Greenhouse Gas Emissions Inventory

and

Climate Action Plan

for

Eureka Springs, Arkansas

An Assessment of Greenhouse Gas Emissions for Municipal Operations and the Community

and

A Strategy for Moving toward Climate Neutrality

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Fayetteville, Arkansas and Tempe, Arizona

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Introduction

Climate change: causes and impacts

The greenhouse gas (GHG) effect is a natural process by which atmospheric gases and particles prevent cooling of the earth by trapping long wave infrared heat from escape into space. For millennia, naturally formed carbon dioxide, water vapor and methane, along with other less important atmospheric gases, combined to regulate earth's climate, temperature, winds, and rainfall, all to a near perfect balance. Ice ages, which are caused by long-term wobbles in earth's revolutions around the sun, reduce global temperatures by several degrees every few thousand years, but earth's climate over the past three hundred thousand years has been remarkably constant.

Fossil fuel uses, fertilizer uses, refrigerant leaks, and emissions from agriculture and industrial processes all constitute GHG emissions. Among these, carbon dioxide from both fossil fuel use and deforestation is by far the largest contributor, accounting for about three-quarters of global warming (i.e., of the radiative forcing), while methane emissions from agriculture deforestation accounts for most of the other fourth (IPCC 2001).

The scientific community is in broad agreement that global climate change is occurring and that human activities, especially the combustion of fossil fuels, is a significant cause of at least some of the changes (IPCC 2007).

In October, 2007, Presidential candidate Barack Obama proposed a reduction of GHG emissions to 80% below 1990 emissions (Obama 2007). The director of NASA's Goddard Institute for Space Studies, James Hansen, along with eight other climate scientists, has argued that to avoid serious disruption in ecological and economic systems, in many countries locally and also globally, a target of 350 ppm of atmospheric CO_2 may be required (Hansen 2008).

The Hansen paper, the Stern Report (Peters et al. 2008), the UN Framework Convention on Climate Change (UNFCCC 2008), the State of California (Schwartzenegger 2005) the U.S. Climate Action Partnership (USCAP 2009), the European Commission (EU 2011) and others have either suggested or explicitly referred to 80% carbon cuts by 2050 as the level of action that will be necessary to effectively resolve climate change issues and problems.

In conformity with these scientific and policy positions, this report sets a target of 80% reduction of GHG emissions by 2050 (compared to the baseline inventory of 2010) for the City of Eureka Springs. The plan shows how community emissions as well as the emissions of municipal operations can be reduced or avoided.

Eureka Springs, Arkansas

A tourist town and arts colony, Eureka Springs, Arkansas, is a town of 2,030 residents. It is visited by over 750,000 people annually. Victorian architecture, fine and folk arts, a vibrant music scene, nearby Beaver and Bull Shoals Lakes, and The Great Passion Play combine to draw visitors of all ages and interests. The heart of the Historic District, Spring Street, has been named by the American Planning Association as one of the ten Great Streets in America, and it's been awarded one of America's Top 25 Small Cities for Art by *American Style* magazine. The city was honoured as one of America's Dozen Distinctive Destinations by the National Trust for Historic Preservation in 2001.

In October 2007, then-Mayor Dani Joy signed the US Mayors Climate Protection Agreement (USMCPA), making the City of Eureka Springs the fourth and smallest city in Arkansas to join the Agreement. Little Rock, North Little Rock, Ft. Smith and Fayetteville are other cities in Arkansas that are currently signatories to the agreement (http://www.usmayors.org/climateprotection/revised/).

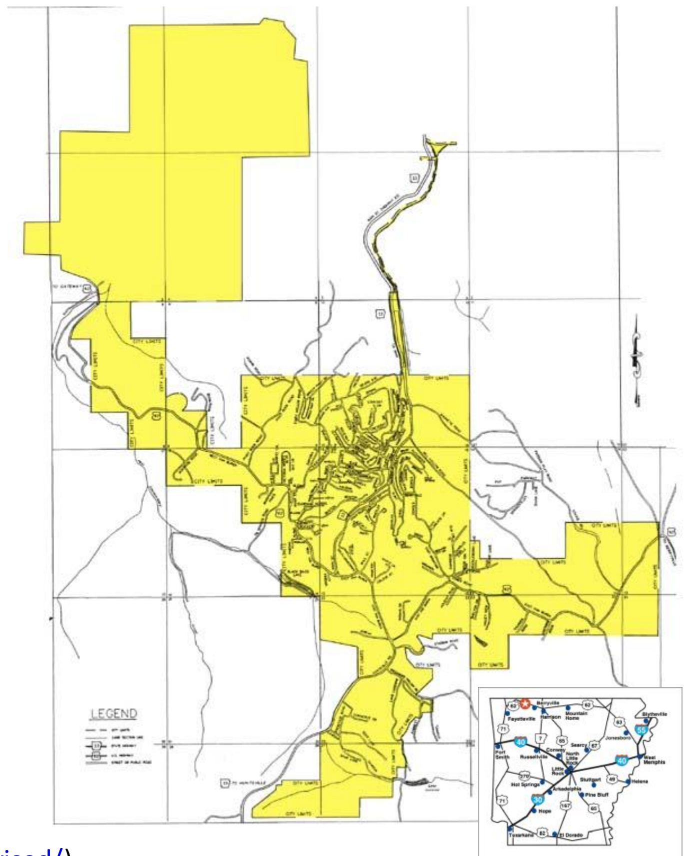

Figure 1. Eureka Springs, Arkansas

There are currently 1055 signatories to the Agreement. The agreement requires signatory cities: 1) to strive to meet or beat the target of the Kyoto Protocol to reduce greenhouse gas (GHG) emissions to a level 7% below the 1990 emissions level by 2012, through anti-sprawl, forest restoration, and educational efforts; 2) to urge state and federal governments to reduce their emissions to meet that target; and 3) to urge Congress to pass bi-partisan GHG reduction legislation.

To meet the first commitment of the USMCPA, a municipality must have completed a GHG emissions inventory, which allows an understanding of the level of emissions produced by the city. A backcast from a more recent emissions inventory is usually necessary.

The city's population has fluctuated from 1,900 in 1990 to 2,278 by 2000, and 2,073 in 2010. The 1990 census counted 902 households on 2769 acres in Eureka Springs (Myers 1994), and the 2009 American Community Survey counted 1046 occupied households on 4,339 acres.

Population growth has been modest, and land annexation over the past couple of decades has consisted largely of the 1,500 acre Lake Leatherwood Park. Data from 1990 are nearly impossible to find, and the certainty of twenty-year-old data is low. Therefore, this plan uses the 2010 inventory as the baseline. Although growth has been relatively flat since 1990, the city has failed to meet the commitment to reduce emissions by 7% since then.

Climate and energy in Northwest Arkansas

Eureka Springs, located in northwest Arkansas, is in the southwest edge of the Ozark Mountains. At 1400 feet elevation (MSL), the city is characterized by moderate winters (average 3981 heating degree days) and mild summers (average 1471 cooling degree days) (NOAA 2012). The City enjoys four distinct but mild seasons. The annual average daily high temperature is 71°F and the low 46°F.

	Jan	Feb	March	April	May	June
Average high in °F	46	52	62	72	78	85
Average low in °F	26	30	38	47	55	63
Av. precipitation – inch	2.4	2.8	4.53	4.25	4.88	4.57
	July	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average high in °F	90	90	81	72	58	49
Average low in °F	68	66	59	50	39	29
Av. precipitation – inch	3.62	3.31	4.45	3.46	4.65	3.43

Table 1. Monthly Temperature and precipitation for Eureka Springs

The City is about fifty percent shaded by semi-natural Ozark oak-hickory forest, which provides special charm and cools the city environment in the summer. Tree cover is valuable as wildlife habitat and as the source of a wooded environment, and this limits the potential for solar installations in many locations. U.S. Highway 62 runs along an east-west ridge atop the town, and businesses there have significant opportunity to take advantage of solar energy for water heating (including pool heat), and photovoltaic applications.

Steep topography limits the potential for ground source heat pumps at many locations throughout the City.

Most residents and businesses heat with natural gas, although there are some residential heat pumps and wood heating systems. Commercial and municipal facilities have air conditioning. As it is in most communities worldwide, there is much potential to improve energy efficiency in commercial and residential buildings in Eureka Springs.

Eureka Springs is served by Southwest Electric Power Company (SWEPCO), which is a subsidiary of American Electric Power (AEP), and also by Carroll Electric Cooperative Cooperation, which is a member of Arkansas Electric Cooperative Association (AECC). Both have a relatively heavy or dirty GHG footprint, being dependent on coal-fired power for base load operations. Both are served by Southwest Power Pool – South (SPSO), which wheels electrical power form their plants to customers. The eGRID factor (USDOE 2012) for SPSO is 0.79 kg CO_2e per kWh of electricity provided.

GHG Emissions Inventory

The GHG emissions inventory produced by this project consists of two inventories that are related, but independent of one another. An *inventory of municipal operations* quantifies emissions from city-owned and city-managed facilities that represent the public sector operations of the City. The city administrative offices, police department, fire and rescue, parks and recreation facilities, public works activities, city promotions board, and the local school system are included. Municipal operations included within the boundary of this inventory accounted for 4,659 MT CO_2e in 2010.

A *community-wide GHG inventory* quantifies emissions that result from all commerce and private activities within the city limits, from visitors and tourists as well as from residents. Total community-wide GHG emissions were 48,475 MT CO_2e in 2010.

Methodology

Greenhouse gas emissions inventories provide an objective, quantitative analysis of the liabilities and assets that are associated with climate change. The Greenhouse Gas Protocol Initiative was developed by World Resources Institute and the World Business Council for Sustainable Development (WRI & WBCSD 2001). It has become the basis for GHG emissions accounting worldwide, and has been used by a wide range of entities, including corporations, non-profit organizations, and governmental agencies at almost every level of operation. This report uses standards and methods prescribed by the GHG Protocol as the basis for acquiring, managing and analyzing data, and for its application to reporting emissions for municipal operations and the community.

GHG Protocol is partnering with Local Governments for Sustainability (ICLEI), Cities Climate Leadership Group (C40), the World Bank, United Nations Environment Program, and UN-Habitat to develop the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC). The GPC is not available as of the date of issuance of this report, but Version 0.9 (Greenhouse Gas Protocol Initiative 2012) was consulted to obtain general direction for this inventory and climate action plan.

The GHG Protocol Corporate Standard provides standards and guidance for companies and other organizations preparing a GHG emissions inventory. It covers the accounting and reporting of the six greenhouse gases covered by the Kyoto Protocol — carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). It was designed with the following objectives in mind:

- To help companies prepare a GHG inventory that represents a true and fair account of their emissions, through the use of standardized approaches and principles.
- To simplify and reduce the costs of compiling a GHG inventory
- To provide business with information that can be used to build an effective strategy to manage and reduce GHG emissions
- To increase consistency and transparency in GHG accounting and reporting among various companies and GHG programs

The GHG Protocol is based on three scopes of emissions, which are described below.

Scope 1 emissions: All direct emission sources from activities taking place within the boundaries of the inventory.

Scope 2 emissions: Energy-related indirect emissions that result as a consequence of consumption, within the community's or institution's boundaries, including grid-supplied electricity and heating and/or cooling from steam and chilled water sources.

Scope 3 emissions: All other indirect emissions that occur as a result of activities within the proscribed boundary.

The first step in carrying out a GHG inventory is defining the boundary of applicability. Two methods are allowed by the GHG Protocol.

Equity share approach

Under the equity share approach, an entity accounts for GHG emissions from operations according to its share of equity in the operation. The equity share reflects economic interest, which is the extent of rights the entity has to the risks and rewards flowing from an operation. The equity share method is well-suited for corporations and other for-profit entities that are organized primarily to manage financial assets. Municipalities and other forms of government rarely use the equity share approach because their assets are usually owned in full by the governmental entity or not owned at all. In cases where large assets of infrastructure are owned partly through publicly financed bonds, such as for stadia and arenas, equity share may be a relevant consideration. But Eureka Springs has no such assets.

Control approach

Under the control approach, an entity accounts for 100 percent of the GHG emissions from operations over which it has control. It does not account for GHG emissions from operations in which it owns an interest but has no control. Control can be defined in either financial or operational terms.

When using the control approach to consolidate GHG emissions, entities must choose between the operational control and financial control criteria.

Approach and boundaries used in this inventory

The GHG inventory used the operational control method to establish institutional boundaries. The City owns a 22 bed hospital, Eureka Springs Hospital, but has leased it to a private company for management (Allegiance Health Management LLC), and outside of the lease agreement, neither benefits nor risks a financial burden from the operation of that facility, and the hospital is therefore excluded from the inventory. Conversely, the City Advertising and Promotions Commission, which is operated by the City and leases office space from private owners, is included.

Eureka Springs is in Carroll County, Arkansas, bordering Missouri to the north and Benton County, the state's northwest corner, to the west. The community of Holiday Island, with a population of about 2,500 and which has about 40 businesses and services, is a Suburban Improvement District located nine miles north of Eureka Springs. Although Holiday Island's residents trade in Eureka Springs, the two communities are distinctly separate commercial districts, and Holiday Island is not included in this inventory. Except for the influences of commuters from across Carroll County into Eureka Springs, the institutional boundary for the inventory is the city limits of Eureka Springs.

The Eureka Springs School District, which operates on 167,000 gross square feet (GSF) of building space and teaches 699 students, is included in the inventory.

Emissions from municipal operations

Emissions from municipal operations are summarized in Table 2. Although population dropped by 12%, emissions from City operations increased by 11% between 2005 and 2010.

The most significant increases came from increased fleet fuels (12% increase), natural gas use (17% increase), and purchased electricity (23% increase). Police and Fire & Rescue Departments do not have '*no idle'* policies and this contributes to relatively heavier use of gasoline. The steep, hilly topography of the city make bicycling and walking an impractical option for some residents, and for tourists. Even so, one police officer routinely patrols the city on a bicycle. Major routes, including AR Highway 23 and US Highway 62, are relatively flat and cycling could be promoted as an alternative to conventional car uses. Bicycle lanes could be added to these routes, but their cost was not assessed by this study.

The Eureka Springs School District has built new elementary and middle school facilities over the past decade, and that also contributes to higher energy use by municipal operations. A new high school is schedule for completion in 2013.

The City owns and manages Lake Leatherwood City Park, which extends across 1,600 acres of forested land on the west side of town. Eighteen other parks, mostly springs that have made the city famous over the past century, combine with Lake Leatherwood City Park to provide about 1,800 acres of city-owned wooded land. These acres sequester CO_2 at a rate of about one metric ton per acre per year. But because the management of these lands already requires a no-harvest, no-cut policy, the ownership and management of them cannot be registered on carbon registries. Although these lands sequester carbon, the sequestration function is *non-additional* to the land use policies in place, and sequestration on these lands cannot be used to offset emissions from the city's GHG inventory.

GHG Summary for municipal operations

Scope 1			**2005**	**2010**
	Stationary combustion	MT CO_2e	249	300
	Fleet fuels	MT CO_2e	663	740
	Refrigerants and chemicals	MT CO_2e	53	64
	Fertilizers	MT CO_2e	1	1
	Total Scope 1	MT CO_2e	**966**	**1,104**
Scope 2			**2005**	**2010**
	Purchased electricity	MT CO_2e	1,487	1,828
	Total Scope 2	MT CO_2e	**1,487**	**1,828**
Scope 3			**2005**	**2010**
	Air Travel	MT CO_2e	1	1
	Solid waste	MT CO_2e	1,251	1,209
	Wastewater	MT CO_2e	0.28	0.28
	Paper	MT CO_2e	18	24
	Local travel	MT CO_2e	686	683
	Scope 2 T&D losses	MT CO_2e	97	119
	Total scope 3	MT CO_2e	**2,053**	**2,037**
Total gross GHG emissions			**2005**	**2010**
	Total gross GHG emissions	MT CO_2e	**4,506**	**4,969**
Offsets			**2005**	**2010**
	Total additional	MT CO_2e	-	-
	Total non-additional	MT CO_2e	(1,800)	(1,800)
	Total offsets	MT CO_2e	**(1,800)**	**(1,800)**
Total net GHG emissions			**2005**	**2010**
	Total net GHG emissions	MT CO_2e	**4,506**	**4,969**

Table 2. GHG emissions from municipal operations

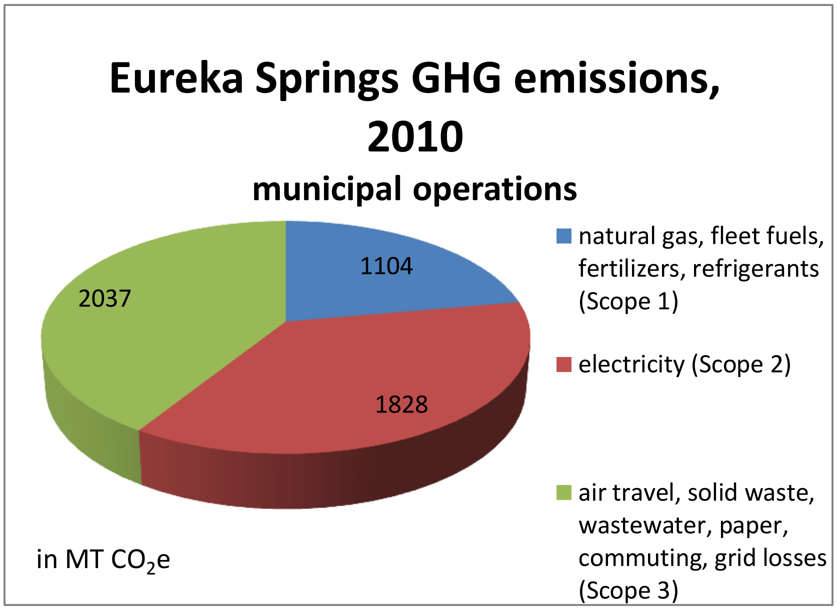

Figure 2. Summary of emissions for municipal operations

Because the city is small, normal governmental operations are relatively inefficient as they calculate to per capita emissions. Municipal operations create 20.8 MT CO_2e per employee per year, which is an extremely high value. Municipal operations create just over 2 MT CO_2e per capita, which is the highest among seven communities that have published comparable data (Figure 3). Much of the poor performance can be attributed to the small size of the town and its government, but some is surely attributable to a lack of systematic attention to energy efficiency and conservation.

Eureka Springs' emissions for municipal operations also calculate much higher than other cities because of the inclusion of the school district in the inventory. School facilities accounted for 62% of all natural gas use, and the total would have therefore been 38% as high as this report shows without inclusion of school buildings. The lack of consistency that derives from each entity defining infrastructure that is included within GHG inventory boundaries leads to limit comparability among inventories.

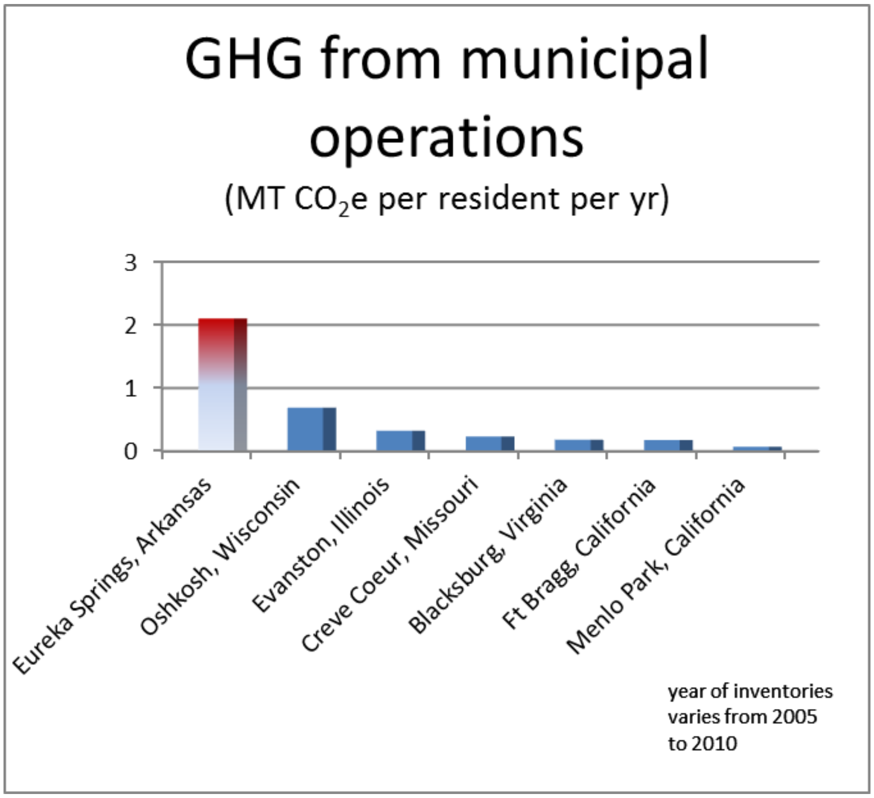

Figure 3. Per capita GHG for municipal operations

Community-wide GHG emissions inventory

In contrast to per employee emissions, the city produces a relatively low level of emissions per resident. This results from two major factors. First, the relatively mild climate calls for less heating and less air conditioning than many locales. Second, the city's economic base is tourism, which is supported by small commercial establishments; over 40% of all businesses in the city are in the restaurant and lodging sector. There is no heavy industry, and fabrication processes are mostly limited to the construction sector. Several small industries, including Eureka Ironworks, Eureka Stone, and other small shops are all located outside of the city limits. With no industrial processes in the city, its GHG emissions are significantly lower per capita than larger municipalities. Nationally, industrial processes account for about a quarter of GHG emissions (USDOE-EIA 2008).

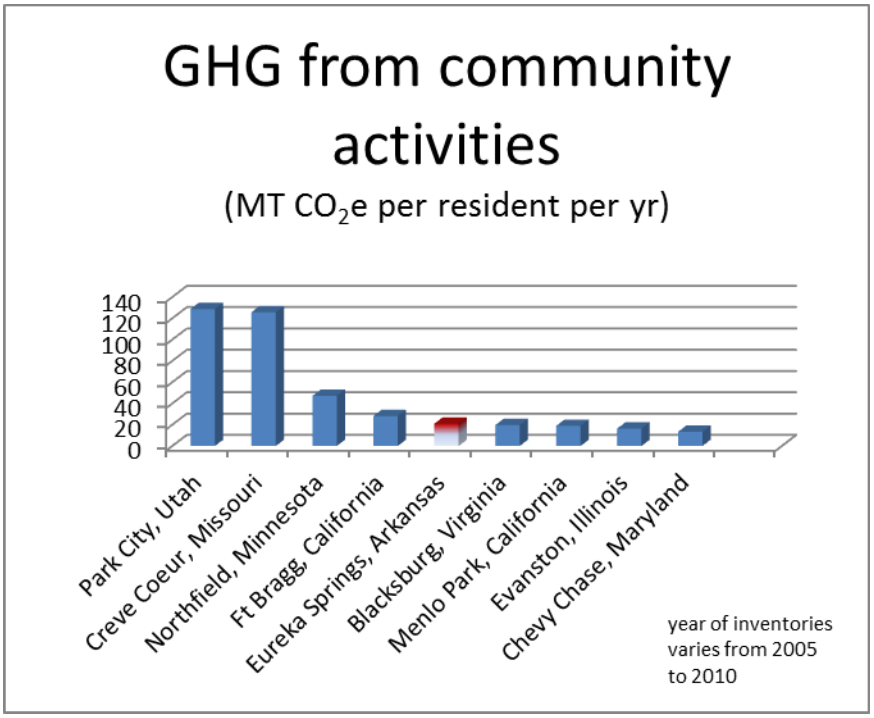

Figure 4. Per capita GHG emissions

Community GHG emissions are heavily influenced by tourist activities. Aspen, Colorado (Heede 2006) and Park City, Utah (Brendle Group 2009), both towns with a similar level of tourism as that of Eureka Springs, each report that tourists account for about one-third of gasoline burned in their jurisdictions. In Eureka Springs, transportation among tourists accounts for nearly 5,000 MT CO_2e per year, and therefore increases the overall inventory by more than 10% above the level of residents' activity alone.

Eureka Transit runs four trolley routes to 130 stops throughout the city, and used 22,137 gallons of diesel fuel in 2010, or about 1/3 of the diesel fuel used by municipal operations. The 217 MT CO_2e produced by trolleys accounted for about 4% of the 2010 GHG inventory.

The City's level of per capita emissions in 2010 was 23.4 MT CO_2e per capita; the U.S. national average was 20.3, and the global average was 4.4. Many factors, including level of affluence, types of transportation available, amount and types of local industry, climate, and cultural values all influence the overall level of emissions for an area.

GHG Summary (community emissions)

Scope 1			
	Stationary combustion	MT CO_2e	8,649
	Local travel	MT CO_2e	13,091
	Refrigerants and chemicals	MT CO_2e	2,625
	Fertilizers	MT CO_2e	6
	Total Scope 1	MT CO_2e	**24,370**
Scope 2			
	Purchased electricity	MT CO_2e	11,406
	Total Scope 2	MT CO_2e	**11,406**
Scope 3			
	Air Travel	MT CO_2e	579
	Train and trolley travel	MT CO_2e	204
	Wastewater	MT CO_2e	243
	Purchased Paper	MT CO_2e	1,822
	Solid waste	MT CO_2e	9,108
	Scope 2 T&D losses	MT CO_2e	741
	Total scope 3	MT CO_2e	**12,698**
Total GHG Emissions			**2010**
	Total GHG emissions	MT CO_2e	**48,475**

Table 3. Community GHG emissions for 2010

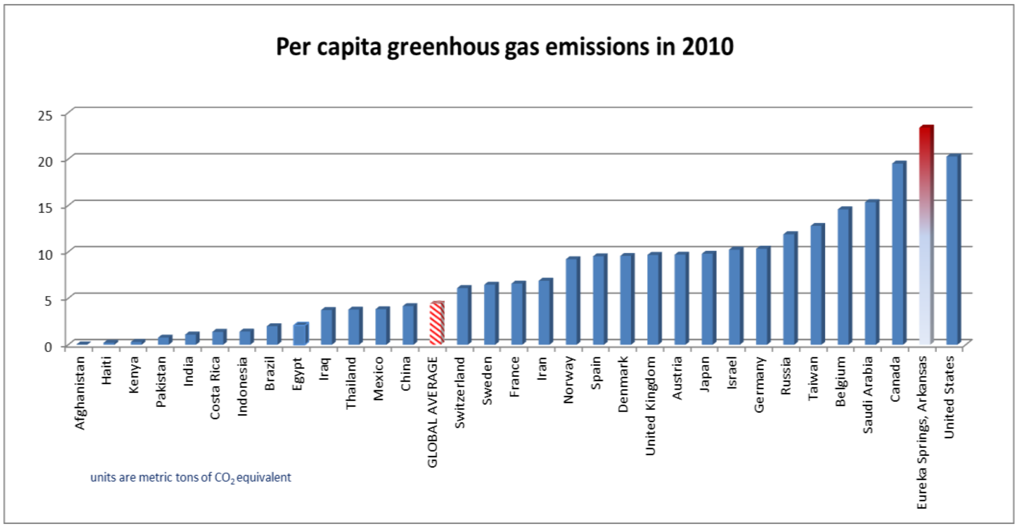

Figure 5 Per capita emissions for Eureka Springs and selected nations

Climate Action Plan

This report recommends that Eureka Springs adopt a plan that will reduce GHG emissions by 50% by 2020, and by 80% or more by 2050. A roadmap to achieve those targets is described through the projects described here. The software (Sustainable Projects Assessment Tool, SPAT) that calculates the costs and benefits of this program will be available to City planners as implementation is underway, and will provide a way to understand how changes in costs and economic conditions will change the viability of proposed projects.

The Built Environment

The City had about 1,119 households and 569 families in 2000. A five acre Historic District in the downtown area protects the City's 19th century architecture and ambiance, and the entire city is listed in the National Register of Historic Places. Steep hillsides limit streets to narrow passage, and limit builders' options for building and re-building in the City.

Fifty percent of Eureka Springs's housing stock was built before 1960, and 36% was built before World War II. Accordingly, energy efficiency is poor in many homes, and there is much opportunity to save residential energy as well as performance in commercial buildings.

Of 1,307 homes and apartments in the city in 2009, only 6 use wood for heating, and none use solar heat (US Census 2000). There is significant opportunity to increase the use these two fuel sources to heat homes and commercial establishments in the city.

There is no large scale industrial facility in Eureka Springs, and commercial establishments, with only a few exceptions, occupy 10,000 sq ft or less. Much of the hotel space in the city was constructed in the 1960s and 1970s, and is energy inefficient by today's standards.

Transportation

Nestled among the steepest hills in the Ozark Mountains, Eureka Springs is sometimes known as the Switzerland of Arkansas. Walking and bicycling are therefore possible for fit members of the community, but the topography limits their wide-scale use by many residents. The hills preclude serious consideration of rail transit in the foreseeable future.

A city-owned trolley system operates on the historic loop (AR Highway 23B) through the heart of the city and on US Highway 62. It provides tours for visitors, but is of limited use for commuters or for travel to much of the city.

The Eureka Springs and North Arkansas Railway runs a diesel train for tourists along a three-mile track, parallel to AR Highway 23 N on the north end of Eureka Springs. It runs only half of the year, and creates about 0.5 MT CO_2e per year from its diesel fuel use.

The city's fleet is thus far a conventional fleet of gasoline powered cars and trucks. Fleet composition has been determined mostly by first costs and by performance requirements.

A CAFE Standard for medium and heavy duty vehicles is in place for vehicles for the model year 2014 forward that is projected to save 55 million MT CO_2e per year, and standards for light vehicles are under development. As these regulations are put into place, the fuel efficiency will double and emissions will be cut in half (USEPA 2012b). Increased availability and lower prices for hybrid vehicles and electric vehicles will provide access to more efficient transportation as a result of CAFE Standards.

Biodiesel and ethanol fuels may become available during the term of projects proposed by this climate action plan, but the distances from arable lands where dedicated crops may be produced suggest that these fuels may not be significant opportunities over the short- and mid-terms.

Waste and Recycling

Municipal solid waste (MSW) is a major source of greenhouse gases. MSW from Eureka Springs is hauled to Cherokee Nation Landfill in Stillwell, Oklahoma, about 90 miles away. Cherokee Nation Landfill has no landfill gas (LFG) recovery system in place, and has been cited by the OK Department of Environmental Quality for excessive methane emissions in recent years. Discussions are under way with Monauk Energy to develop an LFG project, but none is in place.

Using the Waste Reduction Model (WARM), USEPA estimates that mixed municipal waste produces 3.1 MT CO_2e per short ton of waste in landfills that have no recovery. Emissions drop to 0.31 MT CO_2e per short ton of waste where flaring is employed, and energy recovery, in the form of landfill gas to electricity, reduce net emissions to -0.03 MT CO_2e per short ton of waste delivered to the landfill (USEPA 2012b).

The city produced 2938 tons of MSW and diverted 611 tons to commodity markets in 2010, for a diversion rate of 17.2%. Although the City produced only 18% of the total MSW in Carroll County, it recycled 42% of the total material recycled by the Carroll County Solid Waste Authority. The MSW generated in Eureka Springs produced 9109 MT CO_2e in 2010, which was 19% of the total GHG emitted by the community.

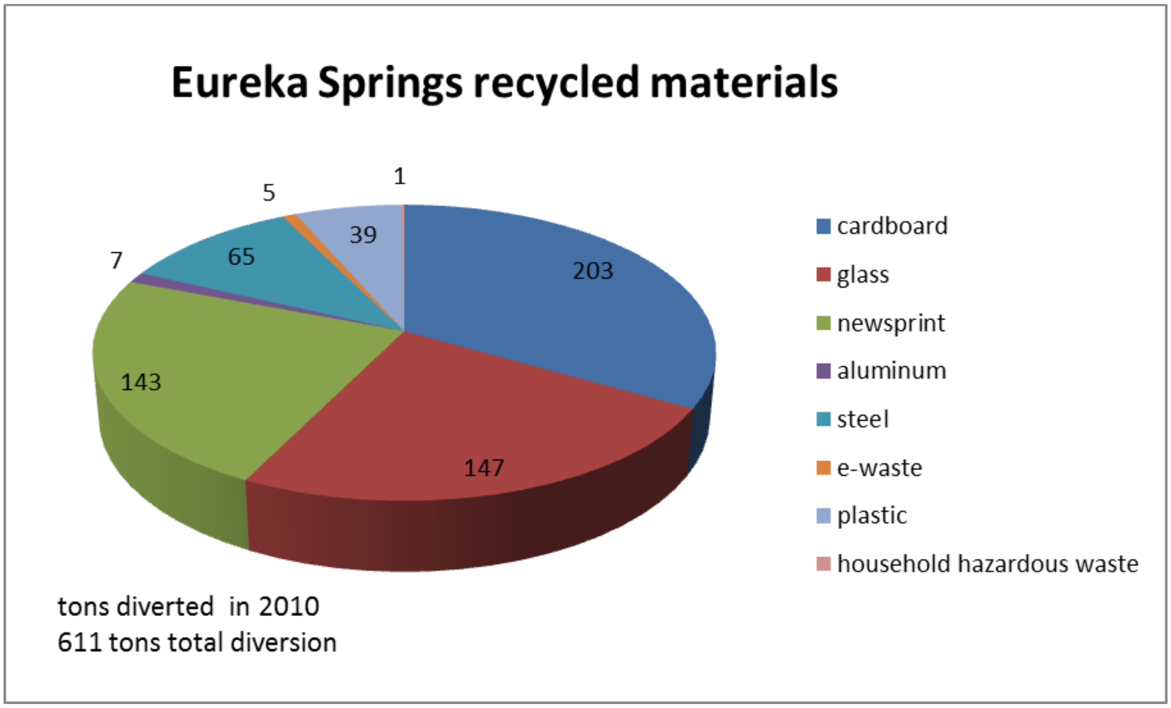

Figure 6. Recycling in 2010

Per capita generation of MSW was 3.52 kg (7.7 lb) per resident per day, which is 75% above the national average for waste generation (USEPA 2010). Much of the increase is explained by tourism, which the Eureka Springs Chamber of Commerce estimates as 750,000 people annually (Eureka Springs Chamber of Commerce 2012). Person-days of tourism were not made available to this study, and a definitive analysis is therefore not possible. But if the Chamber's estimate is taken to signify 750,000 tourist person-days per year, the population of the town effectively doubles (from the residents-only level). This would reduce the level of MSW per person to approximately the national average.

As one fifth of Eureka Springs's GHG emissions derive from MSW, improved management of solid waste is important to the success of GHG reduction efforts. Installation of a system to collect and flare landfill gases at the Cherokee Nation Landfill would reduce GHG by 90% compared to the existing conventional landfill operations. Alternatively, hauling to EcoVista Landfill in Tontitown, which is outfitted with an LFG-to-electricity system, would completely eliminate emissions related to production and disposal of MSW.

The City could develop a Zero Waste Initiative that would aim to 1) improve natural resource use through aversion actions, such as paper reduction, elimination of disposable food service items and single-use plastic bottles, and elimination of plastic shopping bags, and 2) diversion or recycling programs, including recycling public awareness efforts, community-wide composting, improved street-side pick-up of recyclable commodities, and integration of food scraps, yard trim, and wood wastes of many kinds into biomass energy systems.

Renewable Energy Systems

Solar, wind, biomass, hydropower, and geothermal (in the form of ground source heat pumps) energy resources are all available at some level in northwest Arkansas. A complete evaluation of renewable energy potentials is beyond the scope of this report, but some perspective regarding the competitive advantages and limitations of each is useful.

Solar energy is relatively abundant in northwest Arkansas. A panel tilted to the angle of the latitude (34 degrees from horizontal) receives about 5 kWh m^{-2} day^{-1} (kilowatt-hours per square meter per day) of solar energy. By comparison, the Sun Corridor in Arizona receives only about 6 kWh m^{-2} day^{-1} of solar radiation. Note that this is incident radiation, and system efficiency losses will result in significantly less power available to an application.

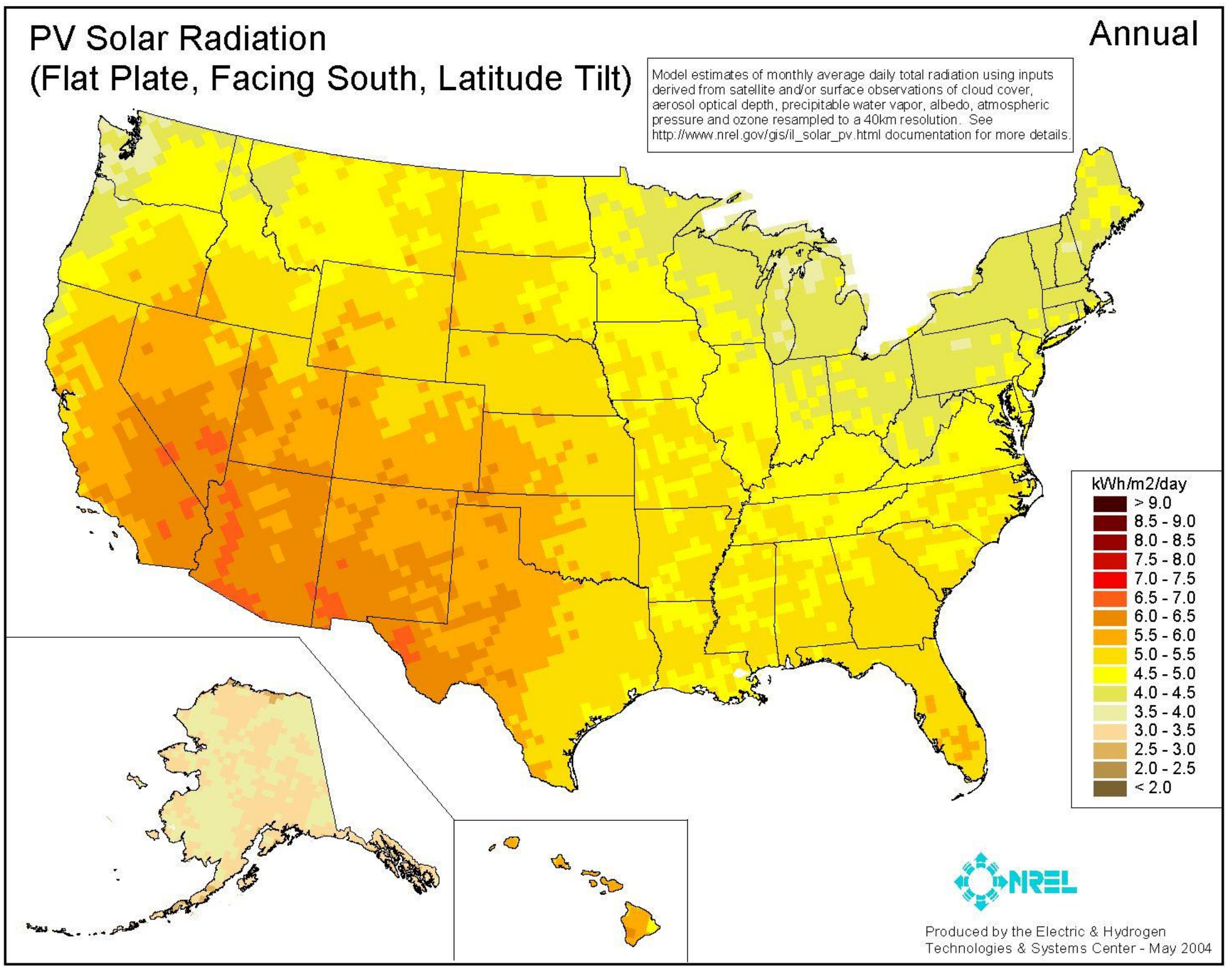

Figure 7. Incident solar radiation map of U.S.

Source: National Renewable Energy Laboratories (2004)

Wind energy is adequately strong and consistent on some Ozark mountain crests to justify installation of small turbines to operate a farm or residence. TradeWind Energy assessed the wind resource on the Springfield Plateau in adjacent Benton County in 2008 (http://www.hpj.com/archives/2008/sep08/sep29/CompanyeyeingwindfarminArka.cfm) and Invenergy assessed nearby mountaintops of the Boston Mountains in Washington County in 2009, (http://thecabin.net/news/2010-10-18/nw-ark-bats-scuttle-plans-wind-farms), but neither company invested in wind farms in the area. Even if the wind resource were adequate to satisfy investors, wind energy applications in Eureka Springs would be limited by noise, vibrations, aesthetics, by environmental and biodiversity considerations, by wind shadowing by hills, trees and buildings, and by restrictions related to the downtown's designation on the National Register of Historic Places.

Biomass energy has significant potential in Eureka Springs and throughout the region. Poultry litter and forest resources are produced densely throughout the region and development and labor costs to manage a biomass feedstock delivery system are modest. Particulate, NO_x and other emissions are of less concern as pyrolysis, combustion with catalytic conversion, and other emissions controls technologies become more effective at lower costs. As energy prices increase, biofuels and biomass energy systems will become increasingly competitive with fossil fuels.

Hydropower is already in use in the region, at two generating facilities within thirty miles of Eureka Springs. The US Army Corps of Engineers operates two 56 MW turbines on Beaver Lake has and four 50 MW turbines on Table Rock Lake, both within thirty miles of the city. These turbines reduce the SPSO eGRID factor by some amount (compared to a fossil fuel-only footprint), but Eureka Springs cannot take advantage of hydropower beyond these existing applications. Additional opportunities to deploy hydropower are scarce throughout the region.

Geothermal energy, in the form of ground-source heat pumps, is a feasible technology in the region as a means to heat and cool commercial buildings. The University of Arkansas has successful installations of ground-source heat pumps in the Razorback Transit bus barn (personal communication David Dunn, Razorback Transit) and has recently completed renovation of a facility for the College of Education and Health Professions that features ground-source heat pump heating and cooling.

Applications in Eureka Springs may be successful along the ridge of U.S. Highway 62 and perhaps along AR Highway 23 where topographical grades are not steep. Ground-source heat pumps require multiple wells for heat transfer fluid (usually water), on 20' centers. (The wells may be open loop, i.e., they draw ground water for use as the heat transfer fluid, or closed loop, which often also use water as the circulating heat transfer fluid.) Steep topography, small lots, compact city design, and lack of open space will limit the feasibility of applications. However, parking lots and building footprints can be used as space for well fields, and some applications will become increasingly competitive as the price of fossil fuels increases.

Carbon Sequestration

While *renewable energy credits* (RECs) can be obtained by producing renewable energy and selling the environmental qualities of that energy, *carbon offsets* can be obtained by sequestering carbon from the atmosphere. Sequestration of GHG is limited to several methods:

- destruction of GHG, especially hydrofluorocarbons and perfluorocarbons, through landfilling, incineration or thermal oxidation
- injection into deep geologic formations, especially CO_2 from electrical power plants
- soil development and build-up of carbon-based detritus, especially on farms and in forests, and
- fixation and long-term maintenance of atmospheric carbon into plants through photosynthesis, including in afforestation and reforestation projects.

The City is about 50% tree covered, and these trees sequester carbon as they grow, totaling about 3,000 tons of CO_2 per year (1,500 from Lake Leatherwood City Park and 1,400 from the "urban forest that the city environment consists of). However, for that sequestration to be applied to a reduction in the GHG inventory, it must feature *additionality.* Additionality is a policy term by which an assessment is made regarding whether or not a project's emissions reductions are in addition to a business as usual scenario (The Climate Trust 2007). Since the maintenance of trees in the yards and commercial landscapes of the city represents business as a usual, and the maintenance of Lake Leatherwood City Park is also status quo, carbon sequestered by these processes do not have additionality and do not qualify for formal inclusion on carbon registries.

No practical projects for the City of Eureka Springs to reduce the GHG inventory through sequestration were identified in this report.

Implementation, Monitoring, and Reporting

The plan presented in this report may be endorsed by City in the form of an Ordinance, a Mayoral Proclamation, and/or by other means. The means of endorsement is less important than the adoption of these and other, related ideas into a working strategy that leads to a future of cleaner and more responsible energy uses. An ideal response would include development of a team, committee or commission that would manage climate change issues for the City, which would advise the Mayor and City Council.

As a signatory to the U.S. Mayors Climate Protection Agreement, the City is bound to report progress to the International Council for Local Environmental Initiatives, ICLEI. As a follow up to this report, the City is well prepared to update its status as an ICLEI signatory. Its progress on this issue will reinforce its reputation as a leader among small cities worldwide on environmental issues.

This report recommends that a City Commission on Climate Change be established to 1) assess the significance of the GHG emissions inventory to the overall prosperity and sustainability of the City, 2) develop hands-on projects that will assure progress toward greenhouse gas emissions reduction, and 3) develop local and regional business strategies for adapting to climate change.

Adapting to Climate Change

The effects of climate change have already been felt by communities worldwide. Over the past two decades, global satellite data indicate that spring has arrived 10 – 14 days earlier across the temperate zone (Climate Change Science Program, (Backlund et al. 2008). In Arkansas, researchers at the Arkansas State University have documented significant changes in the migration patterns of waterfowl that seem to be caused by climate change (Bednarz 2011).

Existing, documented changes in climate and ecosystems seem to be canary in the coal mine. Many other dramatic ecological, natural resources, and social changes leading to disruption seem to be on the horizon. The Climate Change Science Program and many other researchers project dramatic effects across energy production, agricultural production, natural ecosystems alteration, and the human upheaval that these effects are likely to cause in coming decades (CCSP 2008).

Eureka Springs and other communities across the region and the nation will need to assess their vulnerabilities, develop financially, environmentally and culturally acceptable adaptations to rising temperatures, and develop the political will to prioritize solutions that provide long-term solutions for our children and grandchildren.

Specifically, Eureka Springs may need to adapt to a number of impacts of climate change, some which occur in other regions of the nation and around the globe. Effective adaptations will include the following activities.

- When the cost of fuels for transportation begins to affect non-essential travel, the city's tourism industry will shrink. Economic contributions from Eureka's artists and writers will become more important to the overall community than they currently are. The city should work with state and federal governments to assure that impacts of this type are buffered by new economic opportunities that are built on Eureka's fine arts and folk arts, writers and musicians, and on clean energy and principles of sustainable development.
- In the same way that communities will be affected across the temperate zone, rising temperatures will affect agricultural activities by changing the way that seasonality; types, intensities, and effects of pests; and water availability determine the success of farming. The city can limit its liabilities related to problems of agriculture and food by strengthening its Farmers Market, increasing local food production more widely among more backyard gardens, spreading information about organic food production methods, and developing community composting projects.
- Construction and renovation of residential and commercial buildings should be highly energy efficient. The city should adopt strong, forward-thinking building energy standards. Buildings should be designed with passive cooling features, to minimize or eliminate the need for air conditioning. Biomass heating systems, including wood-fired stoves and furnaces, should be installed to avoid the use of natural gas and fossil fuel-produced electricity.
- An anaerobic digestion system can be added to the Eureka Springs municipal wastewater treatment system. The costs and long-term benefits of such a system should be investigated. Such a system can reduce odors in addition to providing electrical energy.

GHG Emissions Reduction Plan

Development of a tractable emissions reduction plan can only occur through a comprehensive analysis of the financial, social, and environmental viability of potential projects. This report uses the Sustainability Projects Assessment Tool (SPAT 1.1©, Brown 2012) to evaluate and prioritize potential policies and project activities. SPAT prioritizes projects by first costs, annual operating and maintenance costs, net present value, the cost of avoiding GHG emissions, the overall potential to reduce GHG emissions and by social and environmental factors.

Sustainability projects assessment tool (SPAT)

SPAT assesses potential GHG reduction projects by using common financial and economic assumptions and applying them to analyses that inform decision makers of their relative values. To assure that each project is considered fairly, identical assumptions are made for all projects. The global assumptions can be modified to understand how they affect project viability. The assumptions used to assess all projects are shown below. SPAT 1.1 allows decision makers to modify any of these assumptions and see how new assumptions affect the relative viability of options.

Global inputs							
(constant across all projects)							
Energy price escalator	yrs 1 - 5	3%		**Consumer price**	yrs 1 - 5	3%	
	yrs 6 - 10	4%		**index (CPI)**	yrs 6 - 10	3%	
	yrs 11 - 15	4%			yrs 11 - 15	3%	
	yrs 16 - 20	4%			yrs 16 - 20	3%	
	blended	3.8%			blended	3.0%	
Discount rate	yrs 1 - 5	2%		**Initial costs**			
	yrs 6 - 10	3%		**electricity**		$0.085	kWh
	yrs 11 - 15	3%		**natural gas**		$0.600	therm
	yrs 16 - 20	4%		**gasoline**		$ 3.85	gallon
	blended	3.0%		**diesel**		$ 4.35	gallon
				water		$ 6.25	1000 gallons
Market shocks		10%	(in 2020)	**tipping**		$ 50	short ton
				waste hauling		$ 20	short ton
				compost		$ 50	short ton

Table 4. Financial assumptions used in the GHG reduction plan

SPAT also evaluates social and environmental aspects of proposed projects. While the system does not carry out full life cycle analyses for these factors, it shows decision makers what factors need to be considered and assessed at some level of due diligence.

Social sustainability factors
Uses land sustainably
Creates community connections
Creates sustainability ethos
Supports local organizations
Supports indigenous people
Supports public health
Creates social justice
Creates right work
5 = positive effect on the community
4 = acknowledges community issues
3 = neutral
2 = tin ear; doesn't hear the community
1 = counter to community needs

Table 5. Social sustainability factors assessed by SPAT

Environmental sustainability factors
G1 - G2 species
G1 - G2 communities
Genetic diversity
Land degradation
Aquatic/marine degradation
Mitigation (direct)
Restoration (indirect)
Local NGO input
5 = positive environmental effect
4 = adequate protection
3 = neutral
2 = inadequately resolved issues
1 = degradation

Table 6. Environmental factors assessed by SPAT

The projects described below combine to show how the city can reduce greenhouse gas emissions by 80% before 2050. The assessment of their financial, environmental, and social costs and benefits are shown in Tables 7 through 9. Most of the projects that are proposed have minimal or positive effects on biodiversity and on social issues, but it is advisable to consult a checklist for those subjects to assure that social and environmental issues get as much consideration as financial ones.

City purchasing policies can play a powerful role in reducing GHG emissions for the City, in the same ways purchasing power significantly defines an individual's personal emissions profile. Policies that require 1) the purchase of Energy Star equipment and efficient fleet vehicles, 2) preference for low packaging and packaging take-back by vendors, 3) preference of locally produced items and materials, 4) low global warming potential (GWP) refrigerants, and 5) low water use processes and devices can reduce GHG emissions and contribute to the City's sustainability in many ways.

Proposed policies (projects 1 – 5)

Energy policies that engender conservation, efficiency, and renewable energy systems have great potential to reduce the use of fossil fuels. Some policies are available to local jurisdictions for considerations, such as energy building codes, property assessed clean energy (PACE) programs, rebates and other incentives for renewable energy system installation. Other policies, for example renewable portfolio standards and feed-in tariffs, are accessible mostly to state and national policy makers.

Deployment of smart energy policies is the easiest way, and can be one of the least expensive ways, to enhance and accelerate the development of conservation projects and renewable energy systems.

1. City energy building code

Eureka Springs could adopt a building code that is more rigorous than the Arkansas Energy Code (see http://arkansasenergy.org/media/321645/zone%209b%20brochure%20_%20rev%20may%202010.pdf). The costs and benefits of this project are drawn from the following assumptions:

- Three new residential permits are issued per year, and a new, stricter code would add $3,000 per house to the cost of construction.
- One new commercial permit is issued per year, and a new, stricter code would add $20,000 to the cost of construction.
- A new stricter code would reduce energy use by 2% below the level that results from construction under the existing code.
- Energy improvements in most of Eureka's 1,000 residences will save 5% of current electrical use.

US DOE has a building energy codes program in place that helps states and municipalities improve their standards (http://www.energycodes.gov/about/). The Building Energy Codes Program (originally called the Building Energy Standards Program (BESP) and later the Building Standards and Guidelines Program (BSGP)) was funded in 1993 in response to the Energy Policy Act of 1992, which mandated that

DOE participate in the model national codes development process and that DOE help states adopt and implement progressive energy codes. A recent update to the BSGP action plan provides program goals (http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/regulatory_programs_mypp.pdf) and activities through 2015. REScheck (http://www.energycodes.gov/rescheck/rescheck_archives.stm) and COMcheck (http://www.energycodes.gov/comcheck/comcheck_archives.stm) are DOE-developed software programs that provide means to local building officials to determine compliance with various national and international energy codes. Additional resources for local energy code activities are found at http://bcap-ocean.org/resource/missouri-local-energy-code-action-kit.

2. Property assessed clean energy

Property assessed clean energy, PACE, is a financing mechanism that facilitates installation of energy conservation and energy efficiency improvements on residential and commercial properties. In Arkansas, PACE financing currently lacks enabling authority, but it can be enabled by state legislation. A financing authority loans property owners money for energy upgrades and improvements in exchange for a lien on the property. The loan can be repaid without additional proof of means because energy savings can provide income to offset the debt retirement. In this way, energy improvements pay for themselves through programs that local agencies and governments establish. For more information on PACE financing see http://pacenow.org/documents/PACE_enablinglegislation%203.18.10.pdf.

If adequately supported with public information and public awareness activities, the proposed program could attract a 10% market penetration in the residential market over a five to eight year term.

3. Feed-in tariff

A feed-in tariff provides incentive to purchasers of renewable energy systems by giving a large rebate to power producers. A well-designed FIT could result in the installation of 1,000 kW_{peak} of photovoltaic energy systems in Eureka Springs. Most of this capacity would be installed in hotels and restaurants along Hwy 62B, where restrictions in the city's Historic District and shade from the city's forested environment would not be problems. About 125,000 kWh per month is produced in northwest Arkansas by 1,000kW of photovoltaic installations.

4. Renewable portfolio standard

A renewable portfolio standard (RPS) requires utility companies to provide a specified amount of green power to customers before a statutory deadline. Thirty-two states have an RPS in place, (http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm) and five more have voluntary targets. This report assumes that an RPS for Arkansas can provide an energy profile of 5% renewable energy, and might result in a $0.01/kWh increase in the price of electricity for ratepayers for a ten year period.

5. Progressive (inclining block) rate structure

Inclining block rates charge less per unit of energy purchased to customers who use less than average energy, and more per unit of purchased energy to customers who use more. It rewards customers who invest in energy efficiency and those who are frugal. It's the opposite of what's currently in place. An inclining block rate could result in a 10% reduction in energy consumption.

Energy conservation and efficiency (projects 6 – 9)

Many buildings in Eureka Springs and across the United States could be made 30% more energy efficient than they are by implementing projects that pay for themselves in energy savings or resource conservation of another type within a few years.

6. Improved building energy efficiency

This project is based on the idea that some homeowners, business owners and builders will build and restore super-insulated and super energy efficient buildings, and install renewable energy systems voluntarily, beyond the requirements of a strict local building code. The costs and benefits of the proposed project are drawn from the following assumptions:

- Ten building permits, including new construction and restoration permits, are issued each year.
- After 10 years or 100 buildings, the City will be saturated with projects that achieve this level of energy performance.
- Although the model uses $2,000 per construction project additional cost, which is a very rough estimate, actual costs and benefits will vary considerably.

7. Improved transit efficiency

Recent EPA standards for fleet efficiency (CAFE standards) require American car makers to double fuel efficiency from current performance to 54.5 mpg by 2025. Many residents and tourists will still be driving older cars and trucks then, and the overall improvement in fuel efficiency will be about doubled from current efficiency, which is about 20 mpg. Residents currently use about 1,000,000 gallons of fuel each year, and tourists use about 500,000 gallons, so doubling efficiency will reduce fuel use by 750,000 gallons of gasoline and diesel per year. The costs and benefits of this project are drawn from the following assumptions:

- CAFE standards are triggered in 2025. New car and truck efficiency will be over 100% better (than current efficiency) by 2025; will be less efficient than that until then and more efficient than that after 2025. Therefore, a 50% reduction in fuel use is estimated to be the average savings over the 20-year period of projection.
- The initial cost of gasoline is $3.80. Costs fluctuate wildly, and the analysis is highly dependent on this assumption and on the rate of fuel cost increase in the future.

8. Decreased consumption and increased recycling

The City currently sends nearly 3,000 tons of waste to the landfill annually and recycles just over 600 tons per year. Recycling rates can be doubled through public awareness efforts with minimal addition to physical infrastructure. The annual costs of the project are based on hiring two people at the recycling center at $20,000/yr each. A comprehensive zero waste initiative would complement the carbon emissions reduction plan well.

9. Composting

Over 40% of municipal solid waste is typically compostable (Richard 2012, Waste Management 2012). Reduction of food scraps and other organic materials to the landfill will reduce GHG emissions. The costs and benefits of this project are drawn from the following assumptions:

- Initial (current) tipping fees are $45/ton.
- Initial value of compost is $50/cu yd; bulk density is 4 MT/cu yd; food scraps are reduced 50% by weight in the composting process.
- A commercial-scale composting facility can be developed for approximately $300,000 initial cost.
- Half of the food scraps in the City (300 tons/yr) will be composted. The other half will be used directly by residents or remain unrecovered.
- One person can manage the compost facility at $20,000/yr salary.

Municipal-scale compost systems have been tried in several locations across the U.S., including Ladue, Missouri (http://www.jgpress.com/archives/_free/000457.html), at Cornell University (http://compost.css.cornell.edu/waterqual.html), and in San Francisco (http://sunsetscavenger.com/residentialCompost.htm, http://www.jepsonprairieorganics.com/). Ladue and Cornell use open air, aerobic windrow composting, while the San Francisco operation uses the same method after pre-processing in grinders and vessels. Fort Lewis, Washington, a U.S. Army Base, also tried large-scale composting, but trials there failed to attain temperatures suitable for compliance to meet regulatory standards (http://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_1_69.pdf).

Other challenges with large-scale composting operations that accept multiple inputs include chemical contamination (for example, see http://www.compostsystems.com/blog/uscc-issues-alert-us-composters), plant diseases and weed seeds and odors (http://www.rcgardens.ca/factsheets/factsheets/municipalcompost.html).

A wide range of information is available about municipal and large-scale composting, including:
http://www.urbangardencenter.com/links/index.html#comp02
http://www.ethicurean.com/2008/07/14/food-scrap-composting/
http://www.co.delaware.pa.us/recycle/composting.html
http://www.jepsonprairieorganics.com/
http://www.lesecologycenter.org/index.php?option=com_content&view=section&id=3&Itemid=6&28e5bbf660cb545fc854f5c048c7be7c=2a97888458123fb95629cd4530a84f2a
http://www.nyc.gov/html/nycwasteless/html/compost/composting_nyc.shtml
http://www.portlandonline.com/bps/index.cfm?c=ebgic
http://www.seattle.gov/util/Services/Yard/CommercialCompostCollection/index.htm
http://www.metrovancouver.org/services/solidwaste/Residents/composting/Pages/default.aspx

Renewable energy (projects 10 – 13)

10. Biodiesel

A micro-refinery to convert used cooking oil (WVO, waste vegetable oil) can be established from off-the-shelf components. The costs and benefits of this project are drawn from the following assumptions:

- Up to 12,000 gallons of WVO is available for collection. WVO will be made available from restaurants at no cost to the collector.
- The initial cost of diesel fuel is $4.00/gallon.
- Methanol and lye for processing cost $1 for each gallon of WVO produced.
- One person, half-time or less, can operate the facility at a salary of $10,000/yr.

11. Biomass

Biomass materials from the region's forests, poultry houses, and cattle ranches could be harvested or collected for use as biofuels and combustible feedstock to bioenergy systems. The estimate used here is based on a pro forma for a wood-fired furnace that heats a school campus in Massachusetts (http://www.nrbp.org/pdfs/pub22.pdf), which used a rate of energy price increase of 1% and a discount rate of 3%.

12. Photovoltaic electricity

The cost and competitiveness of photovoltaic (PV) generated electricity is increasingly favorable compared o other energy sources. Over the next 30 years, up to 2.5 megawatts of PV can be installed on homes and businesses in the City. The costs and benefits of this project are drawn from the following assumptions:

- The initial cost of electricity is $0.085/kWh.
- The initial cost of installation is $3.00/watt$_{peak}$.
- The capacity factor is 16.7%, which is derived from 10 years of empirical data from a 10kW$_{peak}$ system in northwest Arkansas that has a panel efficiency of ~16%.

13. Solar hot water

Solar hot water can be installed to reduce the use of natural gas in residential and commercial applications. Commercial-sized systems of about 10,000 sq ft would be useful to hotel/motel operators who have high laundry and cleaning loads, and who could heat swimming pools. Installations at motels would also avoid issues of the Historical District downtown. The costs and benefits of this project are drawn from the following assumptions:

- The initial cost of natural gas is $5.00/therm.
- The initial cost of installation is $80.00/sq ft of panel.
- 100,000 sq ft of solar thermal energy could be configured into ten to twenty systems of 5,000 to 10,000 sq ft each.
- The average panel provides 1000 Btu/sq ft/day.
- Although the model assumes that all systems are installed in year one, it will be several years before the program is fully in place.
- Benefits will be distributed among system owners.

Carbon sequestration (projects 14 – 15)

14. Forest sequestration in Lake Leatherwood City Park (unregistered)

Lake Leatherwood City Park is one of the largest city parks in the nation, and because of it, over one-third of the City of Eureka Springs is set aside in city parks. At 1,600 acres, it provides trails for biking and hiking, and assures a pure source of water for Lake Leatherwood. In unmanaged Ozark forests, carbon sequestration may be about 1 MT CO_2 per acre per year. Simply maintaining the park as it is sequesters 1,600 MT CO_2 per acre per year, which is about 3% of the level of total community GHG emissions.

15. Forest sequestration citywide (unregistered)

The City encompasses 4,339 acres, and 1600 acres of that area is Lake Leatherwood City Park (see project 14). The remaining 2,739 acres is estimated to be 75% forested, and that area sequesters about 2055 MT CO_2 per acre per year at no cost to the City or its residents. This sequestration cannot be registered, and although it is a positive contribution, it cannot be used to reduce the GHG inventory for planning purposes.

Purchased offsets (projects 16 – 17)

1. Renewable energy credits

The current cost of purchased offsets is at least $15/ MT CO_2e. No purchase of renewable energy credits (RECs) is proposed in this plan, but it is a strategy that may receive consideration in the future.

2. Offsets for commuter emissions from parking fees or other instruments

The current cost of purchased offsets is at least $15/ MT CO_2e. Although there are positive aspects of requiring payment of offsets by commuters and tourists who burn fossil fuels for transportation (pay-as-you-go, user pays full costs), no purchase of offsets for transportation fuels is included in this plan.

Long-term projects (projects 16 – 17)

16. Hybrid, H_2 and biofuels transportation

By 2050, automotive technology and transportation policies will assure that personal transportation will not be based on fossil fuel use. H_2, biofuels, and electricity from solar and wind power will power most forms of transportation. It is impossible to predict which technologies will prevail, or how the transition to them will affect costs and benefits. This plan assumes that vehicles of the future will neither cost nor save residents of Eureka Springs compared to current vehicles. And even if alternative transportation does cost more than current systems, as measured against percent of income or some similar measure, the city and its residents will have little authority to change the markets that provide vehicles.

17. Landfill gas to electric

The plan calls for the City of Eureka Springs to create a partnership with Carroll County Solid Waste Authority to develop a landfill gas-to-electric facility at the landfill. (See EPA's web page http://www.epa.gov/lmop/publications-tools/index.html for information on landfill gas (LFG) energy development possibilities.) An assessment of this potential has not been carried out, and therefore the potential quantity of production is not known.

Waste Management operates facilities of this type in North Little Rock (Two Pines Landfill in Jacksonville, AR, with a 4.8 MW electrical capacity, which reduces emissions by 26,000 MT CO_2e/yr) and Tontitown (EcoVista Landfill, with a 4.0 MW capacity, which reduces emissions by 22,000 MT CO_2e/yr). The costs and benefits of this project are drawn from the following assumptions:

- The initial cost of electricity is $0.07/kWh (wholesale price).
- The initial cost of installation of the landfill gas-to-electric plant is $2.00/$watt_{peak}$.
- The capacity factor is 95%.
- The discount rate is 4% and the rate of energy price increase is 4% per year.
- The proposed project is based on the availability of LFG to power a 1 MW turbine, and cold be scaled up or down to suit actual LFG availability.
- Annual M&O may be higher than projected; this study did not research actual costs of similar installations.
- A projection of arrangement for sharing of costs, benefits, risks, and administration of this proposed project has not been included in this report.

Eureka Springs *GHG emissions reduction plan*

Short-term projects, initiated between 2012 and 2020

Projects	Initial cost	Annual cost	Net present value	MT CO_2e avoided yr^{-1}	\$/MT CO_2e avoided	NPV/CO_2e total avoided
Policies						
1. Building code upgrades	$0	$29,000	($11,130)	228	$126.98	-2
2. Property assessed clean energy	$0	$0	$2,002,175	571	$0.00	125
3. Feed-in tariff	$0	$13,117	($367,265)	1,110	$11.03	-12
4. Renewable portfolio standard	$0	$154,313	$2,143,983	786	$6.54	97
5. Progressive (inclining block) rate structure	$0	$0	$3,999,679	1,141	($4.10)	125
Conservation and efficiency						
6. Improved building energy efficiency	$0	$20,000	-$136,808	1,669	$2.93	-3
7. Improved transit efficiency	$0	$0	$34,615,385	5,775	$0.00	214
8. Increased recycling	$0	$40,000	$72,516	549	$72.86	5
9. Composting	$300,000	$20,000	($425,954)	246	$121.95	-62
Renewable energy						
10. Biodiesel	$25,000	$30,000	$463,065	98	$242.35	236
11. Biomass	$5,000,000	$50,000	$10,009,372	1,140	$252.19	314
12. Photovoltaics	$5,306,000	$0	$8,308,596	2,687	($39.91)	110
13. Solar hot water	$900,000	$10,000	$27,269,791	2,081	$28.84	468
Sequestration						
14. Forest sequestration (Lake Leatherwood CP)	$10,000	$1,500	$0	1,600	$1.35	0
15. Forest sequestration (urban forest)	$0	$0	$0	2,055	$0.00	0
Purchased offsets						
16. Renewable energy credits	$0	$0	$0	0	$15.00	
17. Commuter offsets with parking fees	$0	$0	$0	0	$15.00	
Totals	**$11,541,000**	**$367,930**	**$87,943,404**	**21,736**	**$34.63**	

Long-term projects, initiated between 2020 and 2050

Project	Initial cost	Annual cost	net present value	MT CO_2e avoided yr^{-1}	\$/MT CO_2e avoided
Conservation and efficiency					
18. Hybrid, biofuels, and H_2 transportation	$0	$0	$0	6,860	$0
Renewable energy					
19. Landfill gas to electric	2,000,000	40,000	9,390,962	5,849	($80)

Summary of all projects	Initial cost	Annual cost	net present value	MT CO_2e avoided	\$/MT CO_2e avoided
Totals	$13,541,000	$407,930	$97,334,365	1,308,894	($74)

Summary of short-term projects	% of total first cost	% of annual cost	% of NPV	avoided emissions
policies	0.00%	53.39%	8.83%	17.65%
conservation & efficiency	2.60%	21.74%	38.80%	37.91%
renewable energy	43.54%	21.74%	11.91%	27.63%
sequestration	0.09%	0.41%	0.00%	16.82%
offsets	0.00%	0.00%	0.00%	0.00%

Table 7. Summary of financial and GHG factors for the GHG reduction plan

Environmental summary	MT landfill avoided/yr	MT CO_2e avoided/yr	Impact on biodiversity	Regulated emissions
Policies				
1. City building code	0	228	3.0	3.0
2. PACE	0	571	3.0	3.0
3. Feed-in tariff	0	1,110	3.0	3.0
4. RPS	0	786	3.0	3.0
5. Progressive utility rates	0	1,141	3.0	3.0
Conservation & efficiency				
6. Building efficiency	0	1,669	3.0	3.0
7. Transit efficiency	0	5,775	3.0	3.0
8. Recycling	600	549	3.5	3.0
9. Composting	150	246	4.0	3.0
Renewable energy				
10. Biodiesel	30	98	3.0	3.0
11. Biomass to electricity	0	1,140	3.0	2.5
12. Photovoltaics	0	5	3.0	3.0
13. Solar hot water	0	2,081	3.0	3.0
Other				
14. - 15. Sequestration	0	1,600	4.0	3.0
16. Renewable energy credits	0	2,055	3.0	3.0
17. Offsets with parking fees	0	0	3.0	3.0
18. Hybrids, H_2, electric cars	0	6,860	3.0	3.5
19. Landfill gas-to-electric	0	5,849	3.0	3.5
5 = very responsive to community issues				
4 = acknowledges community issues				
3 = neutral				
2 = tin ear; doesn't hear the community				
1 = counter to community needs				

Table 8. Summary of environmental factors for GHG reduction projects

Social summary	Uses land sustainably	Creates community connections	Creates sustainability ethos	Supports local organizations	Supports indigenous people	Supports public health	Creates social justice	Creates right work	Score
Policies									
1. City building code	3	3	4	3	3	3	3	3.0	3.1
2. PACE	3	3.5	4	3	3	3	3	3	3.2
3. Feed-in tariff	3	3	4	3	3	3	3	3	3.1
4. RPS	3	3	4	3	3	3	2	3	3.0
5. Progressive utility rates	3	3	4	3	3	3	5	3	3.4
Conservation & efficiency									
6. Building efficiency	4	3	4	3	3	3	3	4	3.4
7. Transit efficiency	4	4	4	3	3	3.5	4	3	3.6
8. Recycling	4	4	4	4	3	3	3	4	3.6
9. Composting	4	4	4	4	3	3.5	3	4	3.7
Renewable energy									
10. Biodiesel	4	3	4	3	3	3	3	4	3.4
11. Biomass to electricity	3	2.5	4	4	3	3	3	3	3.2
12. Photovoltaics	3	3	3	4	3	3	3	4	3.3
13. Solar hot water	3	3	3	4	3	3	3	4	3.3
Other									
14. - 15. Sequestration	4	5	4	4	3	4	3	4	3.9
16. Renewable energy credits	3	3	3	3	3	3	3	3	3.0
17. Offsets with parking fees	3	3	3	3	3	3	2	3	2.9
18. Hybrids, H_2, electric cars	3	3	3	3	3	3	3	3	3.0
19. Landfill gas-to-electric	4	3	3	3	3	3	3	3	3.1
5 = very responsive to community issues									
4 = acknowledges community issues									
3 = neutral									
2 = tin ear; doesn't hear the community									
1 = counter to community needs									

Table 9. Summary of social factors for projects in GHG reduction plan

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