

TOWN OF CARRBORO
NORTH CAROLINA

**ENERGY AND
CLIMATE PROTECTION PLAN**

May 20, 2014

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Executive Summary

This Energy and Climate Protection Plan has been developed as a step in supporting the Town in reducing greenhouse gas emissions, becoming more energy efficient and generating more renewable energy. The plan focuses on identifying opportunities, best practices, and planning through budgeting and the Capital Improvement Program. It has been created with a near term focus, with a goal of approximately 5-10% reduction in municipal energy use in FY 14/15-FY 15/16.

The Town is committed to energy sustainability, using the following approaches:

- a. The Town will use this plan as an initial means of articulating:
 - i. Specific near term goals and actions to demonstrate the Town's commitment to responsible energy management and greenhouse gas reductions.
 - ii. Accountability and resources for implementation
- b. The Town will plan to refine this plan in the future to guide:
 - i. Longer term measurable and achievable goals and timelines
 - ii. Additional efforts to measure, inventory, assess, and report on progress
 - iii. Additional identification of energy conservation opportunities, concept development of projects and process changes, and prioritization of improvement efforts
 - iv. Funding and staff resources to define, develop, and execute projects and process improvements
 - v. Reviews of conservation efforts and regular updates to the Plan.
 - vi. Efforts to reach out to the community to identify and pursue community scale efforts for greenhouse gas emissions reduction, increased energy efficiency and renewable energy generation.

The Town has created this plan to address energy use primarily for municipal operations but also to recognize municipal support for the community sector. Key elements of the plan for Town streets and facilities include:

- For outdoor lighting, pursuing retrofits with LED lights
- For buildings:
 - Complete energy assessments at Century Center and Town Hall
 - Retrofitting lights and installing controls and sensors to reduce electricity demand.
 - Replacing older, inefficient heat pumps and appliances with Energy Star rated units prior to their failure.
- For the municipal fleet:
 - Pursue grant funding for a solid waste vehicle
 - Increased foot patrols/reduced vehicle idling
 - Supplementary battery systems.
 - Continued downsizing/rightsizing of vehicles
 - Potentially converting some vehicles to liquid propane (LP) gas (or another alternative fuel)

- Supporting practices that reduce the net consumption of fossil fuels, and increase the use of more sustainable energy sources.
- For public facilities and right-of-ways:
 - Inventory trees and develop and implement tree plans

For the Town's support of the community sector, the following recommendations are presented:

- Community Buildings
 - Explore and pursue opportunities for community outreach
 - Continue the Energy Efficiency Revolving Loan Fund for businesses
- Community Transportation
 - Commit local matching funds for greenways
 - Support Safe Routes to School Implementation Committee
 - Plan for increased transit service connections; car and bike sharing; walkability; carpooling and other TDM strategies
 - Consider GHG emissions in efforts such as parking and long-range transportation plans
- Expand upon efforts to promote renewable energy
 - Identify municipal host sites
 - Pursue outreach to identify investors
 - Continue to support Solarize Carrboro
- Urban forestry
 - Complete tree canopy analysis, and resource assessments and develop a community forestry master plan
- Continue collaboration with Orange Water and Sewer Authority, Orange County, Chapel Hill Transit and others.

In addition to presenting these recommendations for actions for the Town to pursue in the next 1-2 years, this plan includes a section on climate change adaptation and appendices with additional contextual information.

Background and Context

This Energy and Climate Protection Plan is premised on reducing greenhouse gas emissions, becoming more energy efficient and generating more renewable energy. It recognizes the profound and unprecedented global reality of a changing climate and imperative for a healthier relationship with planetary cycles. This is the biocentric or ecocentric, life-affirming perspective. While pursuing this plan will reduce greenhouse gas emissions and environmental impacts, it is also motivated by significant anthropocentric (human) needs for strong local economies, resilience, human health, and societal benefits. Examples of relevant human needs include:

- Lower transportation and building operating costs
- Better environmental quality and a more livable, healthier community
- Insulation against future price hikes
- Retention of local dollars
- Energy independence

Vision & Guiding Principles

A premise of this plan is that the Town of Carrboro strives toward responsible energy management and climate protection in its policies and operations, and aims to demonstrate leadership to the community by the following guiding principles:

- Engaging and educating employees and the community about the challenges climate change presents and driving a collaborative process to implement innovative solutions.
- Promoting inter-departmental collaboration for short and long-term solutions to enhance the Town's organizational excellence and financial efficiency.
- Modeling responsible energy management through efforts in energy efficiency and renewable energy generation.
- Addressing climate change through strategic management of our Town facilities, transportation resources, infrastructure, and land use planning.
- Supporting continued development of a diverse, vibrant, local green economy.
- Measuring, monitoring and communicating the Town's progress toward a defined goal set.
- Partnering and collaborating with other public, private, and nonprofit organizations in harmony with these principles.

Can we meet the needs of the present without compromising the ability of future generations to meet their own needs?

The "Triple Bottom Line" balances environmental stewardship, economic growth and social responsibility.

from Asheville Sustainability Management Plan

While this plan is a report to and for the community, its focus is on the municipal operations that the Town administers. This is the sector where the Town has the most responsibility and control. Given that climate protection, energy efficiency and generation, local living economies and many other community interests cannot be fully pursued within a limited jurisdictional and administrative context, this plan should also be considered within a larger context. Local government operations occur within the larger community scale and regional/state/national/global context. Values such as job creation, greater energy security and influence over energy choices, enhanced potential for public-private partnerships, and increased livability, while not being the focus of discussion in this plan, are important drivers and components for the long term success of the plan. Collaboration with a variety of public and private partners will

continue to be extremely important in pursuing the goals of climate protection and energy planning, and requires foresight and initiative at many levels. It is beyond the scope of this plan to attempt to fully articulate the details of this larger collaboration; this plan is intentionally focused on Town operations.



Planning Focus: Local Government

The U.S. Department of Energy has developed a “Guide to Community Strategic Energy Planning” that identifies two types of planning efforts: one focusing on the government operations and one focusing on the community at large. The former: includes a focus on government buildings, facilities, infrastructure, operations, and transportation; concentrates on activities for which the government has direct influence – personnel, operations, planning, and budgeting – which means tighter control over implementation. The latter (community-wide plan) is a broader plan to also include activities for the entire community that: expands the focus to include energy saving activities across the jurisdiction (residential, commercial, industrial, transportation, and other sectors) of the broader community; recognizes that, while local government actions can greatly influence, energize, and leverage effective activities in the broader community, the government has less direct control over these activities in comparison to a government-only plan. This plan focuses on the former (Local Government Operations), and also attempts to make some progress on the latter (Community Energy Activities).

Building on Past Efforts

This plan is the next step in over a decade of consideration of climate protection and energy planning in Carrboro. The Town has been involved in activities associated with inventorying greenhouse gas emissions and planning for and pursuing emissions reductions since 2001, when the Board of Aldermen adopted a resolution pledging the Town’s commitment to reduce greenhouse gas emissions, improve air

quality and save energy through joining the Cities for Climate Protection (CCP) program. The Town participated with other local governments and ICLEI – Local Governments for Sustainability (an international association of local and regional governments dedicated to sustainable development) to develop a Greenhouse Gas Emissions Inventory for Orange County. Additionally, the Town is a signatory to the U.S. Conference of Mayors’ “Mayors’ Climate Protection Agreement” (see Appendix V for more information). Participating cities in the Agreement serve as conduits to spur local and state action in order to reduce global warming. In the Vision 2020 document, the Town adopted “sustainable” and “green” goals, objectives, and action items, ranging from sustainable land use patterns to reduced energy consumption.

In 2009, the Board of Aldermen passed a resolution resolving that the Board "will seek, and will facilitate the community at large, to cut CO₂ emissions by its proportion of the amount which is required to stabilize the climate back to <350 ppm of CO₂ ...", and asks staff to evaluate how to achieve this target for municipal operations and the community. This plan is a step towards pursuing this charge, while recognizing it is more responsive for municipal operations than for the community at large.

Also in 2009 Carrboro joined 33 other communities in achieving the NC League of Municipalities Green Challenge “Advanced” level. In 2011 A UNC Capstone Team partnered with the Town to complete a Greenhouse Gas Emissions Inventory focusing on Carrboro. In April 2012, a detailed municipal emissions inventory using local data was completed, with a recommendation that the Town “investigate the financial costs of implementing a GHG reduction policy across all Town operations with a goal of reducing emissions 2% of 2007 levels annually through at least 2025. If the costs are found to be acceptable, then it is recommended that the Town implement the policy in order to further the Town’s stated goals of environmental stewardship and “leading by example””. This inventory was updated in the spring of 2013, with the Board requesting at its June 18th, 2013 meeting that staff also look into the implications of a 7% annual reduction in emissions. At its October 8th, 2013 meeting, the Board reviewed staff efforts to initiate this plan, and provided the direction to prepare this plan. Additional details regarding past efforts, the science and global context of climate change and protection are provided in sections and appendices of this plan.

Organization of Plan

The organization of this plan reflects the goals and historical foundation discussed above and the opportunities Town staff have been able to identify in this initial plan. The recommendations provided focus on tractable and specific areas of near term emphasis especially for municipal operations (and to a lesser extent for the broader community), and plans to pursue projects through the operational budget and Capital Improvement Program. The need for a longer term, more comprehensive plan is acknowledged. The focus for this plan is more immediate and tractable, i.e., what are the priorities for in the next 1-2 years.

Climate change is not an abstract problem for the future or one that will only affect far-distant places.

Rather, climate change is happening now, we are causing it, and the longer we wait to act, the more we lose and the more difficult the problem will be to solve.

Center for Biological Diversity

The local government operations section of the plan addresses outdoor lighting, facilities, and the municipal fleet. The municipal support for the community section of the plan addresses community transportation, buildings, renewable energy, and the urban forest. A discussion is also provided on climate vulnerability and adaptation. Sections are presented in a common format as presented in the graphic below.

DRAFT

LEGEND

DESCRIPTION

What is proposed?

BASIS

Why is this being recommended?

BREAKDOWN

How will this be accomplished?

LEAD DEPARTMENT

Which department is taking the lead?

INTERNAL COORDINATION

Who will be involved on staff?

EXTERNAL COORDINATION

Who else will be involved?

RESOURCES REQUIRED

What is needed? Is it in the CIP? What year? Is it budgeted for next year?

CIP: ☐ CIP YEAR: _____

2014/15 BUDGET: ☐

PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS
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Municipal Operations

Introduction

The motivation for the Town to invest in municipal energy efficiency are many:

- Efficiency can *reduce greenhouse gas emissions and other air pollutants*, an important objective for addressing climate change and environmental health concerns.
- Improvements in the energy efficiency of local government operations (e.g., buildings, vehicle fleets) can reduce *maintenance and operating costs* and may *reduce or avoid capital costs*. These avoided costs can, in turn, *decrease or prevent increases in local taxes*, and allow for those funds to be spent elsewhere, which can result in *more investment in the local economy*.
- Efficiency can *improve local energy security* by decreasing demand for resources from outside the community.
- Improvements demonstrate the principal of "*leading by example*", resulting in increased interest from the community.

At the same time, Carrboro faces challenges that are particularly noteworthy for a small town with aging building stock and modest access to capital relative to many larger jurisdictions.

Some of the challenges to comprehensively addressing energy efficiency are as follows:

- **Upfront capital cost:** With limited access to capital, the size and number of potential projects is more limited.
- **Looking for quick payback period:** A common approach is to choose measures that will pay for themselves quickly — the low-hanging fruit. There is a common tension between the limited number of projects with quick paybacks and the larger number of projects with both large capital and extended payback periods. This is where lifecycle cost analysis comes into play, as long-lived infrastructure can generate significant cost savings when measured over years of operating life.
- **Lack of reliable information on energy expenditures and potential savings:** The Town has only recently been able to more rigorously track energy usage, and does not have more comprehensive and detailed information on potential energy savings. Without this knowledge, it is difficult to determine where the most energy is being wasted, what the potential for savings are, and where opportunities lie. This is why projects identified to date are of the "low hanging fruit" variety, but not as comprehensive as needed.

The U.S. EPA recommends the following key approaches for assessing baseline building energy performance in existing buildings:

- Use available, standardized tools and audit protocols for baseline energy consumption assessments. For example, ENERGY STAR'S Portfolio Manager is an online tool that can be used to assess baseline energy performance in existing buildings and compile data across a portfolio of buildings.
- Benchmarking involves comparing a building's energy performance to the performance of similar buildings. The most meaningful benchmark comparisons compare buildings that operate in nearby areas or, at minimum, under similar climate conditions. It is best to perform records-based benchmarking over a two-year period, at minimum, to eliminate the effects of unusual weather conditions.
- Conduct technical assessments and audits. In addition to establishing baseline energy performance and determining a building's relative performance compared to its peers, a thorough energy performance assessment includes comparing the actual performance of a building's systems and equipment with its designed performance level or the performance level of top-performing technologies. These technical assessments can be conducted as part of a whole-building energy audit conducted by an energy professional and used to identify priority energy efficiency investments. If not bundled into the equipment cost, walk-through audits (ASHRAE Level I) are frequently priced at \$.02-\$.05 per square foot. Level II audits are frequently priced at \$.10-\$.15 per square foot. Investment grade audits (ASHRAE Level III) are frequently priced at \$.20-\$.30 per square foot, a sum that may vary depending on the complexity of the modeling to be performed.⁷

An investment-grade audit will determine which energy efficiency measures are cost-effective over a reasonable time horizon (often between 10 and 20 years). Targeted areas typically include building heat losses and excess energy consumption from older equipment. Recommendations can include simple items like insulation, window replacements, lighting replacements, boiler and chiller upgrades or replacements, high efficiency motors and variable frequency drives on pumps, and energy management control systems. Energy audits can also focus on local government services and operations such as for street lights and fleets.

Best practices for energy audits and retrofit installation include the following:

- Use qualified professionals. Energy audits are best performed under the direction of a professional or firm specializing in energy audit activities. Individuals qualified to perform energy audits may include licensed professional engineers, certified energy managers, or commissioning authorities. Firms qualified to conduct building energy audits include energy service companies (ESCOs), building engineering companies, and building energy consulting companies.

In the case of retrofits involving significant capital improvements, it is often wise to engage a third-party construction manager to ensure that the retrofit is taking place according to plan. It is wise to scrutinize the credentials of proposed service providers and to require multiple bids before selecting vendors. Local governments that lack a sufficiently trained staff to vet vendors might wish to contract with a third-party expert to help select vendors.

Past Efforts

For Town operations, the Town has taken the following steps in the past. In 2008 and 2009, the Town partnered with Waste Reduction Partners, a program sponsored by the State and Triangle J COG, to perform an energy audit of Town buildings (Century Center, Town Hall, Fire Station #1, Public Works). The Town also worked with Big Woods Engineering in 2009-2010 to identify lighting and HVAC retrofits that could be pursued through the Energy Efficiency Conservation Block Grant program administered by the State Energy Office for these four buildings.¹ Both of these efforts can be considered as “walk through audits”.

The Town also designed the new fire substation on Homestead Road to LEED silver standards. In the past several years, Public Works staff has been replacing older (T-12 fluorescent) lighting ballasts and bulbs with higher efficiency (T-8) ballasts and bulbs. Public Works staff estimate that 40% of these fixtures have been upgraded to date. Other incremental steps have also been pursued, such as installation of programmable thermostats, a community solar project at the Town Commons, and contributions (\$80/month) for renewable energy to NC Green Power. The Town has also taken steps for the municipal fleet to reduce emissions, use alternative fuels, and save on operational expenses. Examples include: purchasing hybrid vehicles; implementation of 2007 emissions standards phased in over several years; downsizing/rightsizing of vehicle purchases; adoption of idling policy; and a fuel conservation initiative. Beginning in 2014, the Town is formalizing commitment to sustainability and energy measures in Capital Improvement and Operating Budget annual updates.

Collaboration and Partnerships

While not being formally part of Carrboro municipal operations, entities that the Town cooperates with are important partners for energy and climate action efforts. Perhaps the two most important of these are OWASA and Orange County. OWASA’s water conservation efforts are important for energy conservation, as every gallon conserved is a gallon that is not pumped and treated. OWASA staff estimate that, for every 1000 gallons of treated water and sewage conserved, 7.5 kilowatt hours (kWh) of energy/electricity are also saved, which is equivalent to the energy generated by the solar array at Town Commons for 1.5 hours. In addition, OWASA is pursuing opportunities to reduce energy use and costs e.g., by replacing older mechanical equipment with more efficient units, installing more efficient lighting and temperature controls, and using renewable energy sources instead of conventional fuels. Work is underway to install more energy efficient treatment wastewater treatment equipment, which will reduce electricity usage by about 20 percent when the project is completed later this year. OWASA has recently presented a strategic plan which includes the development and implementation of an energy management plan to further reduce energy use. For solid waste, Orange County is recognized as being number one in the state for waste reduction, reaching 59% of its 61% reduction goal. The County is disposing 0.56 tons/person compared to the base year of 1991-92, when the disposal rate measured 1.36 tons. Waste reduction benefits emissions reductions both through reductions in methane (a potent greenhouse gas which is being captured at the landfill) and reduced emissions

¹ The grant application was not funded because criteria favored economically disadvantaged communities; more information on measures recommended is available in Appendix II.

associated with hauling. The Town is faced with an emission reductions challenge with the closure of the landfill on Eubanks Road given the longer transport to the transfer station and out-of-county landfill. Another partner worth mentioning is Piedmont Biofuels (PBF) Cooperative; the Public Works facility has been hosting a community biodiesel pump run by PBF since 2004, with this pump being one of the earliest on the “B100” trail, and the supply chain for the fuel produced being provided from carbon neutral local sources. In 2012, the Town collaborated with Carrboro Community Solar to install a photovoltaic system at the Town Commons. In 2013/14, the Town has been providing logistical support to a nonprofit, Next Climate, Inc. to pursue “Solarize Carrboro” to encourage homeowner installation of solar electricity.

Steps Presented in This Plan

The sections that follow provide recommendations for the Town to pursue in the next 1-2 years with municipal operations to improve energy efficiency. A high priority action is to work with utility providers (Duke Energy and Piedmont Electric membership Corporation) to replace existing streetlights and area lights (currently leased from utility companies) on Town maintained property with LED fixtures. Other recommended actions include: completing studies and assessments of the Century Center HVAC system and Town Hall; improving energy use and management in buildings and equipment through energy savings capital and operational improvements; and pursuing fleet initiatives such as grant funding for more efficient vehicles, increased foot patrols/reduced vehicle idling, installing supplementary battery systems and continued downsizing/rightsizing of vehicles; and potentially converting some vehicles to LP gas (or another alternative fuel). It is also recommended that the Town continue to annually report on its municipal greenhouse gas emissions inventory to track changes in energy use, and consider other approaches for measuring, assessing, and reporting on energy use and emissions.

References

Some of this introduction is excerpted from:

USEPA Environmental Financial Advisory Board. January, 2014. Municipal Energy Efficiency and Greenhouse Gas Emissions Reduction: Financing and Implementing Energy Efficiency Retrofits in City-Owned Facilities. http://www2.epa.gov/sites/production/files/2014-02/documents/municipal_energy_efficiency_and_ghg_emissions_reduction.pdf

See also:

ACEEE. “Fact Sheet: Energy Efficiency Policies for Local Governments.” Available at: <https://www.aceee.org/fact-sheet/local-government-ee-policy>

2.A LED Outdoor Lighting

DESCRIPTION

The proposed emphasis with outdoor lighting is to replace existing streetlights and area lights (currently leased from utility companies) on Town maintained property with LED fixtures. Because the Town does not own the lights, the timing of how quickly the Town may be able to pursue replacement with LED lights is currently unknown. The initial plan is to replace the roughly 700 fixtures on Town streets starting in FY 14-15 and complete the project in FY 2015-16. The remaining 200 fixtures on State (NCDOT) roads will require state approval with less certainty about a probable time frame. A rate structure for LED replacement of high pressure sodium (the predominant type of fixture in the current inventory) and metal halide under a utility owned option is currently under development. If a rate option and structure is made available that allows the Town to own street light fixtures, the Town will have an option of taking over ownership. The replacement timing and payback should become clearer in the summer of 2014.

BASIS

LED lights typically last over 100,000 hours, or 20+ years, and feature a “plug and play” electrical system which lowers maintenance costs. The LED lamps would be owned by the Town, rather than leased from the utility company, which would result in operational savings. LED lighting is much more efficient than current standard lighting fixtures, yielding a relatively short payback period for capital investment (3 years or less). The cost of LED lighting is also dropping rapidly, suggesting more favorable financial benefits. Street lighting is a large contributor to all municipal emissions (22%). It is anticipated that the LED streetlights would have a relatively rapid payback that could result in roughly a 10% municipal footprint reduction for the year(s) in which fixture replacement occurs.

BREAKDOWN

- Develop and implement comprehensive streetlight replacement plan
- Replace streetlights first on Town property and then on State roads
- Coordinate with Duke Energy, PEMC, and NCDOT, and perform community outreach

LEAD DEPARTMENT

Public Works

INTERNAL COORDINATION

Outdoor lighting workgroup

EXTERNAL COORDINATION

Utility providers; contractors

RESOURCES REQUIRED

\$262k (preliminary estimate if customer owned option available); contract support

CIP: ☒ **CIP YEAR:** 2014/15, 15/16

2014/15 BUDGET: ☒

The City of Asheville has determined that LED streetlight replacement to be the best investment for meeting greenhouse gas and sustainability goals.

PAYBACK PERIOD					
	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS

2.B.i Building Assessments and Ratings

DESCRIPTION: Building energy assessments and ratings are valuable tools to determine the scope, costs, and energy and operational savings for future improvements and compare building energy use to other comparable buildings. In 2008 and 2009, the Town partnered with Waste Reduction Partners to perform an energy audit of Town buildings. The Town also worked with Big Woods Engineering in 2009-2010 to identify lighting and HVAC retrofits.¹ Carrboro could also work with a contractor to determine improvements needed for Town buildings to become an USEPA Energy Star™ partner organization, and in doing so, participate in Portfolio Manager, EPA's online tool to award the Energy Star™ designation. An Energy Star™ facility meets strict energy performance standards, is less expensive to operate, and causes fewer GHG emissions than its peers. To qualify for the Energy Star™ designation, a building must score in the top 25 percent based on EPA's National Energy Performance Rating System. Carrboro has not used the Portfolio Manager system, and doing so will require outside assistance because of limited staff time and expertise.

BASIS

Performing an energy assessment or audit is a crucial step to assessing and improving energy efficiency. There are many types of assessments that can be performed, ranging from 'walk-through audits' to more comprehensive 'process audits. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) refers to benchmarking as a process that involves collecting facility energy data, reviewing energy bills, and comparing the facility's energy consumption with similarly-sized facilities using similar processes. EPA recommends all facilities use Portfolio Manager or another benchmarking tool. Through analysis of the buildings in Portfolio Manager and in concert with building assessments, targeted energy conservation projects can be identified and demonstrate the energy benefits of the projects.

¹ See Appendix II for additional information

TASK BREAKDOWN

Complete study/assessment of Century Center HVAC system in FY 14/15

Complete study/assessment of Town Hall in FY 14/15

Consider other future building assessments beginning in FY 15/16

LEAD DEPARTMENT:

Public Works

INTERNAL COORDINATION

Buildings Energy Workgroup

EXTERNAL COORDINATION

Contract support

RESOURCES REQUIRED

\$65k in FY 14/15 operating budget for Century Center, Town Hall studies (Town Hall includes non-energy items)

CIP: ☒ **CIP YEAR:** FY 14/15, 15/16

2014/15 BUDGET: ☒

Payback to be determined as part of assessments

PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS
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2.B.ii Facility Energy Efficiency

DESCRIPTION: Energy efficiency in facilities applies to efforts to reduce energy consumption capital and operational improvements. Retro-commissioning projects ensure that existing building systems operate well considering their current use. Occupant behavior change is goal of communications strategies which encourage conservation. Improved controls involve measures such as upgraded thermostats, occupancy sensors, and enforcement of a setpoint policy, including carefully monitoring setpoints for unoccupied buildings for evenings, weekends and holidays. Life-cycle cost analysis incorporate energy conservation/ efficiency into the decision-making process for capital decisions to gain a full understanding of total cost over the useful life of project or equipment. Public utility incentives are available to subsidize costs for selected improvements. The Town can develop a policy requiring that Energy Star™ qualified products are chosen for purchases such as Information technology can continually be evaluated and operated for energy efficiency improvements Operation and maintenance best practices can continually be considered to identify procedures that consider and encourage equipment efficiency.

BASIS: Installation of more energy efficient measures, controls along with policies and strategies can reduce energy use and utility costs. Cost savings can potentially be reinvested. Significant reductions in energy use also means reductions in greenhouse gas emissions. Improvements may also allow for indoor air quality improvements that may not otherwise have been possible due to funding constraints. Retro-commissioning can produce significant cost savings, reduce energy waste, improve system operation beyond preventive maintenance and potentially yield a payback of less than 3 years. A more rigorous setpoint control procedure could significantly reduce energy waste and operating cost. Additional benefits could include avoided accelerated equipment degradation, and extended equipment life. Energy Star™ results in reductions in energy use without compromising and potentially improving quality and performance. Lowest life cycle cost is the most straightforward and easy-to-interpret measure of economic evaluation.

BREAKDOWN

Retro-commissioning: Century Center, Town Hall
Internal staff communications
Controls and setpoint strategy
Life-cycle cost analysis
Review purchasing policies/modify language
Gather energy savings data when replacing existing equipment

LEAD DEPARTMENT

Public Works/Management Services

INTERNAL COORDINATION

Department Heads, Administrative Staff, Buildings
Energy Workgroup

EXTERNAL COORDINATION

Contract support/vendors

RESOURCES REQUIRED

Studies of Century Center HVAC and Town Hall
in FY 14/15 will help determine.

CIP: ☒ **CIP YEAR:** 2014/15-16/17

2014/15 BUDGET: ☒



PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS
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2.C FLEET REPLACEMENT AND EFFICIENCY

DESCRIPTION: Historically, the Town has taken steps for the municipal fleet to reduce emissions and save on operational expenses. Examples of practices include: purchasing hybrid vehicles; implementation of 2007 emissions standards; downsizing/rightsizing of vehicle purchases; adoption of idling policy; and a fuel conservation initiative. Data has demonstrated that carbon emissions from the fleet have decreased. As older vehicles are replaced with newer, more efficient models, this trend should continue. Based on early information for FY 13/14, the increase in emissions due to transporting solid waste to Durham may not be as large as expected. For FY 14-15, if vehicles are replaced, added and deleted as planned, the vehicle fleet should produce 658.19 MTCDE, a decrease of 2.09% from FY12-13. That metric assumes the removal of two vehicles from the fleet, the addition of one fuel-using vehicle (a Vacuum Leaf Loader that performs the work currently requiring four pieces of equipment), the replacement of police vehicles with newer, more-efficient vehicles and a more efficient Fire Engine. Additional opportunities to decrease GHG emissions in the Town's fleet in FY14-15 include potential grant funding for a hybrid MSW collection vehicle (decreasing emissions to 653.41 MTCDE or a reduction of 2.81% from FY 12-13 levels); increased foot patrols and reduced vehicle idling in the Police Department; and use of supplementary battery systems in Police vehicles that allow the vehicle's systems to run without the engine. The Town participates in the Triangle Clean Cities Coalition which provides grant funding, technical assistance, and networking opportunities. Additional strategies under consideration for future years include downsizing/rightsizing vehicles up for replacement and converting portions of the fleet to LP gas (or another alternative fuel).

BASIS: The fleet is responsible for about 1/3 of the Town's total municipal sector emissions; a more efficient fleet is therefore an important component of climate and energy planning. Increased efficiency has the potential to also provide positive fiscal impacts such as reduced operating costs and life cycle costs. Replacement vehicles

should be acquired with the goal of minimizing operational costs by replacing the vehicles in a timely manner.

BREAKDOWN

Implement CFAT grant award for municipal solid waste vehicle

Increased foot patrols/reduced vehicle idling

Supplementary battery systems.

Continued downsizing/rightsizing of vehicles

Potentially converting some vehicles to LP gas (or another alternative fuel; future years)

LEAD DEPARTMENT

Manager's Office and Department Directors

INTERNAL COORDINATION

Fleet Workgroup

EXTERNAL COORDINATION

Vendors; Clean Cities Coalition; NC Solar Center

RESOURCES REQUIRED

Equipment financing annually updated

CIP: ☒ **CIP YEAR:** All

2014/15 BUDGET: ☒

5 police vehicles to be purchased in FY 14/15 will be equipped with a Havis Idle Manager to allow officers to pursue critical work without the engine.

PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS
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Community Sector

Introduction

While it is difficult to quantify, the community transportation sector is perhaps the sector in which the Carrboro has made the most progress in addressing and reducing energy usage historically. To provide alternatives to vehicle use in general, the Town has been a partner in the State's most ambitious and successful (and fare free since 2001) transit program (Chapel Hill Transit) for several decades. The system provides over 7 million rides per year. The Town contributes about \$1M annually to the operation of the system, or about 5% of the Town's annual budget. In addition to the high ridership, higher efficiency busses are being employed in the fleet, with 15 new hybrid busses acquired in 2013 (one third of the fleet is now employing hybrid technology), and solarizing lighting at bus stops has also been pursued. The Town has also been assertively supporting bicyclists and pedestrian for many years, with the Town being recognized as a "Silver" level bicycle friendly community by the League of American Bicyclists. (Carrboro is one of a handful of communities, and the smallest, east of the Mississippi River to receive this designation.) The Town has promoted walkability and bikability through the Safe Routes to School Action Plan, bicycle facilities¹, and sidewalks and greenways with support from a bond passed in 2003. The Town continues to pursue other measures (e.g., transportation demand management, transit-oriented/mixed use land use planning, participation in regional transit efforts, road connectivity, alternative fuels) to reduce community vehicle miles traveled and emissions and encourage alternative transportation modes. A relatively recent area of focus relevant to community transportation has been working to expand affordable housing options for workers employed in and near Carrboro that currently commute long distances, in part because of high local housing costs.

With support from federal stimulus funds, Carrboro pursued efforts in the past several years to reduce energy use in buildings in the community through establishment of the "Worthwhile Investments Save Energy" (WISE) program. During the recently ended grant period, the Carrboro WISE program: provided commercial loans to local businesses through the Energy Efficiency Revolving Loan Fund (EERLF); provided incentives for 18 single-family home and two multifamily complexes energy efficiency retrofits; reached over 200 additional citizens in Chapel Hill and Carrboro through a grass roots energy efficiency outreach and education campaign; and trained home performance contractors to be Home Performance with Energy Star certified contractors.

Steps Presented in This Plan

The sections that follow provide recommendations for the Town to pursue in the community to improve energy efficiency, support renewable energy, and pursue urban forestry efforts that have energy efficiency, climate protection, and other benefits. For community transportation, it is recommended that the Town continue initiatives underway and more explicitly consider energy and climate protection in transportation-related planning. For community buildings, it is recommended that the Town continue

¹ e.g., bike lanes, sharrows, multi-use paths, paved shoulders

to offer and promote energy efficiency loans to businesses through the Energy Efficiency Revolving Loan Fund (EERLF), to support community volunteers (“Elite Petes”) trained by Clean Energy Durham, and to support Solarize Carrboro. To support renewable energy, Town staff will continue to work with Solarize Carrboro. Further involvement with community solar projects will require additional dedication of resources and/or initiative from the community in pursuing a project in collaboration with the Town. Further urban forestry efforts are recommended to provide climate protection and energy benefits, and also recognize the many other benefits of urban trees. Ongoing measurement, inventory, assessment, and reporting is also recommended, which will require support through collaboration (as has been done in the past) with UNC potentially others.

DRAFT

3.A Community Transportation

DESCRIPTION

The Town has historically been active in the community transportation sector. No significant new direction is recommended in this plan; it is recommended that initiatives underway are continued and energy and climate protection is more explicitly considered in transportation-related planning. The Town has been a partner in Chapel Hill Transit, which is an alternative to automobile use. The Town has also been assertively supporting bicyclists and pedestrians for many years through the construction of bicycle facilities, sidewalks, and greenways. The Town adopted a bicycle plan in 2009 and a Safe Routes to School action plan in 2012. The Town also continues to pursue transportation demand management, transit-oriented/mixed-use land use planning, participation in regional transit efforts, road connectivity, and alternative fuels. A step that is included in Town planning documents and worth emphasizing for its climate protection/energy benefits is to identify local matching funds to allow greenway design work for Bolin Phase 2 and Morgan future phases to proceed. With the expiration of grant funds, it is also recommended that the Town offer support for Safe Routes to School implementation.

BASIS

Conceptually, changes in energy use and greenhouse gas emissions for the community transportation sector are directly associated with: changes in population; changes in vehicular use per capita; and changes in technology affecting energy use and emissions. These in turn are affected by factors such as alternatives available, infrastructure, land use, and economics. Quantifying the GHG footprint associated with vehicular use in Carrboro is difficult. A UNC Capstone team (2011) pursued this using a regional transportation model (RTM). The Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC-MPO) uses the Triangle Regional Model, a unified four-step travel demand model that estimates vehicle miles traveled (VMT) based on trip generation, trip distribution, mode choice and route assignment. Some MPOs also employ models that estimate GHG emissions.

BREAKDOWN

- * Commit local matching funds for greenways
- * Support Safe Routes to School Implementation Committee
- * Plan for: increased transit service connections; car and bike sharing; walkability; carpooling and other TDM strategies
- * Consider GHG emissions in efforts such as parking and long-range transportation plans

LEAD DEPARTMENT

Planning

INTERNAL COORDINATION

Community Transportation Workgroup

EXTERNAL COORDINATION

MPO, transit agencies, NCDOT, Chapel Hill

RESOURCES REQUIRED

Support for the above actions

CIP: ☒

CIP YEAR: 2014-2020

2014/15 BUDGET: ☒

← payback difficult to determine →

PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS
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"Dear future generations. Please accept our apologies. We were running drunk on petroleum" –Kurt Vonnegut

3.B Community Buildings

DESCRIPTION

For three years and with support from federal stimulus funds, the Town pursued energy efficiency in buildings through the WISE (Worthwhile Investments Save Energy) program. WISE: provided loans for businesses and incentives for single-family homeowners and multifamily complexes; reached over 200 additional citizens through a grass roots energy efficiency outreach and education campaign designed by Clean Energy Durham; and trained home performance contractors to be Home Performance with Energy Star certified contractors. Now that the grant and program has ended, the Town has a new challenge: how to maintain the momentum created by the WISE program without the federal support. Two modest next steps envisioned for sustaining the initiatives established with the WISE program are to continue to offer and promote energy efficiency loans to businesses through the Energy Efficiency Revolving Loan Fund (EERLF) and to support community volunteers ("Elite Petes") trained by Clean Energy Durham, and the Solarize Carrboro initiative.

BASIS

The U.S. Green Building Council (USGBC) provides statistics which indicate that, nationally, buildings account for 40% of primary energy use, 72% of electricity consumption and 39% of CO₂ emissions. Studies have determined that improving buildings can reduce energy use and CO₂ emissions by up to 50%. Community buildings are the largest single contributor to the community greenhouse gas footprint, with electricity consumption estimated to contribute about six times as much as natural gas consumption. The utilities providing electricity continue to rely on coal, along with nuclear energy, for a significant portion of the energy supply. An emphasis on community buildings, and particularly on electrical consumption, is therefore an essential component of energy and climate protection planning in Carrboro. At a municipal level, however, the Town has limited legal authority and responsibility for the energy supply and efficiency of private buildings, and also limited capacity. The current best options available include support for outreach and education and promoting the EERLF.

BREAKDOWN

- Explore opportunities to maintain grass roots outreach; support Solarize Carrboro
- Update website
- Continue to offer loans through the EERLF and explore ways to promote the loan program

LEAD DEPARTMENTS

Planning and Economic and Community Development

INTERNAL COORDINATION

Community Buildings Workgroup

EXTERNAL COORDINATION

Businesses, Elite Pete volunteers, Next Climate, Inc.

RESOURCES REQUIRED

Small operating and outreach budget

CIP: ☐ CIP YEAR: _____

2014/15 BUDGET: ☒

					
PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS

3.C Renewable Portfolio

DESCRIPTION: Renewable energy sources include photovoltaics, solar thermal, wind, and geothermal heat. To be financially competitive, “renewables” take advantage of federal and state tax credits, renewable energy credits and accelerated depreciation. As a municipality, Carrboro cannot take advantage of these incentives alone. As a pilot project to investigate alternatives, the Town partnered with Carrboro Community Solar in 2012 for a small-scale (5kW) solar electric system at the Town Commons. The community investing model results in an “average” breakeven return for private investors in 5-6 years, and a free or bargain system for the Town after 5-6 years with revenue generating ability from the sale of electricity. In the community sector, the “Solarize” model is currently being tested to encourage homeowners to install solar electric systems. <http://www.solarizenc.org/>

BASIS: Currently, cost-effective integration of renewable energy is dependent upon partnerships with private sector investors who can take advantage of the available tax credits and depreciation for installing renewable systems, and funnel their tax liability towards renewable energy. North Carolina is currently a progressive state regarding these credits, and when coupled with the federal tax credits, renewable energy becomes much more cost-effective. It is worth noting that these credits are not indefinite and will need to be renewed in the next two years to continue to incentivize renewable energy. A non-monetary “value” should also be placed on renewable energy development in Carrboro. Using installed systems for demonstration can provide Carrboro a “value-added” characteristic to pursue outreach about the importance of renewable energy. Into the future, a mix of solar energy with conventional energy will also reduce the overall utility cost for the Town.

BREAKDOWN

Community Solar Project:

Identify municipal host site(s)

Pursue outreach to identify investors

Enter into lease agreement for system

Continue to support Solarize Carrboro



LEAD DEPARTMENT

TBD

INTERNAL COORDINATION

TBD

EXTERNAL COORDINATION

Private investors

RESOURCES REQUIRED

Consider contract support for community investing

CIP: ☐ CIP YEAR: _____

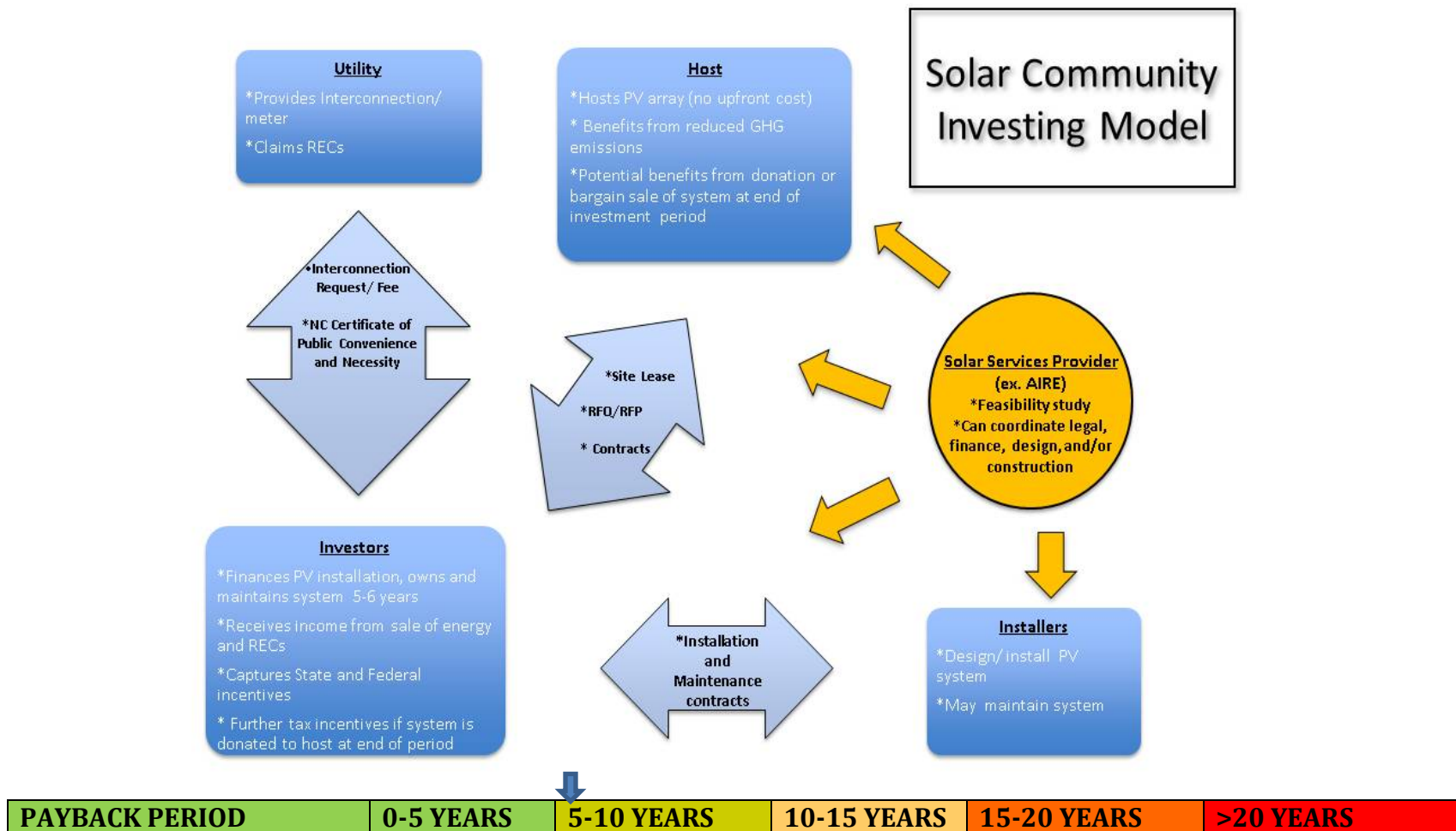
2014/15 BUDGET: ☐

PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS
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*“Community is the secret ingredient of sustainability” –Nick Meima and Abraham Paiss.
Second graphic Courtesy of Appalachian Institute for Renewable Energy: www.aire-nc.org*

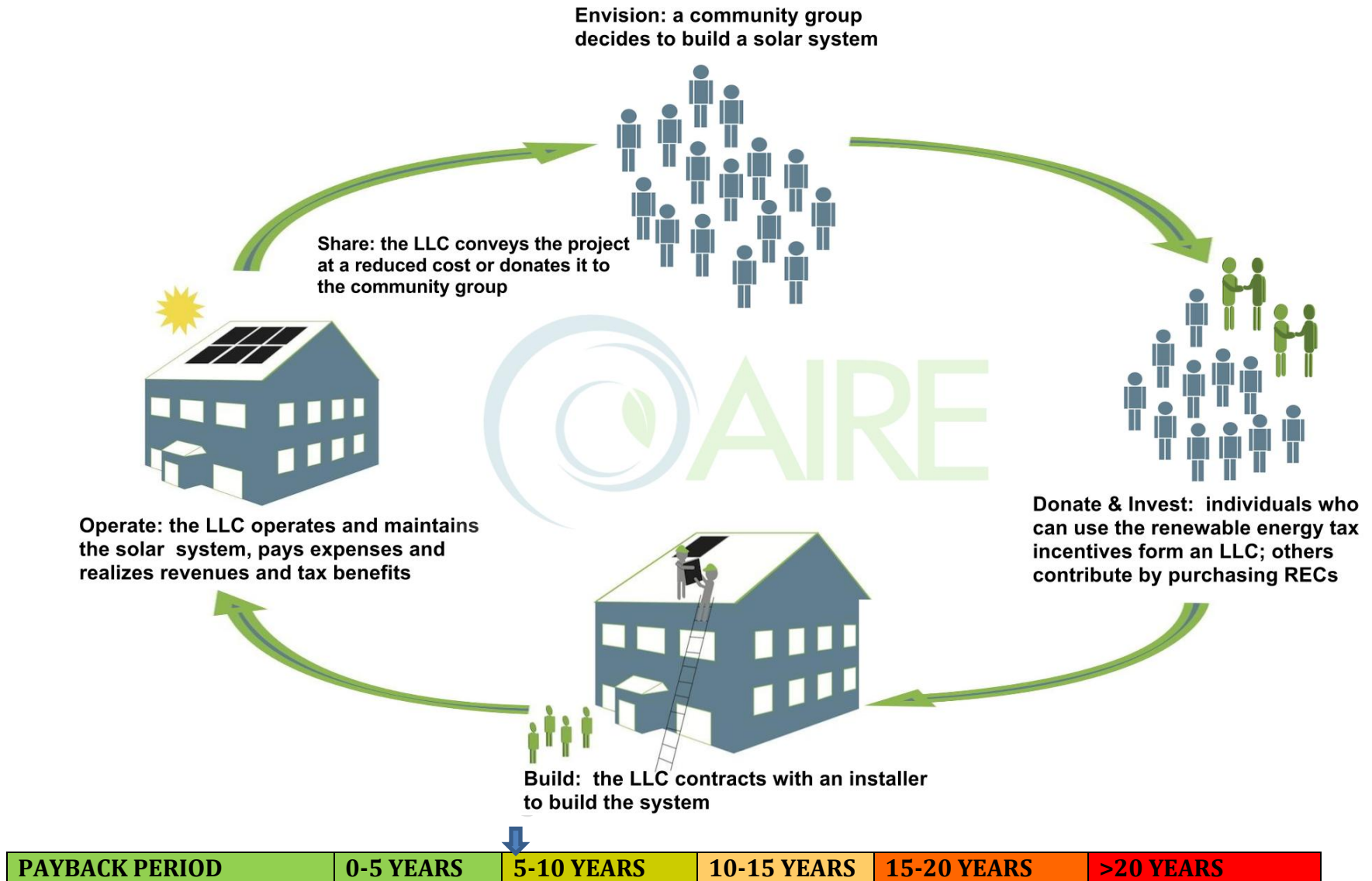
3.C Renewable Portfolio

The Town collaborated with Carrboro Community Solar in 2012 to install a photovoltaic system at the Town Commons (see www.carrborosolar.org/.) General graphics of the community investing model are shown below. More information on this model is available at <http://aire-nc.org/>.



*"Community is the secret ingredient of sustainability" –Nick Meima and Abraham Paiss.
Second graphic Courtesy of Appalachian Institute for Renewable Energy: www.aire-nc.org*

3.C Renewable Portfolio



*"Community is the secret ingredient of sustainability" –Nick Meima and Abraham Paiss.
Second graphic Courtesy of Appalachian Institute for Renewable Energy: www.aire-nc.org*

3.D Urban Forestry Program

DESCRIPTION :

The Town has been pursuing urban forestry efforts for many years. Examples include participation in Tree City USA and Arbor Day, purchase of the Adams Tract and development of a management plan for the property, and development of provisions for tree protection and open space in the Land Use Ordinance, including a potential update to the ordinance currently under review by staff. Further program development is recommended as a part of this plan to provide climate protection and energy benefits, and also recognize the many other benefits of urban trees (see Appendix 3). Examples of initiatives that can be considered included: tree inventories, canopy analysis and resource assessments; development of master tree plans for streets and facilities and the community, and pursuit of actions that would help the Town qualify for a Tree City USA Growth Award and be eligible for the NC Forest Service urban forestry grant program.

BASIS:

There is significant merit and synergy in managing the Carrboro's forest to reduce energy consumption and store carbon, while simultaneously forwarding many community goals. Trees influence thermal comfort and energy use by providing shade and reducing wind speeds. For example, three or more large trees strategically placed on sunny sides of a house reduce the air-conditioning demand as much as 30 percent. One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. The urban forest also provides significant ecological and societal services such as air, water and soil quality improvement, wildlife habitat, enhanced biodiversity, mental, emotional and physical health and well-being, aesthetic value, and economic value. Another urban forestry interest is in planning for forest resilience in consideration of the impacts of climate change.

← payback difficult to determine →

BREAKDOWN

Complete tree inventories, canopy analysis, and resource assessments

Develop public and community master plans

Investigate grant opportunity with NCFS

LEAD DEPARTMENT

Public Works, Planning

INTERNAL COORDINATION

Public Works, Planning

EXTERNAL COORDINATION

North Carolina Forest Service

RESOURCES REQUIRED

TBD

CIP: ☐ CIP YEAR: _____

2014/15 BUDGET: ☐

PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS
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"Imagine if trees gave off WiFi signals. We'd be planting so many trees and would probably save the planet. Too bad they only give off the air we breathe". Viral internet posting of unknown origin

4. Measurement, Inventory, Assessment, and Reporting

DESCRIPTION: Measurement involves monitoring and metering energy use, and is vital in creating “management by fact.” An inventory involves using the measurement data along with calculations and analysis to comprehensively compile estimates of energy use and associated greenhouse gas emissions for different types of uses. Assessment involves the process of studying and placing in context the measurements and inventory information. Reporting involves sharing the results with the community in a way that is meaningful. Software tools such as emissions software, energy dashboards, and scorecards are increasingly being used for these activities. The Town has been involved in annual monitoring of municipal emissions for several years, and has worked with other local jurisdictions and a UNC Capstone team on community emissions estimates. The American Council for an Energy Efficient Economy (ACEEE) has developed a scorecard that allows communities to score their energy efficiency efforts by evaluating locally-enacted programs and policies across local government operations, community-wide initiatives, and building, energy and water, and transportation policies.

BASIS: Milestone 5 of Cities for Climate Protection specifically calls for monitoring. Pursuing these activities is important to create a feedback loop, inform stakeholders, and to create transparency. Based on experience, the payback for an energy dashboard system is typically less than three years due to increased energy awareness and identified energy conservation opportunities. Organizations and business that monitor and report alone have seen energy consumption drop by 5 to 10 percent. The ACEEE Local Energy Efficiency Self-Scoring Tool provides the benefit of presenting options for the Town to consider for future actions, and for comparing efforts with other jurisdictions.

BREAKDOWN

- Identify and obtain best software tools
- Seek and obtain support
- Complete and submit ACEEE scorecard

LEAD DEPARTMENT

Planning

INTERNAL COORDINATION

All workgroups

EXTERNAL COORDINATION

Support from contractors and possibly UNC

RESOURCES REQUIRED

Staff time and budget for contract support

CIP: ☐

CIP YEAR:

2014/15 BUDGET: ☐

← payback specific to action pursued →

PAYBACK PERIOD	0-5 YEARS	5-10 YEARS	10-15 YEARS	15-20 YEARS	>20 YEARS
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5. Climate Change: Vulnerability and Adaptation

The following discussion is excerpted from the recently completed study "Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability (Ingram et al (ed.), Island Press, 2013). It does not specify actions or goals, but is included to provide a context for future consideration of adaptation strategies in Carrboro.

Climate adaptation can be defined as the "adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects". It is a different concept than the primary focus of this plan, climate change mitigation. Climate change mitigation refers to activities that avoid or decrease the release of greenhouse gas (GHG) emissions, or decrease atmospheric GHG concentrations, e.g., carbon storage in forests or soils. Closely related to the concept of adaptation is climate resilience. ICLEI¹ has developed a 5 step resiliency process that is similar to their 5 step process for climate mitigation:

Milestone One: Conduct a Climate Resiliency Study

Milestone Two: Set Preparedness Goals

Milestone Three: Develop a Climate Preparedness Plan

Milestone Four: Publish & Implement Preparedness Plan

Milestone Five: Monitor & Reevaluate Resilience

The process of adaptation can be conceptualized as a series of steps moving from developing an understanding of current and future climate changes related to the system of interest, assessing vulnerabilities and risks, evaluating management options, implementing strategies, monitoring outcomes, and re-evaluating those analyses and decisions (Figure 1). The process generally prescribes multiple iterations to incorporate new information and changing conditions. The emphasis on risk management and identification of opportunities and co-benefits differs among frameworks, but there is good consistency at the conceptual level that this is a critical piece to adaptation.

¹ ICLEI stands for International Council for Local Environmental Initiatives," but in 2003 the organization dropped the full phrase and became "ICLEI-Local Governments for Sustainability"

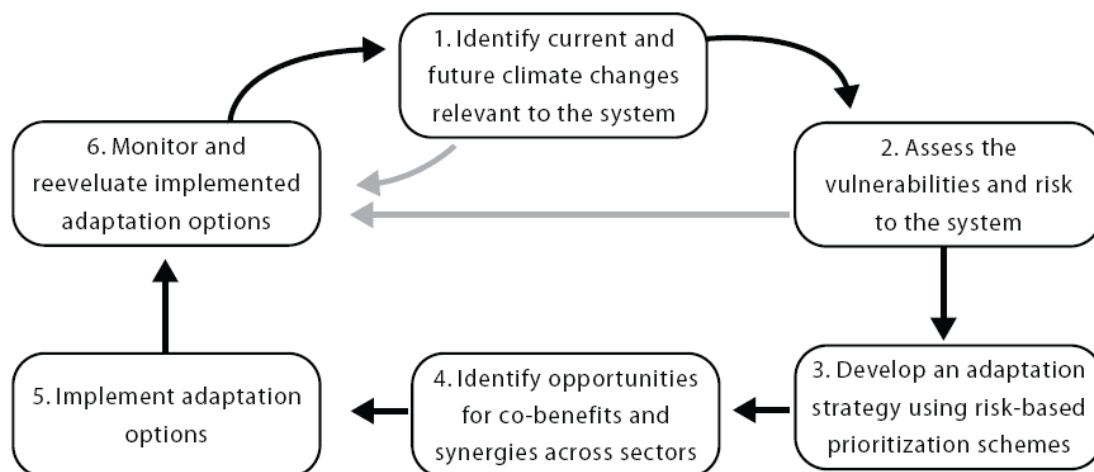


Figure 13.1 Adaptation planning is envisioned as a cyclical, iterative process incorporating these six steps (NRC 2010a).

The adaptation/resilience process is complex and must include partnerships for cross-disciplinary coordinated response from many sectors including financial, technical, governance, and social. In the future, as groups move from risk and vulnerability assessments to strategic adaptation planning and implementation, it is anticipated that there will be a shift in activities and information needs that place more emphasis on costs, benefits, and co-benefits of adaptations. As efforts advance, evaluation of adaptation efforts will become important in decision making.

The remainder of this section includes a high level summary of some of the findings and implications from the southeastern US study, organized by major theme (temperature change; precipitation change; human health; built environment; energy; forests) as a starting point for identifying climate change implications (step 1 in figure above) that will need to be considered in adaptation planning. The discussion includes agricultural interests because of the Carrboro's commitment to supporting farmers.

Temperature Change

Increasing temperatures and the associated increase in frequency, intensity, and duration of extreme heat events will affect public health, natural and built environments, energy, agriculture, and forestry. 2014 National Climate Assessment: Southeast Region

Since the 1970s, temperatures have steadily increased in the southeastern US, with the most recent decade (2001 to 2010) noted as the warmest on record. A portion of this warming may be due to increased nighttime temperatures resulting from human development of the earth's surface. There is better scientific agreement and overall confidence in temperature projections, which indicate an overall increase through the end of the 21st century. Increases in the length of the growing season, the number of cooling degree days, the number of consecutive hot days, and interannual temperature variability are all projected to occur.

Non-native, invasive species will increase due to less frequent and shorter durations of cold temperatures caused by climate change. Increasing summer heat stress will reduce crop productivity,

especially if it occurs during flowering and seed set and if it is combined with drought. Warm temperatures during the winter months reduces fruit set on crops that have a chilling requirement. These adverse impacts can be partly offset through the application of growth regulators, but such methods increase costs of production. Heat stress already limits production of dairy and livestock, especially during summer months. An increased frequency of heat stress events will have the potential to force some dairy and livestock production northward.

Warming air temperatures likely will increase regional drying through increased forest water use via evapotranspiration (ET) regardless of changes in precipitation, and this drying will likely increase wildfire risk across southeast USA forests. Longer growing seasons will likely increase the risk of insect outbreak and very likely will expand the northern range of some species, such as the southern pine beetle.

Precipitation and Runoff

Mean annual precipitation may slightly increase in North Carolina through the first half of the 21st century. The greatest changes are expected during the summer months. However, water availability in central North Carolina is not expected to increase, as evapotranspiration will also increase. Interannual precipitation variability has increased across the southeast region, with more exceptionally wet and dry summers compared to the middle of the 20th century.

Flood frequency likely will increase as a result of predicted increased numbers and intensity of storms. Floods cause direct damage to crops, especially if they occur during fruit set or near crop maturity, as well as indirect damage through soil erosion, leaching of nutrients, and loss of future productivity. More frequent droughts coupled with increasing water demands from greater evapotranspiration (ET) and growing human consumption may result in more frequent stream drying, even in systems historically considered perennial.

Under most scenarios and locations in the southeast, the net effect of temperature and precipitation changes will result in a greater uptake of soil water by forests and lead to reductions in streamflow. Future climate warming likely will increase water loss through evapotranspiration (ET) due to increased evaporative potential and plant species shift. Greater ET can decrease total streamflow, groundwater recharge, flow rate, and regional water supplies.

Regionally, water supply stress is projected to increase significantly by 2050 due to hydrologic alteration caused by climate change and increased water use by key economic sectors, such as domestic water supply, irrigation agriculture, and power plants. Water supply stress will become most severe in the summer season when normal rainfall is typically not sufficient to meet evaporative demand of the atmosphere. Declining runoff and increasing demands for water resources are likely to increase the pressure on the existing reservoirs, leading to deeper and longer lasting drawdowns. Runoff and soil erosion potential are projected to increase in some areas due to changes in rainfall that either increase rainfall erosivity or decrease vegetative cover protection.

Human Health

Climate change is expected to have a broad impact on human health. Major categories for human health consideration in central North Carolina include: extreme weather events (e.g., more extreme heat events); air quality and respiratory/airway diseases; vector-borne and zoonotic disease; water

quality and quantity; and healthcare disruption. Health impacts in other areas, such as mental health and food security may also occur, but more research is needed to determine the potential effects.

Rising air temperatures will worsen heat waves and increase levels of harmful pollutants such as ozone. Shifts in precipitation are expected to lead to more extreme precipitation events that can cause direct injury and other related health effects. Vector-borne disease like dengue and malaria could be affected by rising temperatures and shifting precipitation patterns.

Built Environment

Development of adaptation plans to maintain built environment infrastructure are imperative to cope with the effects of climate change and to ensure built environment sustainability. Because of the complexity of the built environment and its supporting ecosystems, we must operate at a component-by-component level to assess various types of adaptability measures needed to make the individual systems sustainable and resilient. Good stewardship of the resources that comprise the subcomponents of systems related to the built environment, as well as climate change adaptation planning, are primary requirements of success in dealing with these challenges. Both “grey” and “green” infrastructure should be considered. Areas of the built environment likely to be affected by climate change (and not described under other headings) include: the urban heat island effect; the urban wildland interface; tourism; poverty and socio-economic vulnerability; migration, and security.

Energy Sector

As the climate changes, concerns exist for energy services due to the potential for changing patterns of demand, such as increased demand for air conditioning, as well as the potential impacts on electricity generating capacity and energy distribution infrastructure. Improvements in both energy efficiency and renewable energy generation provide a large potential for a more resilient energy sector.

Forests

Despite climate and land use changes, forests in the southeastern USA will likely continue to provide a sink of atmospheric carbon dioxide (CO₂). There is potential for mitigating CO₂ emissions through carbon sequestration in soils and plant biomass. Protection of these natural carbon sinks in the face of development pressures is an important issue for climate change mitigation. The potential savannafication of the southeast, in which forests are converted into more open woodlands due to a combination of hotter and drier conditions, is one of the most significant potential climate change impacts in the USA.

References

Ingram, K., K. Dow, L. Carter, J. Anderson (eds). Climate of the Southeast United States: Variability, Change, Impacts, and Vulnerability. Washington, D.C. Island Press, 2013.

NRC (National Research Council), 2010. Adapting to the Impacts of Climate Change. Washington, D.C. National Academies Press,

Glossary and Acronyms

ASHRAE: The American Society of Heating, Refrigerating and Air-Conditioning Engineers, founded in 1894, is a global society advancing human well-being through energy efficiency, indoor air quality, refrigeration and sustainability within the industry. <https://www.ashrae.org/about-ashrae/>

Capstone: “Capstone” refers to the Capstone Research Projects of the UNC Institute for the Environment. These projects bring together the education, research and outreach/service missions of the Institute. They are conducted by teams of undergraduate students. Topics for the projects are selected from recommendations by Community Advisory Boards and other clients and focus on a significant environmental issue requiring broad, interdisciplinary research. The projects are a learning experience for our students, a chance for them to conduct team-based research typical of professional practice and the Institute's way of using the expertise of Carolina to help find solutions to the issues facing communities. http://www.ie.unc.edu/for_students/courses/capstone.cfm

Energy Efficiency Revolving Loan Fund: In the fall of 2010, Carrboro combined federal and local funding to seed a new small business loan fund aimed at improving building energy efficiency. These funds are being administered in a similar model as Carrboro’s existing Small Business Revolving Loan Fund. The goals of these loans include reduced energy consumption (15-20%) and reduced energy bills for local businesses. Funds are available to all for- and non-profit businesses in Carrboro town limits with 50 employees or fewer. Applications are first-come first-served and loans are subject to availability. <http://www.townofcarrboro.org/ECD/PDFs/EERLF/EERLFCarrboroDescriptionandCriteria.pdf>

Energy Star: ENERGY STAR is a U.S. Environmental Protection Agency (EPA) voluntary program that helps businesses and individuals save money and protect our climate through superior energy efficiency. The ENERGY STAR program was established by EPA in 1992, and is "a basic engineering research and technology program to develop, evaluate, and demonstrate non-regulatory strategies and technologies for reducing air pollution." In 2005, Congress updated the program "establish at the Department of Energy and the Environmental Protection Agency a voluntary program to identify and promote energy-efficient products and buildings in order to reduce energy consumption, improve energy security, and reduce pollution through voluntary labeling of or other forms of communication about products and buildings that meet the highest energy efficiency standards."

ESCO: An energy service company or energy savings company (acronym: ESCO or ESCo) is a commercial or non-profit business providing a broad range of energy solutions including designs and implementation of energy savings projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation and energy supply, and risk management *(from Wikipedia)*.

GHG emissions: A greenhouse gas (sometimes abbreviated GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. This process is the fundamental

cause of the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Greenhouse gases greatly affect the temperature of the Earth; without them, Earth's surface would average about 33 °C colder. Emissions refer to the process and quantity of gas being released into the atmosphere from various sources.

HPwES: The Home Performance with Energy Star is a national program that has supported over 330,000 homeowners with whole house improvements that improve comfort and indoor air quality while reducing energy bills. http://www.energystar.gov/index.cfm?fuseaction=hpwes_profiles.showsplash

ICLEI: An organization “International Council for Local Environmental Initiatives,” but in 2003 the organization dropped the full phrase and became “ICLEI-Local Governments for Sustainability”. <http://www.iclei.org>

LED lights: LED lighting products use light emitting diodes to produce light very efficiently. An electrical current passed through semiconductor material illuminates the tiny light sources called LEDs. The heat produced is absorbed into a heat sink. LEDs are now being incorporated into bulbs and fixtures for general lighting applications. LEDs are small and provide unique design opportunities.

Portfolio Manager: EPA created ENERGY STAR Portfolio Manager®, an online tool you can use to measure and track energy and water consumption and greenhouse gas emissions based on the premise that you can’t manage what you don’t measure. It is used to benchmark the performance of one building or a whole portfolio of buildings, all in a secure online environment. <http://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager>

Retro-commissioning: When most existing buildings were built, energy efficiency was not a major concern. The result is a building using more energy to accomplish less. Even if it was fully commissioned when built, the building may not be operating at peak efficiency today. A comprehensive testing of building systems with the goal of improving quality — retrocommissioning — allows building deficiencies to be identified and corrected for optimum energy use. Retrocommissioning is a systematic process to improve an existing building’s performance that will increase occupant comfort and save energy. The process can be performed alone or with a retrofit project. Typical energy savings are between 5 percent and 20 percent, often with paybacks of less than one year. Retrocommissioning consists of four phases. In the planning phase, the building systems to be analyzed are identified. The next phase determines how those systems are supposed to operate, and a prioritized list of operating deficiencies is prepared. During the implementation phase, the highest priority deficiencies are corrected and proper operation is verified. In the hand-off phase, improvements are reported and facilities executives are shown how to sustain proper operation.

Transportation Demand Management (TDM): Transportation demand management is the application of strategies and policies to reduce travel demand (specifically that of single-occupancy private vehicles), or to redistribute this demand in space or in time. In transport as in any network, managing demand can be a cost-effective alternative to increasing capacity. A

demand management approach to transport also has the potential to deliver better environmental outcomes, improved public health, stronger communities, and more prosperous and livable cities. <http://mobilitylab.org/2013/09/18/tdm-is-not-scary-a-101-on-transportation-demand-management/>

Solarize Carrboro: Solarize Carrboro is a collaboration between NextClimate (a Carrboro-based non-profit), the Town of Carrboro, and the NC Solar Center that makes solar simple and affordable. The solar installer partners are Southern Energy Management and Yes! Solar Solutions.

WISE Program: The Town of Carrboro conducted a Town-wide energy efficiency program for small commercial business owners and homeowners from 2010-2013 with federal stimulus funding. The program was a collaboration between the Carrboro, Chapel Hill, the Southeastern Energy Efficiency Alliance, Clean Energy Solutions (CESI), Clean Energy Durham, and a network of prequalified contractors.

Appendix I

Summary of Carrboro's Greenhouse Gas Emissions Inventories and Status for Cities for Climate Protection Five Milestones

A common theme discussed in this Plan and principle impetus for pursuing the Plan is the reduction of greenhouse gas (GHG) emissions. The baseline of GHG conditions below establishes a foundation for Planning. As discussed in Appendix 4, climate change has multiple and far-reaching environmental, economic, and social effects. In order to begin to mitigate the effects of global warming, Carrboro is emphasizing the importance of understanding its GHG emissions profile. Table 1 summarizes the date and focus of previous inventories.

Table 1. Summary of Previous Greenhouse Gas Inventories

<u>Inventory Date</u>	<u>Inventory Focus</u>	<u>Completed By</u>	<u>Link</u>
2005	All emissions in county	ICLEI and local governments	http://www.co.orange.nc.us/ercd/greenhousegas.asp
2009	Carrboro municipal and community	UNC Capstone Team	April 19, 2011 Board of Aldermen agenda item at http://www.townofcarrboro.org/BoA/Agendas/2011/04_19_2011.htm
2011	Carrboro municipal	Chris Lazinski	April 3, 2012 Board of Aldermen agenda item at http://www.townofcarrboro.org/BoA/Agendas/2012/04_03_2012.htm
2012	Carrboro municipal	Chris Lazinski	June 18, 2013 Board of Aldermen agenda item at http://carrboro.legistar.com/Calendar.aspx

A baseline greenhouse gas emissions inventory provides a starting point for planning for emissions reductions, and is considered to be one of the 5 milestones of the CCP 5 Milestone process (Table 2).

Table 2. Cities for Climate Protection Five Milestone Process

Milestone	Description	Notes
1	Conduct a baseline emissions inventory and forecast.	See above
2	Adopt an emissions reduction target.	The Orange County inventory presented several scenarios for reduction targets. The Board of Aldermen adopted a climate protection resolution in 2009. Further articulation of the resolution using a 2%-7% annual reduction goal is currently being reviewed.
3	Develop a Local Action Plan	The Orange County inventory and above agenda items presented preliminary concepts for inclusion in a Local Action Plan.
4	Implement policies and measures	As described in plan.
5	Monitor and verify results	The Town has been involved in annual monitoring of municipal emissions for the past two years, and worked with a UNC Capstone team on emissions estimates in 2011.

Standard greenhouse gas (GHG) reporting classifies emission types into three types or “scopes”. Scope 1 emissions are direct emissions resulting from the combustion of fuel on-site. Examples of Scope 1 emissions include vehicular tailpipe emissions from vehicles and emissions from burning natural gas to heat buildings. Scope 2 emissions are indirect emissions associated with the consumption of purchased or acquired energy. Scope 2 emissions primarily result from electricity consumption. Scope 3 emissions are other indirect emissions not covered in Scope 2, such as the extraction and production of purchased materials and fuels, electricity-related activities such as transmission and distribution losses, outsourced activities, and waste disposal.

UNC Capstone Team Inventory (2011)

The UNC Capstone team inventory summary is shown in Table 4.

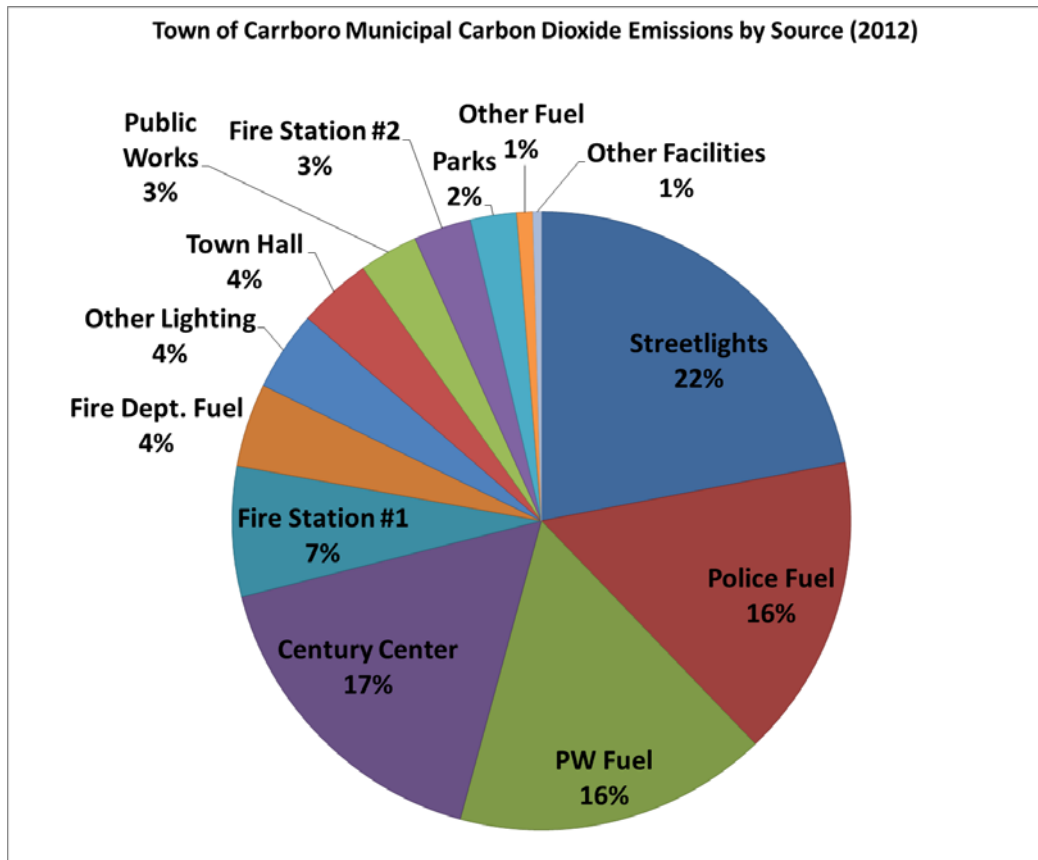
Municipal Inventory (2012, 2013 Update)

One conclusion from the Town’s municipal inventory is that the Town total emissions of roughly 2k metric tons of carbon dioxide equivalents (MTCDE), is a little less than 2% of the 115k total community inventory, including all community and public sources (Figure 1).

TABLE 4: UNC Capstone Inventory	Scope 1 GHGs (MTCDE)	Scope 2 GHGs (MTCDE)	Scope 3 GHGs (MTCDE)	Row Total (MTCDE)
<u>Town of Carrboro Municipal Sources</u> (excludes school and OWASA sources)				
Buildings and Facilities	100	484	-	584
Streetlights, Floodlights and Traffic Signals	-	467	-	467
Vehicle Fleet	676	-	-	676
OCSW	-	-	55	55
Public Transit* (Chapel Hill Transit)	-	-	960	960
<i>Municipal Subtotals (excluding Scope 3)</i>	776	951	-	1,727
<i>Municipal Subtotals (including Scope 3)</i>	776	951	1015	2,742
<u>Town of Carrboro Public Sources</u> (includes municipal, school, OCSW and OWASA sources)				
Schools (within municipal limits)	1,292	4,651	-	5,943
OWASA	-	-	2,030	2,030
<i>Public Subtotals (excluding Scope 3)</i>	2,068	5,602	-	7,670
<i>Public Subtotals (including Scope 3)</i>	2,068	5,602	3,045	10,715
<u>Town of Carrboro Community Sources</u> (excludes public sources)				
<i>Residential</i>	8,430	44,691	-	53,121
<i>Commercial</i>	1,782	16,687	-	18,469
<i>Industrial</i>	15	39	-	55 (due to rounding)
<i>Transportation (within municipal limits)</i>	31,576	-	-	31,576
<i>OCSW</i>	-	-	1,678	1,678
<i>Community Subtotals (excluding Scope 3)</i>	41,803	61,417	-	103,220
<i>Community Subtotals (including Scope 3)</i>	41,803	61,417	1,678	104,899 (due to rounding)
<u>Town of Carrboro Sources</u> (includes community and public sources)				
<i>Town total (excluding schools, excluding Scope 3)</i>	42,579	62,368	-	104,946
<i>Town total (including schools, excluding Scope 3)</i>	43,871	67,019	-	110,889
<i>Town total (including schools, including Scope 3)</i>	43,871	67,019	4,723	115,614 (due to rounding)

* For this table, Chapel Hill Transit buses GHG emissions are considered as Scope 3 relative to Carrboro because the Town of Chapel Hill administers the service.

Figure 1¹



POLICY AND IMPLEMENTATION RECOMMENDATIONS FROM INVENTORIES

The community and organizations the Town partners with are encouraged to refer to these inventories for additional recommendations, with examples provided below.

From the Orange County Inventory:

- ∞ Explore further retrofits on all municipal buildings;
- ∞ Evaluate fleet for improvements to fuel efficiency and the use of alternative fuels;
- ∞ Further advance green purchasing policies;
- ∞ Study the viability of alternative vehicles (e.g., hybrids) for their fleets; and
- ∞ Solar panels (alternative energy source) installed on all LED traffic signals or flashers to power them.

¹ Inventory update completed by Chris Lazinski, first as a UNC DELTA Fellow and then under contract. Emissions are shown for 2012. For future calculations, staff intend to use a 3-year average as a baseline.

Recommendations for ways in which the various communities can reduce emissions in the community sector include:

- ∞ Further partnership development between the jurisdictions and the local utilities;
- ∞ Work with state and federal programs that could be implemented within the jurisdictions;
- ∞ Reduce single occupancy vehicle (SOV) trips throughout the jurisdictions through transportation demand management (TDM) initiatives, and promotion of non-motorized transportation planning principals; and
- ∞ Further partnership development with community groups and local businesses.

From the UNC Capstone Inventory:

All traditional incandescent light bulbs should be replaced with compact fluorescent light bulbs (CFLs) or Light-Emitting Diodes (LED)s.

Purchase Energy Star appliances when replacing outdated equipment, and they should be promoted to the residential and commercial sectors of Carrboro

Setpoints: Room temperature should be adjusted seasonally; UNC Energy Management policy, for example, recommends setting summer indoor temperatures to 76-78°F and winter indoor temperatures to 69-71°F

Set up an energy resource center of its own, perhaps in the form of an Energy Efficiency Exhibit at the Century Center

Encourage energy conservation in its municipal buildings by holding a competition between occupants of different town buildings for the greatest percent reduction in energy intensity.

From the municipal inventory (Lazinski):

It is recommended that Carrboro explore the feasibility and fiscal impact of implementing a GHG reduction policy that sets an annual reduction goal of 2% of 2007 levels per year annually through at least 2025. An annual percent reduction strategy is recommended because it provides the most easily measurable goal for the Town to pursue. Implicit in future efforts would be exploration of the best financing mechanisms for pursuing efforts, whether it is through performance contracting, an internal revolving fund or “energy bank”, community investing in renewable energy, or other ways to finance projects through energy savings, as well as possibly through debt servicing such as Qualified Energy Conservation Bonds.

Appendix II: Summary of Recommended Energy Improvements for Municipal Buildings, 2010
Study (Big Woods Engineering)¹

<u>Building/Improvement</u>	<u>Upfront Cost</u>	<u>Annual Energy Savings</u>	<u>Annual Cost Savings</u>
Town Hall: 1) Lighting retrofit: T12 to T8 fixtures/lamps (50% delamping); Incandescent to CFL; Exit signs to LED 2) Heat pump replacement : 4 units (2,3,4,5 ton), 6 SEER to 16 SEER	\$30k	44,865 kWh	\$4030
Fire Station #1: 1)Lighting retrofit: T12 to T8 fixtures/lamps (50% delamping); 2) Heat pump replacement : 4 units (3 ton), 8 SEER to 16 SEER	\$23k	19,700 kWh	\$1170
Public Works: 1) Lighting retrofit: T12 to T8 fixtures/lamps (50% delamping)	\$8k	10,270 kWh	\$822
Century Center: Lighting Controls: new switches and sensors for corridors, meeting rooms, and offices- substantial wiring work required and engineer stamp. 60 fixtures are currently uncontrolled and on 24/7. Remaining fixtures to be controlled would benefit from sensors in meeting rooms, offices, and other rooms. <i>(Note that heating/cooling system beyond scope of Big Woods study)</i>	\$15k	38,000 kWh	\$2300

¹ Public Works staff estimate that T12 to T8 replacements are 40% complete.

The costs and energy savings have not been adjusted for inflation or other factors from 2010. More efficient (19 to 20 SEER rated), and more expensive, heat pumps are now available. The cost of a four ton 20 SEER unit currently averages about \$6,500 to \$7500.

Appendix III: Urban Forestry, Climate Protection, and Ecological and Community Benefits

The following discussion demonstrates why Carrboro's urban forest has a wide variety of benefits that include but are not just limited to climate protection and energy management.¹ Therefore, there is significant merit and synergy in managing the forest to reduce energy consumption and store carbon, while simultaneously forwarding many community goals.

Nationally, urban forests in the United States are estimated to contain about 3.8 billion trees, with an estimated structural asset value of \$2.4 trillion. This dollar value reflects only a portion of the total worth of an urban forest. Urban trees also provide innumerable ecosystem services that affect both the local physical environment (such as air and water quality) and the social environment (such as individual and community well-being) that contribute to urban quality of life.

Urban forest services and benefits include:

Local climate and energy use—Trees influence thermal comfort and energy use by providing shade and reducing wind speeds. The establishment of 100 million mature trees around residences in the United States has been estimated to save about \$2 billion annually in reduced energy costs. For example, three or more large trees strategically placed on sunny sides of a house shade it from the hot summer sun, thus reducing the air-conditioning cost as much as 30 percent.

Carbon storage—urban trees mitigate climate change by directly storing carbon within their tissues and by reducing carbon emissions from power plants through lowered building energy use. Urban trees in the conterminous United States have been estimated to store 770 million tons of carbon, valued at \$14.3 billion. One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen. This is enough to meet the annual needs of 18 people.

Air quality—Trees improve air quality by lowering air temperatures and removing air pollutants and in doing so, reducing the impacts of emissions from both stationary and mobile sources. Urban trees in the conterminous United States have been estimated to remove some 784,000 tons of air pollution annually, with a value of \$3.8 billion.

Water flow and quality—Trees improve water quality, reduce runoff and erosion, and mitigate the need for costly stormwater treatment by intercepting and retaining or slowing the flow of precipitation reaching the ground. This allows more recharging of the ground water supply. During an intense storm in Dayton, OH, for example, the tree canopy was estimated to reduce potential runoff by 7 percent. In Carrboro, increased tree canopy could have a specific regulatory benefit of helping the Town comply with rules to protect Jordan Lake by reducing nitrogen and phosphorus in runoff.

Wildlife and biodiversity—Urban forests help create and enhance animal and plant habitats.

¹ Most of information in this section extracted from Nowak, D. et al., "Sustaining America's Urban Trees and Forests". USDA Forest Service, Northern Research Station. State and Private Forestry General Technical Report NRS-62. June 2010.

Soil quality—Trees and other plants help improve soil quality by breaking up heavy soils, mining nutrients, and remediating soils at contaminated sites by absorbing, transforming, and containing a number of contaminants.

Community well-being—Urban forests make important contributions to the economic vitality and character of a city, neighborhood, or subdivision. Community involvement in urban forestry efforts has been demonstrated to contribute to a stronger sense of community and neighborhood empowerment.

Individual well-being and public health—The presence of urban trees and forests creates a more aesthetic, pleasant, and emotionally satisfying place in which to live, work, and spend leisure time. Urban trees also provide numerous health benefits. For example, tree shade reduces ultraviolet radiation and its associated health problems. Hospital patients with window views of trees have been shown to recover faster and with fewer complications than patients without such views. The reduction in airborne pollutants results in significant human health benefit such as reduced rates of respiratory disease and illness. In laboratory research, visual exposure to settings with trees has produced significant recovery from stress within five minutes, as indicated by changes in blood pressure and muscle tension.²

Aesthetics—trees are not only beautiful in themselves but add beauty to their surroundings. Trees add color to the urban scene, soften the harsh lines of buildings, screen unsightly views, and provide privacy and a sense of solitude and security, while contributing to the general character and sense of place in communities. The specimen trees in downtown Carrboro are a great example of this benefit.

Noise abatement—properly designed plantings of trees and shrubs can significantly reduce noise. Wide plantings (around 100 ft.) of tall dense trees combined with soft ground surfaces can reduce apparent loudness by 50 percent or more (6 to 10 decibels).

Real estate and business—landscaping with trees can increase property values and commercial benefits. One study found that on average, prices for goods purchased in Seattle were 11% higher in landscaped areas than in areas with no trees. A mature tree can often have an appraised value of between \$1,000 and \$10,000³. Landscaping, especially with trees, can increase property values as much as 20 percent.⁴

A well-recognized national nonprofit, American Forests, recommends that communities set and maintain tree canopy goals. A community can design tree cover targets that fit the policy and environmental quality needs of the community. Chapel Hill updated its tree protection ordinance, and in doing so, established minimum tree canopy standards.⁵ As another local example, Raleigh recognizes the community benefits of the urban forest by treating it as a local government capital responsibility. The City not only maintains an active urban forestry program⁶, but also includes significant funds for tree replacement in their capital budget. Town staff are considering using i-Tree, a state-of-the-art, peer-reviewed software suite from the USDA Forest Service, as a tool to support urban forestry efforts. The i-Tree tools help communities strengthen their urban forest management and advocacy efforts by quantifying the environmental services that trees provide and the structure of the urban forest. More information is available at <http://www.itreetools.org/index.php>.

² Dr. Roger S. Ulrich Texas A&M University, as reported by City of Raleigh

³ Council of Tree and Landscape Appraisers, as reported by City of Raleigh

⁴ ICMA, as reported by City of Raleigh

⁵ <http://www.townofchapelhill.org/index.aspx?page=879> (December, 2010)

⁶ <http://www.raleighnc.gov/neighbors/content/PRecParks/Articles/UFDivision.html>

Appendix IV: Summary of Science On Climate Change

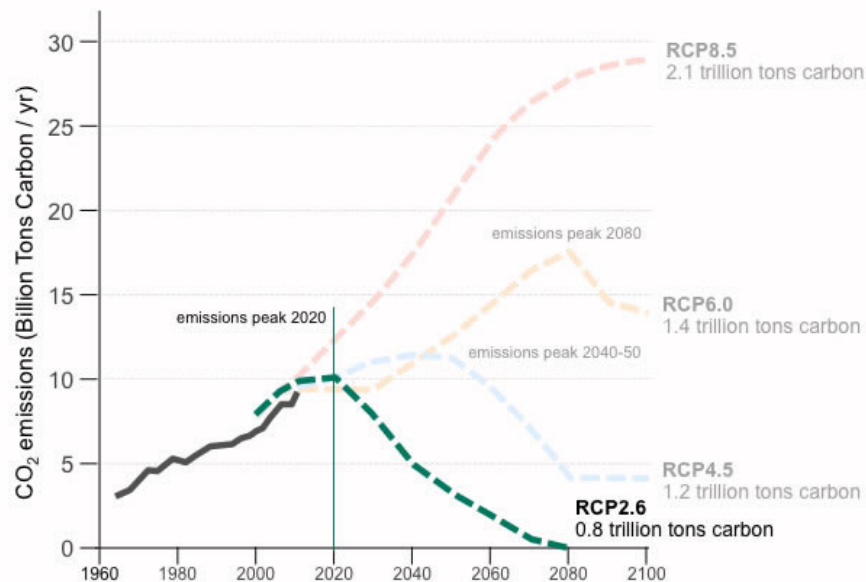
Table 1 summarizes some of the important indicators of the global impacts of climate change.

Air Temperature	Extreme Weather Events
The decade from 2000 to 2010 was the warmest on record ¹ ; 2005 and 2010 tied for the hottest years on record ² ; January through September 2012 were the warmest first nine months of any year on record for the contiguous U.S. ³	Extreme weather events, most notably heat waves and precipitation extremes, are striking with increased frequency ⁸ , with deadly consequences for people and wildlife
Public Health	Recent years have seen central North Carolina experiencing drops of 5 to 15 percent of annual rainfall. Availability of fresh water for drinking and other uses in much of North Carolina will also trend downward in the next 50 years, perhaps by 2.5 percent ¹³ .
The Environmental Protection Agency determined that current and future greenhouse gas concentrations endanger public health ⁶	In the US in 2011, a record 14 weather disasters (droughts, heat waves, and floods) occurred that cost at least \$1 billion each in damages/loss of human lives ⁹
According to the Global Humanitarian Forum, climate change is already responsible every year for some 300,000 deaths, with 325 million people seriously affected ⁷	Climate change creates conditions that lead to more destructive storms like 2012's Superstorm Sandy ¹⁰ , by loading storms with more energy and more rainfall ¹¹ , raising sea levels and causing storm surge to ride on a higher sea surface so that more coastline floods ¹² , and warming the Arctic and melting sea ice, which causes changes in the jet stream that are bringing more extreme weather to the U.S. ¹³
Economic Impacts	Sea Level Rise
According to the Global Humanitarian Forum climate change is already responsible every year economic losses worldwide of U.S. \$125 billion ⁷	The world's land-based ice is rapidly melting, threatening water supplies in many regions and raising sea levels ¹⁹ , and Arctic summer sea ice extent has decreased to about half what it was several decades ago ²⁰ , and reached a record low in 2012 ²¹ , with an accompanying drastic reduction in sea-ice thickness and volume ²² , which is severely jeopardizing ice-dependent animals ²³
Climate change is affecting food security by reducing the growth and yields of important crops ¹⁴ ; droughts, floods and changes in snowpack are altering water supplies ¹⁵ ; as of October 2, 2012, 64.6 percent of the contiguous U.S. was experiencing moderate-to-exceptional drought ¹⁶ ; and in 2012, the USDA designated more than half (50.3 percent) of all U.S. counties disaster areas, mainly due to drought ¹⁷	Global sea level is rising 60% faster than projected by the Intergovernmental Panel on Climate Change ²⁴ ; the U.S. East Coast is a hotspot for sea level rise with rates three to four times faster than the global average ²⁵ ; sea level rise is accelerating in pace ²⁶ ; and sea level could rise by one to two meters in this century, threatening millions of Americans with severe flooding ²⁷
Biodiversity	
Scientists have concluded that by 2100 as many as one in 10 species may be on the verge of extinction due to climate change ¹⁸	The current level of CO ₂ in the atmosphere is approximately 392 parts per million ⁴ (ppm). One of the world's leading climate scientists, Dr. James Hansen, stated in 2008: "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted....CO ₂ will need to be reduced to at most 350 ppm" ⁵

The International Panel on Climate Change (IPCC) Fifth Assessment Report confirms the necessity for immediate and sustained action. The IPCC report reveals how close we are to a turning point in the earth's climate system, and reveals two critical numbers that speak to the urgency of the situation:

- One trillion tons – a maximum global carbon budget of one trillion tons burned is necessary to keep global warming under two degrees Celsius above preindustrial levels; and
- 2020 – the year global CO₂ emissions must peak in order to burn less than one trillion tons of carbon (the world has already burned more than half of that to date).

The underlying conclusion of the report is that the time has arrived for taking the necessary steps to preserve livable conditions on earth: i.e., we must stop burning fossil fuels as quickly as possible. Only by peaking GHG emissions in the year 2020 or sooner, and phasing out conventional fossil fuel burning around 2080, can we stay beneath the total of one trillion tons of carbon burned, which represents the threshold of catastrophic climate change, as shown in the following graphs:



Pathways for Fossil Fuel CO₂ Emissions to 2100

Source: Architecture 2030: Adapted from the IPCC Fifth Assessment Report, 2013.



A GHG emissions peak by about 2020 (RCP 2.6) will be necessary to keep global warming under the two degrees Celsius (above preindustrial levels) threshold. If we exceed the world carbon budget of one trillion tons burned (RCP 4.5, 6.0 and 8.5), the models project the planet will keep warming and it will be virtually impossible to bring global average temperature back under the two degrees Celsius threshold.

The good news is U.S. GHG emissions peaked in 2007 and are currently 12% below 2007 levels. We must continue this trend in America. The bad news is, global GHG emissions are continuing to rise. The major driver of global energy consumption and GHG emissions over the next two decades is projected to be increasing urbanization. During this period, an area equal to a staggering 3.5 times the entire built environment of the U.S. will be redesigned, reshaped, and rebuilt in urban areas worldwide.

There is consensus among climate scientists that the increase of GHG emissions are caused by human activities such as the burning of fossil fuels, change in land use, and increased agriculture production. According to the International Panel on Climate Change (IPCC), concentrations of GHGs in the atmosphere have been on the rise since the industrial age. Currently, the concentration of carbon dioxide (CO₂) is over 390 ppm, which far exceeds pre-industrial levels and those seen in the past 650,000 years (as determined through the analysis of ice core data). According to the IPCC, the concentration of CO₂ in the atmosphere will need to plateau at 450 ppm in order to stabilize emissions and the effects of climate change. Because CO₂ stays in the atmosphere for approximately 50 years, we are committed to a level of climate change from emissions already released, regardless of reductions made today.

There are six GHGs as identified by the IPCC: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF₆). Each of these gases contributes to the greenhouse effect by trapping heat in the atmosphere and causing the global temperature to increase. The effects of climate change are already being seen throughout the world: global circulation models around the world indicate with high confidence that increased global temperature have led to a decrease in mountain glaciers and snow cover affecting water sources, increased global ocean temperatures, and melting of ice sheets. Both of the latter lead to a rise in sea levels, and in addition, an increase in ocean temperature may lead to greater storm intensity. The U.S. Environmental Protection Agency (EPA) projects that the effects of climate change on the state of North Carolina could include increased temperatures in all seasons, leading to more heat-related death and disease and affecting water quality and supply, increased precipitation resulting in flash flood events in the mountains and subsequent soil erosion, and the loss of species that have adapted to the state's historical climate.

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Appendix V:

Background on Global and National Efforts to Address Climate Change

In 1993, one year after the Rio Earth Summit, the International Council for Local Environmental Initiatives (ICLEI) launched the Cities for Climate Protection Campaign to support local governments in greenhouse gas emissions monitoring and reduction. This program is the most widely-used method to date that local governments have adopted to address global warming. Cities for Climate Protection leads participants through a five-milestone framework (see *Box 1*) to reduce emissions through policies and practices that conserve energy and develop renewable energy sources. Local governments worldwide are participating in this campaign, including hundreds of municipalities in the U.S.

On February 16, 2005 the Kyoto Protocol went into effect for the 141 countries that ratified it, which notably did not include the United States and Australia. Since then, four significant efforts have been launched to promote and support local government action on climate change:

Mayors Climate Protection Agreement. On the same day that the Kyoto Protocol went into effect, Seattle Mayor Greg Nickels issued a challenge for U.S. mayors to agree to "meet or beat" the greenhouse gas reduction goals of the Protocol in their own cities. This challenge was formalized as the U.S. Mayors Climate Protection Agreement (see *Box 2*) and passed unanimously by the U.S. Conference of Mayors in June 2005.

World Mayors and Municipal Leaders Declaration on Climate Change. At the December 2005 United Nations Climate Change Conference (which included the eleventh meeting of nations party to the UNFCCC and the first meeting of those party to the Kyoto Protocol) the parallel Fourth Municipal Leaders' Summit on Climate Change adopted the World Mayors and Municipal Leaders Declaration on Climate Change. The Declaration endorsed emissions reduction targets of 30 % by 2020 and 80% by 2050 for developed countries, and asserted the need for local governments to have a greater role in UNFCCC efforts.

Clinton Climate Initiative. In August 2006, the William J. Clinton Foundation launched a partnership with the Large Cities Climate Leadership Group by establishing the Clinton Climate Initiative. The Initiative is organizing an international purchasing consortium of the world's largest cities to bring down the cost of energy-efficient products and to accelerate development of emissions-reducing technologies. Although formal membership in the program is restricted to the world's 40 largest cities, smaller cities can receive some benefit by joining as affiliates.

Cool Counties Climate Stabilization Declaration On 16 July 2007, twelve large U.S. counties and the Sierra Club launched the Cool Counties Climate Stabilization Declaration, in which signatories pledge to reduce global warming emissions 80 percent by 2050. The Declaration also calls for vehicle fuel economy standards to be raised to 35 miles per gallon within a decade.

The U.S. Conference of Mayors, ICLEI, the City of Seattle and the Sundance Institute have partnered to make global warming information and mitigation resources-including handbooks and best practices

reports-available at a single online portal, www.coolmayors.com. The U.S. and Canadian affiliates of the international Climate Action Network include organizations that are working on global warming at the local, state/provincial, regional and national levels. Other efforts are underway at state and regional levels, such as the development of carbon "cap-and-trade" systems, renewable portfolio standards, emissions targets and climate action plans

Box 1: Cities for Climate Protection

Local governments join the Cities for Climate Protection (CCP) campaign by passing a resolution pledging to reduce greenhouse gas emissions from their local government operations and throughout their communities. To help cities achieve their goals, ICLEI then assists the cities undertake the CCP's five milestones. The five milestones of the CCP and the methodology that underlies the milestones provide a simple, standardized means of calculating greenhouse gas emissions, of establishing targets to lower emissions, of reducing greenhouse gas emissions and of monitoring, measuring and reporting performance.

The five milestones are:

Milestone 1. Conduct a baseline emissions inventory and forecast. Based on energy consumption and waste generation, the city calculates greenhouse gas emissions for a base year (e.g., 2000) and for a forecast year (e.g., 2015). The inventory and forecast provide a benchmark against which the city can measure progress.

Milestone 2. Adopt an emissions reduction target for the forecast year. The city establishes an emission reduction target for the city. The target both fosters political will and creates a framework to guide the planning and implementation of measures.

Milestone 3. Develop a Local Action Plan. Through a multi-stakeholder process, the city develops a Local Action Plan that describes the policies and measures that the local government will take to reduce greenhouse gas emissions and achieve its emissions reduction target. Most plans include a timeline, a description of financing mechanisms, and an assignment of responsibility to departments and staff. In addition to direct greenhouse gas reduction measures, most plans also incorporate public awareness and education efforts.

Milestone 4. Implement policies and measures. The city implements the policies and measures contained in their Local Action Plan. Typical policies and measures implemented by CCP participants include energy efficiency improvements to municipal buildings and water treatment facilities, streetlight retrofits, public transit improvements, installation of renewable power applications, and methane recovery from waste management.

Milestone 5. Monitor and verify results. Monitoring and verifying progress on the implementation of measures to reduce or avoid greenhouse gas emissions is an ongoing process. Monitoring begins once measures are implemented and continues for the life of the measures, providing important feedback that can be used to improve the measures over time. The five milestones provide a flexible framework that can accommodate varying levels of analysis, effort, and availability of data. This element makes the CCP both unique and innovative, by increasing its transferability amongst local governments. It is the breadth of this program that enables it to cross north/south, developed/ developing, metropolis/town boundaries and that has made it successful worldwide.

Box 2: US Mayors Climate Protection Agreement

The mayors of ten cities introduced the U.S. Mayors Climate Protection Agreement to the U.S. Conference of Mayors on June 13, 2005, where it was passed unanimously. By mid-2007, over 600 mayors had signed the agreement. From City of Seattle, www.seattle.gov/mayor/climate

The U.S. Mayors Climate Protection Agreement

A. We urge the federal government and state governments to enact policies and programs to meet or beat the Kyoto Protocol target of reducing global warming pollution levels to 7% below 1990 levels by 2012, including efforts to reduce the United States' dependence on fossil fuels and accelerate the development of clean, economical energy resources and fuel-efficient technologies such as conservation, methane recovery for energy generation, wind and solar energy, fuel cells, efficient motor vehicles, and biofuels;

B. We urge the U.S. Congress to pass the bipartisan Climate Stewardship Act sponsored by Senators McCain and Lieberman and Representatives Gilchrist and Olver, which would create a flexible, market-based system of tradable allowances among emitting industries; and

C. We will strive to meet or exceed Kyoto Protocol targets for reducing global warming pollution by taking actions in our own operations and communities such as:

1. Inventory global warming emissions in City operations and in the community, set reduction targets and create an action plan.
2. Adopt and enforce land-use policies that reduce sprawl, preserve open space, and create compact, walkable urban communities;
3. Promote transportation options such as bicycle trails, commute trip reduction programs, incentives for car pooling and public transit;
4. Increase the use of clean, alternative energy by, for example, investing in "green tags", advocating for the development of renewable energy resources, and recovering landfill methane for energy production;
5. Make energy efficiency a priority through building code improvements, retrofitting city facilities with energy efficient lighting and urging employees to conserve energy and save money;
6. Purchase only Energy Star equipment and appliances for City use;
7. Practice and promote sustainable building practices using the U.S. Green Building Council's LEED program or a similar system;
8. Increase the average fuel efficiency of municipal fleet vehicles; reduce the number of vehicles; launch an employee education program including anti-idling messages; convert diesel vehicles to bio-diesel;
9. Evaluate opportunities to increase pump efficiency in water and wastewater systems; recover waste water treatment methane for energy production;
10. Increase recycling rates in City operations and in the community;
11. Maintain healthy urban forests; promote tree planting to increase shading and to absorb CO₂; and
12. Help educate the public, schools, other jurisdictions, professional associations, business and industry about reducing global warming pollution.