As part of the initial feasibility study for on-site energy production, it is recommended that the City identify barriers to the installation of small wind turbines such as permitting complications, zoning barriers, and utility grid hookups.

Initial Cost

Small wind energy systems cost from $3,000 - $5,000 for every kilowatt of generating capacity, or about $40,000 for a 10 kW installed system without taking into account rebates or incentives.[26] For the purpose of analyzing the cost benefit of this measure, we will assume that the City installs ten small-scale wind turbines, which would equal $30,000 - $50,000 without assistance.

The California Solar Initiative provides rebates for wind turbines less than 50 kW. The American Wind Energy Association estimates that this program, along with other federal programs, will cover the cost of a wind turbine within 10 years, resulting in 20 years of relatively no-cost energy.[27]

For the purposes of this study, we will assume that half of the cost of the wind turbines will be borne up-front in order to create consistency with other measures that also have a payback. Therefore, the initial cost of ten wind turbines is estimated to be $15,000 - $30,000 assuming most planning and coordination by Staff is completed as part of the initial feasibility study.

Greenhouse Gas Emissions Reductions

For the purpose of this cost/benefit analysis, we will assume that the City will install at least ten small-scale wind turbines and the community will install at least five. Each turbine of 10 kW will produce approximately 22,000 kWh per year.[28] That's a total of 328,500 kWh of clean energy produced per year in San Carlos and 131 metric tons of CO_2e prevented from release into the atmosphere.

5.3. Identify opportunities for Biomass energy opportunities

This measure would lead to the identification of opportunities for biomass energy production and consumption. Biomass energy is energy from plants and plant-derived materials like agricultural waste, yard waste, and even methane from waste decomposition. It can be used for power production, products, and fuels.[29]

It is difficult to make an estimate of initial cost and greenhouse gas emissions reductions from biomass energy, even for the sake of analysis. The only method of biomass energy production that is quantifiable is methane capture. However, since the landfills serving

[26] American Wind Energy Association (AWEA), "Finding Incentives," http://www.awea.org/smallwind/toolbox2/financing.html, accessed November 3, 2008.
[27] AWEA, "Finding Incentives"
[28] 10 kWh system * .25 capacity factor * 24 hours/day * 365 days per year = 21,900 kWh. Capacity factor provided by AWEA at http://www.awea.org/faq/basicen.html accessed November 4, 2008.
[29] National Renewable Energy Laboratory, Biomass Energy Basics. http://www.nrel.gov/learning/re_biomass.html. Accessed October 13, 2008.

the City of San Carlos are all outside of City limits, it is unlikely that this biomass energy could be routed back into City limits.

Table 8
Summary of Energy Use Reduction Measure 5

	Component	Initial Cost to the City	GHG Reduction (metric tons CO_2e / year)	Cost per metric ton CO_2e
Overall Cost for a feasibility study of on-site renewable energy generation		**$10,000**	**0**	**N/A**
1	Identify opportunities for increasing solar system installations in the community and on City facilities.	$480,000*	263*	$1,825
2	Wind energy generation	$15,000 - $30,000*	131*	$114.50 - $229
3	Biomass energy	Unknown	Unknown	N/A
TOTAL		**$505,000 – $520,000**	**394**	**$1,282 - $1,320**

** These are minimum estimates of what the City could produce under these measures for the purpose of the cost/benefit analysis. These cost estimates do not factor in the energy use reductions that would result, and the associated utility bill savings. Estimated return on investment is 15-20 years.*

6. Implement reduction strategies included in the energy audit of City facilities and continue to monitor City facility performance

-160 Metric Tons Co2e

The City is currently working on auditing the energy performance of City owned and operated facilities. This measure is to implement the recommendations included in the audit to increase efficiency in City-owned and -operated buildings. The City may also consider seeking energy audits of organizations to which it makes financial contributions.

A lighting audit of the Adult Community Center (ACC) has already been completed. The preliminary audit shows that the City will save approximately $91,000 in the long run from a lighting retrofit in the ACC alone!

Lighting retrofits and other measures will continue to save the City money on electricity while lowering its greenhouse gas emissions. It will also establish the City as an example for privately-owned facilities to follow.

Initial Cost

Until the audit is completed, the cost of modifying City facilities and their operations to increase efficiency is unknown.

Greenhouse Gas Emissions Reductions

The greenhouse gas emissions reductions cannot be calculated until the audit of City facilities is completed. However, from the completed audit of the Adult Community Center we can calculate that at least 16 metric tons of CO_2e will be saved annually. From that audit and examples of similar municipal consumption rates, it is estimated that the municipal audit will save at minimum 160 metric tons of CO_2e annually, which is about a 3% reduction in emissions from the commercial sector.

Table 9
Summary of Energy Use Reduction Measure 6

	Component	Initial Cost to the City	GHG Reduction (metric tons CO_2e / year)	Cost per metric ton CO_2e
1	Implement the audit of municipal facilities when completed	Unknown	160	N/A
TOTAL		**Unknown**	**160**	**N/A**

7. Provide for increased albedo (reflectivity) of all urban surfaces including roads, driveways, sidewalks, and roofs in order to minimize the urban heat island effect

-2,230 Metric Tons Co2e

'Cool roofs' and 'cool pavements' are made of materials with higher solar reflectivity, which counters the urban heat island affect and reduces air conditioning use. Dark pavement and roofs absorb heat from the sun, creating higher urban temperatures and increasing the need for air conditioning. According to a recent study by Akbari, Menon, and Rosenfeld, using white materials for a 1,000 square foot roof can reduce carbon dioxide emissions by approximately 10 metric tons and urban surface temperatures up to three degrees.

California has required white colored material for flat roofs since 2005. Under this reduction measure, the City would pave all surfaces with high-albedo concrete or aggregate when in need of repair with the overall goal of paving 15% of all hardscape under the City's control with high albedo materials. Surfaces can include parking lots, sidewalks, driveways, and roads.

Initial Cost

The US Environmental Protection Agency identifies multiple cool pavement technologies, many of which are similar if not lower in cost to traditional asphalt. There

would be some staff time for coordinating with public works and including the high albedo content requirements in the design of projects included in the Capital Improvement Plan (CIP). CalTrans would also need to be contacted regarding El Camino Real and the State's efforts to increase albedo on State highways.

Greenhouse Gas Emissions Reduction

The Lawrence Berkeley National Laboratory Urban Heat Island Group estimates that pavement reflectivity can be raised on average only 15% in an urban area. This 15% causes four metric tons of carbon dioxide to be offset per 1,000 square feet replaced when compared to traditional asphalt. Assuming that 12% of San Carlos is covered in pavement, or approximately 2 million square feet, and assuming that 30% of all hardscape controlled by the City is repaved with high albedo content material by 2030, we estimate that this measure will result in at least 2,320 metric tons of CO_2 equivalent savings per year.

Table 10
Summary of Energy Use Reduction Measure 7

	Component	Initial Cost to the City	GHG Reduction (metric tons CO_2e / year)	Cost per metric ton CO_2e
1	Provide for increased albedo (reflectivity) of all urban surfaces including roads, driveways, sidewalks, and roofs in order to minimize the urban heat island effect.	Negligible	2,320	Negligible
TOTAL		**Negligible**	**2,320**	**Negligible**

8. Encourage tree planting

-356 Metric Tons Co2e

This reduction measure calls for increased support for community tree planting programs and more rigorous tree planting requirements for new development. Trees reduce greenhouse gas emissions by naturally sequestering carbon dioxide and creating more oxygen. Additionally, the shade from trees helps minimize or prevent the urban heat island effect, a condition where urban surface and air temperatures are higher than rural surrounding areas due to development patterns.[30] The urban heat island effect can have a large impact on local air temperatures and long-term climate patterns. Air temperature differences of approximately 3.6°F to 7.2°F have been observed for urban neighborhoods of contrasting tree cover, averaging approximately 1.8°F per 10% canopy cover.[31]

[30] US Environmental Protection Agency, "Heat Island Effect." http://www.epa.gov/hiri/about/index.html. Accessed Oct 12, 2008.
[31] Scott, Simpson, and McPherson. "Effects of Tree Cover on Parking Lot Microclimate and Vehicle Emissions." Journal of Arboriculture 24(3): May 1999, 129.