandates that by 2012 the state will cap emissions from major industries, including utilities, oil and gas refineries and cement manufacturers.[5]

In signing the bill, Governor Schwarzenegger stated, "We can now move forward with developing a market-based system that makes California a world leader in the effort to reduce carbon emission. The success of our system will be an example for other states and nations to follow as the fight against climate change continues. AB 32 strengthens our economy, cleans our environment and, once again, establishes California as the leader in environmental protection."[6]

As with many initiatives that begin in California, it is likely that this trend will reach other states soon. Within a week of the California announcement, the Governor of Arizona issued a similar executive order. In 2006 the Governors of Arizona and New Mexico Governor signed an agreement launching the Southwest Climate Change Initiative, which establishes a framework for the two states to collaborate on strategies to address the impacts of climate change in the Southwest and reduce greenhouse gas emissions in the region. New Mexico has also joined the Chicago Climate Exchange, becoming the first state in the nation to sign up for this greenhouse gas emission reduction and trading program.[7]

The United States Voluntary Market

Cities interested in offsetting their emissions have two main options. The first is joining the Chicago Climate Exchange (CCX). CCX is "the world's first and North America's only legally binding, multi-sector, rule-based and integrated GHG registry, trading and reduction system."[8] A second option is purchasing and retiring carbon offset credits or renewable energy credits (RECs) from a range of suppliers in the broader voluntary market.

Chicago Climate Exchange: Membership for Cities

CCX currently has over 200 Members that range from large US corporations like Ford and Motorola, to universities such as Tufts and University of Minnesota, to small businesses like Natural Capitalism, to farmers in Iowa and Nebraska and the Iowa Farm Bureau. Member Municipalities include Chicago, Illinois; Oakland, California; Boulder, Colorado; Aspen, Colorado and Portland, Oregon.

In Phase I, CCX Members made a voluntary but legally binding commitment to reduce GHG emissions 1% per year for each of years 2003 through 2006, below an average baseline period 1998-2001. Phase II parameters extend the reduction period through 2010, with an additional 2% reduction commitment for current Members and a total of 6% reduction commitment by 2010 for new Members below baseline. CCX Members that reduce emissions beyond their targets can sell the surplus allowances on the Exchange or bank them for later use. Members that do not achieve the annual reduction target must

[4] Point Carbon "Carbon Market Analyst: Carbon Trading in the U.S.: The Hibernating Giant." 13 September, 2006, www.pointcarbon.com/, 5 October 2006.
[5] Ibid.
[6] Judy Li "Governor, Democrats reach pact" The Sacramento Bee, Thursday, August 31, 2006, Page A1.

meet their compliance commitment by purchasing emission allowances from seller Members. The NASD, the largest private-sector financial regulators, independently reviews emissions.[9]

Goals of CCX are:

To establish GHG emissions trading with transparency, design excellence and environmental integrity

To build the skills and institutions needed to cost-effectively manage GHGs in both public and private sectors

To strengthen the intellectual framework required for cost-effective and valid GHG reduction

To incorporate a diverse portfolio of credible GHG emissions offsets from forestry, agriculture and other products

To help inform the public debate on managing the risks of global climate change

Becoming a Municipal Member of CCX

Membership for cities in CCX covers emissions from operations of city government only (buildings, vehicle fleets, etc.). Direct emissions result from the on-site burning of fossil fuels such as natural gas to heat city buildings and gasoline to operate the municipal vehicle fleet. Indirect emissions result from the purchase of power, such as electricity, and its corresponding emissions.

To become a member, a city must:

Assemble inventory and baseline—energy consumption data for city operations

Submit baseline data to CCX—CCX will provide preliminary analysis

Weigh reduction trends planned, establish reduction schedule

Make a legally binding reduction commitment. This entails joining CCX

Demonstrate progress through annual true-up of actual emissions with predicted reductions. This will then enable a member to buy credits if necessary, sell extra reductions, or trade them

Participate in CCX governance committees (optional)

Benefits of CCX Membership for Municipalities

Ability to take action now—for citizens and future generations

Achieve a first mover role in GHG mitigation efforts—CCX is synergistic with all policy and precludes none, whether state, regional, national, mandatory or voluntary

Contribute to shaping environmental policy by joining a leading group of organizations proactively building the institutions to solve climate change

Increase visibility as a leader and innovator

Develop employee capacities in GHG emissions calculation and trading

Master municipal GHG data, which is essential to achieving any climate change goal

Acquire a state-of-the art, turn-key greenhouse gas emissions management system

Lead by example—setting standards, increase understanding in business and residential community

Reduce cost effectively—while technologies and policies advance, buying allowances may be the most cost effective option for reducing GHG emissions

Earn possible revenue through emission reductions

Have confidence through "gold standard" of NASD independent verification.

Range of Offset Credit Options

CCX is a popular means for cities to offset emissions. However, municipalities and institutions may choose to purchase credits outside of the

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[7] Press conference at the National Governors' Association Meeting Feb 2006, 216.239.59.104/search?q=cache:Rq87W1n0RsMJ:www.governor.state.nm.us/press/2006/feb/022806_01.pdf+New+Mexico+climate+initiative&hl=en&ct=clnk&cd=6&gl=us&client=safari, 15 January 2007.

[8] Chicago Climate Exchange, www.chicagoclimatex.com, 5 October 2006.

[9] NASD, www.nasd.com/index.htm, 10 October 2006.

CCX system. Some municipalities may not yet be willing to commit to CCX. Others are interested in encouraging citizens to offset their own emissions (which is not possible via CCX), wish to offset only a specific activity, or want to invest in specific offset projects. For example, the city of Boulder is a member of CCX, but employees in the Office of Environmental Affairs use a variety of retail offset providers to purchase credits to offset the GHG resulting from office travel. Cities may choose to purchase directly from offset project managers, seek out a broker to facilitate the transaction or simply purchase credits from the numerous offset retailers now entering the market.[10]

Offset credits evolve from a variety of sources. As illustrated by the diagram below, project types can be categorized by whether they abate or sequester greenhouse gases. Abatement means reducing the amount of GHGs emitted into the atmosphere. Sequestration means taking GHGs that would otherwise have been emitted and locking them up either in trees, soil or deep geological formations. The most common project type for sequestering is forestry. Trees, and other plants (especially grasses), absorb CO_2 from the air as they grow, and convert it to woody material. Conversely, when they die or are burned, they release the CO_2. Sequestration programs must ensure that the trees planted actually grow to maturity, and that the resulting wood is not burned on fast rotation.

CCX has also begun offering credits generated from forestry, no-till farming and conversion from conventional farming to organic farming. These techniques build carbon in the soil instead of stripping it out, and thus count as a program to remove carbon from the air durably. Technological sequestration (for example, capturing waste CO_2 that otherwise would have been vented into the atmosphere, injecting it into oil fields to pressurize hard to reach oil reserves and then trapping the gas in the underlying bedrock) is less common in the voluntary market. However, one organization, Blue Source, in partnership with Natsource, is selling retail level credits from such geological sequestration. For more information on sequestration see below.

Emissions reductions can be further divided into two other categories: fossil fuel reductions versus the capture and destruction of other greenhouse gases, such as methane. The following diagram, modified from the book *Voluntary Carbon Markets: An International Business Guide to What they are and How they Work,*[11] provides examples of the range of project types used to create credits. Because different projects have a range of co-benefits, prices, advantages and disadvantages, depending on the type, size and location, municipalities purchasing credits should be aware of stakeholder interests and the type of projects behind offsets that providers are offering.

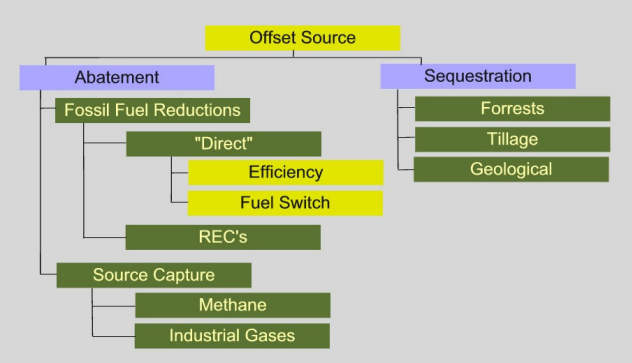

Figure: Carbon Offset Sources[12]

[10] A directory of retail offset sellers and description of various certification programs is included in: Bayon, R., Hawn, A., and K. Hamilton (2006) Voluntary Carbon Markets: An International Business Guide to What they are and How they Work, Earthscan.

[11] Bayon, R., Hawn, A., and K. Hamilton (2006) Voluntary Carbon Markets: An International Business Guide to What they are and How they Work, Earthscan.

[12] Hamilton, Katherine (2006) "Navigating a Nebula: Inistitutional use of the U.S. Volunatay Carbon Market," Master's Thesis. Yale School of Forestry and Environmental Studies. Archived at: www.climatemanual.org/Cities/Chapter5/ReducingImpact/Hamilton_USVoluntaryMarket.pdf, 5 December 2006.

Under the category of fossil fuel emissions reductions, it is especially important to differentiate between reducing what are often regarded as 'direct emissions' and buying Renewable Energy Credits (RECs), often called "indirect reduction' of emissions. RECs are also referred to as Tradable Renewable Energy Certificates (TRECs) or Green Tags. They are a separate commodity from the electricity generated and represent the environmental attributes that renewable energy generation provides, such as displaced pollution. According to EPA's Green Power Partnership, voluntary RECs account for 25% of renewable energy currently sold to commercial and industrial customers.[13] While RECs do mean that fewer emissions are produced when renewable energy is substituted for fossil fuel energy, there is some debate on how these certificates should fit within the carbon credit market. For example, one concern is the difficulty of measuring exactly how much fossil fuel is backed off the grid due to additions of renewable energy. New renewable energy projects may only displace future power plants that would otherwise be built, not lead to less use of current fossil energy. Hence, RECs are best used to only offset electricity use.

	ADVANTAGES	CHALLENGES
Methane capture from landfills	- Efficient means of reducing GHG emissions - Captured methane can be used as fuel - Somewhat reduced odors - Reduced risk of ground water contamination - Relatively inexpensive	- Accounting and baseline concerns should be carefully considered
Methane capture from livestock	- Efficient means of reducing emissions - Captured methane can be used as fuel - Reduced odors and co-pollutants - Reduced risk of ground water contamination - Relatively inexpensive	- Accounting and baseline concerns should be carefully considered
Methane capture from coal mines	- Efficient means of reducing emissions - Captured methane can be used as fuel - Few leakage concerns - Can improve safety for mine workers - Relatively inexpensive	- Accounting and baseline concerns should be carefully considered
Industrial gas destruction	- Very efficient - Highly additional - Relatively inexpensive	- Potential supply is limited
Direct fossil fuel reduction	- Supports clean technology - Creates cost savings - Reduces co-pollutants (ex. Sox, PM, VOCs) - Reduces fossil fuel dependency - Potential social benefits	- Less efficient means of reducing GHGs that industrial gas or methane destruction
Renewable Energy Credits	- Already established market with certification/verification systems - Supporting on-grid renewable energy important for decreasing reliance on fossil fuels - Reduces co-pollutants (ex. Sox, PM, VOCs) from fossil fuels	- Compatibility issues between markets for RECs and carbon offsets - Accounting and baseline concerns should be carefully considered - Less efficient means of reducing GHGs that industrial gas or methane destruction
Reforestation/ Afforestation of native tree species	- Large number of potential social co-benefits - Contributes to biodiversity conservation - Addresses deforestation which is an important part of the climate change problem	- Lack of permanence - Relatively inefficient means of reducing GHGs - Less efficient than many mono-crop projects - Relatively expensive
Avoided deforestation of native tree species	- Large number of potential social co-benefits - Contributes to biodiversity conservation - Addresses deforestation which is an important part of the climate change problem	- Lack of permanence - Relatively inefficient means of reducing GHGs - Less efficient than many mono-crop projects - Relatively expensive

[13] Green Power Partnership website, www.epa.gov/greenpower/, 3 May 2006.

	ADVANTAGES	CHALLENGES
Monoculture forestry	- Some potential for social co-benefits - Trees with high sequestration rates can be selected - Often lower cost - Deforestation part of the climate change problem	- Lack of permanence - Relatively inefficient means of reducing GHGs - Concerns about water consumption - Reduced social and environmental co-benefits compared to projects working with native tree species
Soil sequestration	- Promotes healthier food production - Reduces erosion - Large number of potential social co-benefits - Improves water quality - Relatively inexpensive	-Lack of permanence - Accounting and baseline concerns should be carefully considered
Geological sequestration	- Huge potential for storage - Enhances domestic fuel source	- Enables fossil fuel use, leading to more CO_2 emissions

Carbon Offsets

CASE STUDY: Ballard, WA

Citizens, business owners and local governments have joined forces in a campaign to make Ballard, Washington, the United States' first "carbon neutral city." The goal is to educate residents on how they can reduce and then offset emissions. The non-profits NetGreen and Sustainable Ballard are organizing the program by "empowering individuals, businesses and communities to achieve a net reduction in emissions today, while working to reduce their emissions over time."[14] NetGreen has partnered with the state-chartered non-profit, The Climate Trust, to provide offset purchases. The Climate Trust invests funds from Oregon power plants as well as citizens and businesses voluntarily offsetting their emissions in projects, which reduce GHG emissions.[15] Buyers can estimate their emissions online and then purchase offsets from Climate Trust at $10 per ton of carbon.

While this program is primarily driven by local non-profits, local government representatives have been actively involved. At the kick-off, King County Council member Larry Phillips pronounced:

> By the will of the people, the governments of King County and Seattle have become national leaders in developing global warming solutions. We're here today to show that the individual efforts of all of us add up quicker than you think and can have a tremendous impact—right now.
> I congratulate Ballard and challenge other neighborhoods to follow suit."[16]

Convincing people not only to reduce their emissions but also individually to purchase offsets is a major challenge. One local business owner, who calculated that it would take $100 a year to offset her business' emissions commented, "right now I can't afford it, but I definitely would."[17] However, a range of local residents, businesses and organizations have already committed to reducing their carbon footprint. For example, several churches, a high school and businesses from a radio station to a dry cleaner have signed on to the effort.

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[14] NetGreen website, www.achievenetgreen.org/, 5 October 2006.
[15] The Climate Trust, www.climatetrust.org/, 5 October 2006.
[16] "Local Leaders Pledge to Make Ballard First 'Carbon Neutral' Community in the United States." Seattle Daily Business News. 4 October, 2006.
[17] Ibid.

Carbon Offsets

CASE STUDY: Vail, CO

In August 2006 the city of Vail signed an agreement to offset 100% of its electricity use over the next three years, or about 20 million kilowatt hours of electricity use.[18]

The agreement followed Vail Resorts' purchase of RECs to offset energy use of all its properties, such as its ski resorts, shops and hotels, making them the second largest purchaser of wind power of all corporations in the United States.[19] The RECs purchased from the Boulder based Renewable Choice Energy will cost the city of Vail about $12,000 per year in addition the regular energy bill.

Vail Town Manager Stan Zemler, explained the town's motivation. "We believe that protecting Vail's natural environment is critical to the health and prosperity of our community. Wind power is a simple step in continuously improving our environmental practices at the town."[20] The city estimates this effort will reduce about 14,000 tons of carbon dioxide that would otherwise have been emitted into the atmosphere and equates this effort to taking 2,600 cars off the road.

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Carbon Sequestration

Vegetation on land and in the ocean is considered a carbon 'sink' because it removes carbon from the atmosphere, storing it as biomass. Numerous human activities, such as deforestation and carbon intensive agricultural practices, are reducing the total amount of carbon sequestered in these stocks. Human driven land use changes, along with increased emissions of greenhouse gases, have contributed significantly to climate change. Cities can help fight climate change and reap numerous other benefits by increasing the number of carbon sinks in their communities.

Urban Forests and Green Spaces

Planting and maintaining trees and green spaces is the easiest means of increasing carbon sequestration within most communities.[21] Due to the numerous benefits of tree planting projects and green spaces, such as community gardens, roof gardens and parks, many cities around the U.S. have been motivated to literately 'green' their communities.

Urban forests sequester carbon and also save energy. Urban absorption of heat due to lack of trees is known as an "urban heat island effect." When strategically planted, trees can decrease energy costs by shading buildings, pavement and vehicles in the summer, as well as blocking winds in the winter. American Forests calculates that a single tree will sequester one ton of carbon over a 40 year life. They calculate that due to mortality, three trees must be planted to insure that one will have a 40 year life.[22]

For example, the Chicago urban tree canopy removes 15 metric tons of carbon monoxide, 84 metric tons of sulfur dioxide, 89 metric tons of nitrogen dioxide, 191 metric tons of ozone and 212 metric tons of particulates each year, according to David Nowak, project leader of the U.S. Forest Service's Urban Forest Ecosystem Research Unit. Sacramento, California, planted more than 200,000 trees around the city in the mid-1990s.

[18] Stoner, Edward. "The Town of Vail goes all wind power too." Vail Daily. 7 August, 2006.
[19] Vail resorts website, www.vailresorts.com/, 5 October 2006.
[20] "TOV 100 Percent Powered by Wind" Press Release, 15 September 2006. ci.vail.co.us/release.asp?r_id=2856, 5 October 2006.
[21] Some scientists challenge the idea that planting forests outside of the tropics helps reduce global warming, pointing out that forests trap more heat than they get rid of by sequestering carbon. However, in cities, planting and maintaining trees does appear to be a net reduction of global warming. For more information, environment.guardian.co.uk/climatechange/story/0,,1972729,00.html, 15 January 2007.
[22] The Urban Forest Network Newsletter, http://www.thefreelibrary.com/Parks+as+Lungs-a079575245, "Parks as Lungs" by Roddy Scheer, 11 April 2007.

Greg McPherson of the Western Center for Urban Forest Research found that the region's urban forest removes more than 200,000 metric tons of carbon dioxide from the atmosphere each year, saving taxpayers as much as $3 million annually in pollution cleanup costs.[23]

A study in Los Angeles showed that urban forestry and such measures to reduce the urban heat island as the use of light colored paving and roofs could cool the city by about 6 degrees. This would cut the city's cooling loads by about 20% and smog by about 12%. A similar program nationwide was estimated to be able to save $4 billion a year on air conditioning costs, 7 million metric tons of annual carbon emissions. For these reasons, an urban tree keeps about nine times as much carbon out of the air as the same tree planted in a forest.[24]

The city of Boulder, Colorado, which has integrated forestry into its climate strategy, estimates its 400,000 trees on public and private land are storing an estimated 110,000 million tons of carbon. Through new growth, sequestration and energy savings Boulder estimates the city's trees result in another additional reduction of 43,000 million tons of carbon each year, which they compared to offsetting the carbon "released through driving approximately 16.1 million miles each year."[25] The city of Boulder's Climate Action Plan notes, "According to the U.S. Forest Service, trees properly placed around buildings can reduce air conditioning needs by 30% and can save 20-50% in energy used for heating."[26]

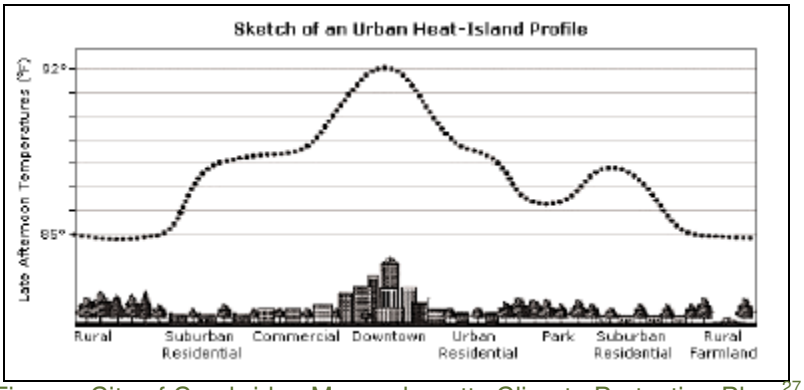

Figure: City of Cambridge Massachusetts Climate Protection Plan [27]

Such energy savings can equate to considerable dollar savings. Boulder estimates the city's trees provide an average energy savings 950 kWh for a one or two story single family detached home, saving families an average of $58/year. A 2005 analysis of municipal tree resources found that each dollar invested in maintaining public trees resulted in $3.64 in benefits due to avoided costs for energy consumption, air pollution control, as well as other benefits.[28]

Proponents of such land use changes also note that green space and forestry are tangible and emotionally appealing. Moreover, at some point most citizens have learned about the role trees play in the carbon cycle and hence, can identify with the role of trees in GHG mitigation. Creating and maintaining green space is thus an easy way to involve all ages in a city's climate action plans. Municipalities can greatly benefit from this citizen involvement. For example, the

[23] The Urban Forest Network Newsletter, www.leaftoronto.org/UFNnews32.pdf, 5 October 2006.
[24] Art Rosenfeld, et al, "Policies to Reduce Urban Heat Islands," LBL 38679, Lawrence Berkeley National laboratory, 1996, and Rosenfeld, "The Art of energy Efficiency," Annual Review of Energy and Environment 1999.
[25] City of Boulder Climate Action Plan. 161.98.15.236/files/Environmental%20Affairs/climate%20and%20energy/cap_final_14aug06.pdf#search=%22Boulder%20Climate%20Action%20Plan%22, also archived at, www.climatemanual.org/Cities/Chapter5/Mitigating/Boulder_CAP_14aug06.pdf, 5 October 2006.
[26] Ibid.
[27] Cambridge Climate Protection Plan, www.ci.cambridge.ma.us/cdd/et/env/clim_plan/clim_plan_full.pdf, also archived at, www.climatemanual.org/Cities/Chapter5/Mitigating/Cambridge_ClimatePlan.pdf, 5 October 2006.
[28] Ibid.

city of Cambridge's Climate Protection Plan states that the wide range of organizations working on issues related to land use have been critical to creating an maintaining green spaces and trees in the community.[29]

Urban forestry and green spaces also have numerous other benefits, including:

Reducing storm water run-off and soil erosion

Improving local air quality

Proving habitat for wildlife

Adding beauty—aesthetics

Increasing property values and residents' quality of life

Despite the benefits associated with urban forestry and green spaces, cities promoting these activities face a range of challenges. A fundamental issue is maintaining vegetative health. Despite the city of Boulder's efforts to promote urban forestry their Climate Action Plan notes that due to recent droughts and budget costs the city has had a net loss of trees, removing 230 trees per year on average (nine-year average) and planting 130 trees per year on the same nine-year average. "To maintain the stream of environmental benefits provided by our urban forest, urban trees must be managed to maintain optimal health and the city must have, at a minimum, a replacement program that offsets the number of removals."[30] Recognizing such challenges, the city of Minneapolis created an urban forest policy designed around "best management practices to mitigate tree loss and tree damage and to promote the long-term health of urban trees."[31]

Other urban reforestation issues relate to permanency and accounting. For example, while Boulder has carefully considered the role of trees in its Climate Action Plan, because the city has not been collecting forestry data since 1990, the city's urban forests have not been included in the GHG accounting inventory. Some uncertainty also surrounds sequestration rates for various vegetation types. Due to the time, cost and evolving scientific understanding around sequestration, municipalities must gage the benefits of accuracy versus estimates. It is also important to remember that if these trees are destroyed, whether due to human intervention or natural causes, carbon stored in vegetation is released back into the atmosphere. Therefore, it is critical they be regarded as, and accounted for as a temporary sink, rather than a permanent reduction.

Soil Conservation

According to the United States Department of Agriculture, "Soil is the largest terrestrial global carbon pool, estimated to be about one-and-a-half trillion tons."[32] However, farming practices have severely depleted soils' organic carbon levels in many agricultural areas.

For municipalities that encompass agricultural areas, providing incentives for agricultural best management practices to sequester carbon is an important step in climate protection. For example, the practice of no-till or conservation tillage[33] farming, which can increase the amount of storage in the soil and reduce emissions from farm equipment used to till the fields has gained considerable attention recently. Other best management practices that contribute to sequestration include organic agriculture, changing grazing practices to forms of "Holistic Management,"[34] converting marginal agricultural land to grassland, forests or wetland and grass buffers.

The following Environmental Protection Agency (EPA) chart summarizes some of these activities and their benefits.

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[29] Ibid.
[30] City of Boulder Climate Action Plan. 161.98.15.236/files/Environmental%20Affairs/climate%20and%20energy/cap_final_14aug06.pdf#search=%22Boulder%20Climate%20Action%20Plan%22, also archived at, www.climatemanual.org/Cities/Chapter5/Mitigating/Boulder_CAP_14aug06.pdf, 5 October 2006.
[31] City of Minneapolis 2004 Environment Report, www.ci.minneapolis.mn.us/environment/docs/MPLSEnvOverview071604.pdf, also archived at, www.climatemanual.org/Cities/Chapter5/Mitigating/Minneapolis_CAP.pdf, 5 October 2006.
[32] USDA Agricultural Research Service, www.ars.usda.gov/research/, 5 October 2006.
[33] Also in this manual, see Chapter 5, Long Term Initiatives, Sustainable Agriculture section.
[34] See Dan Dagget, Gardeners of Eden, Tarcher, 2005.

Key Agricultural Practices	Typical definition and some examples	Effect on greenhouse gases
Conservation or riparian buffers	Grasses or trees planted along streams and croplands to prevent soil erosion and nutrient runoff into waterways.	Increases carbon storage through sequestration.
Conservation tillage on croplands	Typically defined as any tillage and planting system in which 30% or more of the crop residue remains on the soil after planting. This disturbs the soil less, and therefore allows soil carbon to accumulate. There are different kinds of conservation tillage systems, including no till, ridge till, minimum till and mulch till.	Increases carbon storage through enhanced soil sequestration, may reduce energy-related CO_2 emissions from farm equipment, and could affect N_2O positively or negatively.
Grazing land management	Modification to grazing practices that produce beef and dairy products that lead to net greenhouse gas reductions (e.g., rotational grazing).	Increases carbon storage through enhanced soil sequestration and may affect emissions of CH_4 and N_2O.

Table: U.S EPA[35]

Along with sequestration there are numerous co-benefits associated with such changes in land management practices including reducing soil erosion, reducing emissions from farm equipment, increasing the levels of organic material in the soil and reduced water pollution. Like other forestry and green spaces activities, such co-benefits can be the drivers in implementing activites. For example, the Miami Conservancy District in Dayton, Ohio has recently initiated a water quality trading program that provides funding for changes in agricultural practices, such as no-till farming and conservation buffers, to reduce nitrogen and phosphorus water pollution.[36] A major side benefit is increased carbon sequestration.

Challenges associated with utilizing agricultural land use changes in municipal climate protection plans include accurately accounting for carbon storage and the fact that a relatively small amount of carbon is stored per acre. Moreover, carbon sequestered can be quickly lost in a season when a farmer changes tilling practices. Municipalities considering creating incentives for increased soil sequestration will need to ensure that the benefits of carbon storage, reduced emissions and other co-benefits will be maintained.

Technical Sequestration

Included within the context of sequestration is technical sequestration. Due to high costs and evolving technology, this type of sequestration is not yet applicable for most municipal climate strategies. However, a brief introduction is provided for context.

New and evolving means of technologically sequestering include geological and oceanic storage. The potential benefit of these methods is their huge potential for rapid sequestration, especially in comparison to terrestrial sequestration. Geological storage involves capturing carbon dioxide from pollution sources and then injecting it into geological formations in the earth. Examples include enhanced oil recovery or "clean" coal production in which the carbon (and mercury) is stripped off in gasification and then sequestered. Oceanic sequestration involves pumping carbon dioxide deep into the ocean.

One real challenge with all of these methods is that it is not entirely clear whether the carbon will stay where it is put. The permanency of the sequestration is a major concern and risk for both technologies. There are also concerns about such environmental risks as changes in ocean acidity. Because the understanding of the risks and benefits of this technology is still evolving, while technical sequestration may become a significant means of mitigating climate change in the future, land use changes represent a more accessible means for municipalities to encourage sequestration at present.

[35] EPA Carbon Sequestration in Agriculture and Forestry, www.epa.gov/sequestration/ag.html, 4 October 2006.
[36] Hamilton, Katherine. "Testing the Waters: The Great Miami River Watershed Water Quality Credit Trading Program." The Katoomba Group Ecosystem Marketplace. September 2006.

Additional Resources

Voluntary Carbon Markets: An International Business Guide to What they are and How they Work, Bayon, R., Hawn, A., and K. Hamilton (2006) Earthscan

EPA calculators. yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterToolsCalculators.html

***My Climate* video** on the carbon offset concept: www.myclimate.org/film/film_en.php

Consumers' Guide to Retail Carbon Offset Providers
Clean Air-Cool Planet has released a new report designed to help organizations and individuals that are considering purchasing offsets to help achieve carbon neutrality. The report evaluates 30 providers selling offsets in the US market on seven criteria and explains some of the key attributes that consumers should look for when purchasing carbon offsets. The survey and report were undertaken by Trexler Climate + Energy Services, Inc. of Portland, Oregon. www.cleanair-coolplanet.org/ConsumersGuidetoCarbonOffsets.pdf

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