# A Proposal for Solar Energy Power in the city of Boulder, Colorado

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With resources quickly diminishing, it is up to this generation to begin to investigate new forms of energy. Boulder is the ideal site to implement this initiative because it has been open to alternate forms of power in the past. The city's residents are open to new ideas and are willing to change to benefit the environment. In fact, in 2005 Boulder took on a wind challenge, with a goal of having 500 wind power subscribers. Boulder went above and beyond the challenge by recruiting 1,150 residents. Boulder is now a Green Power Community, the only one currently in the state of Colorado. A Green Power Community is designated by the Environmental Protection Agency as being a community that is "government accredited clean, renewable energy sourced from the sun, wind, water and waste" (EPA, 2006). Because Boulder is already certified in the wind aspect of Green Power Community, it would not be difficult to become certified in solar power also.

Photovoltaic solar cells will be the best answer to the problem with diminishing nonrenewable energy. Solar energy in Boulder is the best choice due to Boulder's amazing location and the immense amount of sunlight that it receives each year. Boulder is one of the sunniest cities in the country, with about 300 days of sunshine per year. Why not use all of that beautiful sunlight for something useful? Boulder receives about 5kWh per $m^2$ per day from the sun (See appendix; National Atlas, 2006). This makes solar power a viable alternative to fossil fuel sources.

The word photovoltaic combines two terms: photo meaning light and voltaic meaning voltage (Encyclopedia Britannica, 2006). A photovoltaic system uses photovoltaic cells to directly convert sunlight into electricity. Photovoltaic cells are essentially a specially designed diode, usually made of silicon crystal. A diode is an electronic device that restricts current flow to one direction. The electrons flow from the cathode (positive layer of diode) to the anode (negative layer of diode) (Encyclopedia Britannica, 2006). When light enters the exposed active surface, it jars electrons loose from their sites in the crystal. The electrons that have enough energy to go through the diode cannot return to positions on the other side, without passing through an external circuit (Encyclopedia Britannica, 2006). The current generated from the cells is small and the voltage is low, and therefore they must be connected in “large series-parallel arrays” (solar panels) in order to produce useful amounts of energy. Typical solar panels of this kind are about 10% to 15% efficient in converting light energy into electrical energy.

For many years the most common use for solar panels was to provide electric power for satellites (Encyclopedia Britannica, 2006). Currently solar panels provide energy to private residences, businesses and cities with large scale demands. Large scale power conversion solar cells have many problems; the most serious of these is the wide variation of voltage and current, which oscillate directly with the amount of sunlight. This can be compensated for by storing the energy produced during peak periods in batteries. Another solution to this problem is to create a grid tied system, which outputs the energy not being used directly back into the grid. The energy transferred back into the grid can be metered and private companies or residences can sell it to the local utilities. However, this still does not solve the problem of energy storage when too much energy is produced.

Currently many governments have created subsidies for private citizens and businesses, which purchase this “green” energy at an above market rate to create incentives for people to incorporate photovoltaic (PV) systems to power homes and businesses. Although this does not work in remote areas that are off the grid, it is a good alternative to batteries in areas that are. Photovoltaic cells will soon begin to power some of the homes in Boulder in order to keep the environment clean.

In 2004, Boulder produced 41 million kilowatt hours (kWh) of renewable energy, such as wind, solar, and hydropower. This was enough power to fully power 13% of Boulder's households, or about 5,200 homes (City of Boulder). The production of this energy replaced 20,500 tons of coal usually used to produce Boulder's energy. In addition, the amount of $CO_2$ released into the atmosphere was reduced by 41,000 tons (City of Boulder).

The environmental advantages to producing a portion of Boulder's energy by renewable sources, specifically solar energy, are evident. As Boulder's energy demands increase along with the world's, the demands on the electricity plants also increase. The increase in energy consumption goes hand in hand with the increase in coal burning, adding more greenhouse gases to the atmosphere. With some of the energy demand being offset by an increase in solar energy production, these emissions will be reduced. In addition, the need for an additional coal or fossil fuel fired power plant may be eliminated, or at the very least, delayed.

Boulder will initially provide $4 million, or about 2% of the total 2005 budget, toward this solar energy initiative. This money will primarily subsidize Xcel Energy's Solar Rebate Program (DSIRE, 2006). In this program, Xcel will pay up to $4.50 per Watt (W) installed for customers who install grid connected photovoltaic (PV) cells on their homes or businesses. Of this $4.50, $2.00 per W is a rebate, and the other $2.50 per

W is a Renewable Energy Credit (REC). This rebate program was a part of Colorado's Amendment 37, passed in 2004. As part of this program, businesses are required to purchase 10% of their energy from renewable sources by 2015, with 4% generated by solar.

In the city of Boulder, the average household's electricity bill is around $650 a year. This is about 1kW per hour for the 40,000 households in the city of Boulder, or about 350 gigawatt hours (GWh) per year. With a budget of $4 million, Boulder would be able to pay $0.40 for each kilowatt hour produced (versus about $.08 per kWh used). Based on this budget, 10 GWh returned to the grid could be paid for in the first year of operation. This would account for nearly three percent of Boulder's annual total energy use. This is very advantageous to Boulder, which as a city prides itself on its respect for the environment.

If Boulder were to follow the installation rate of PV systems supported by our Feed-in-Tariff (FiT) for the duration of this initiative, in 20 years Boulder would produce more than half of its total energy usage by solar energy. This would be a huge accomplishment because the city of Boulder would not only meet the growing demand of energy, but it will be achieved through a renewable resource which has no environmental byproducts.

For the consumer, this is an exceptional investment. For example, a British Petroleum (BP) 3 kW system costs the consumer roughly $11,500. This cost takes into account the base price of $27,000 minus $13,500 in rebates receivable and $2,000 in tax credit. The calculated annual bill savings for the consumer is $257 and the annual tax savings is $247 (Table 1). This $504 annual savings is equal to putting the initial

$11,500 into a bank and earning 4.4%. This is a generous yield compared to the 2 to 3% that a normal savings account yields. In addition, earnings of $0.40 per kWh produced by the installed 3 kW PV system of about $1,700 annually (Table 1). These earnings are calculated from the annual kWh produced by a 3 kW solar system, which has been calculated as 4,223 kWh (Table 1). This is an additional annual return of about 14%. This return is better than the statistical return of the S&P 500, which has been 10.4% over the last 79 years (USA Today, 2006).

Using solar cells benefits both the city of Boulder and the residents who opt to power their homes with solar power. The rate of return on the initial investment is astronomical compared to what one could earn in either a bank or the stock market in the same period of time. The city can pride itself on conserving energy and petition the government to acquire more funding for the operation.

There are many reasons why one should make photovoltaic cells and solar energy a part of their daily life, but the major incentive is that this will protect the environment. This is a potentially profitable venture for the government, both the City of Boulder and the United States, to become involved in. As less than 10% of energy is produced by renewable means, now is the time to support communities using alternative energy options before the supply of fossil fuels is depleted and the damage to the environment is irreversible. By embracing the solar initiative presented here, Boulder can help its residents and its government move toward a cleaner and more renewable way of living.

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# Appendix

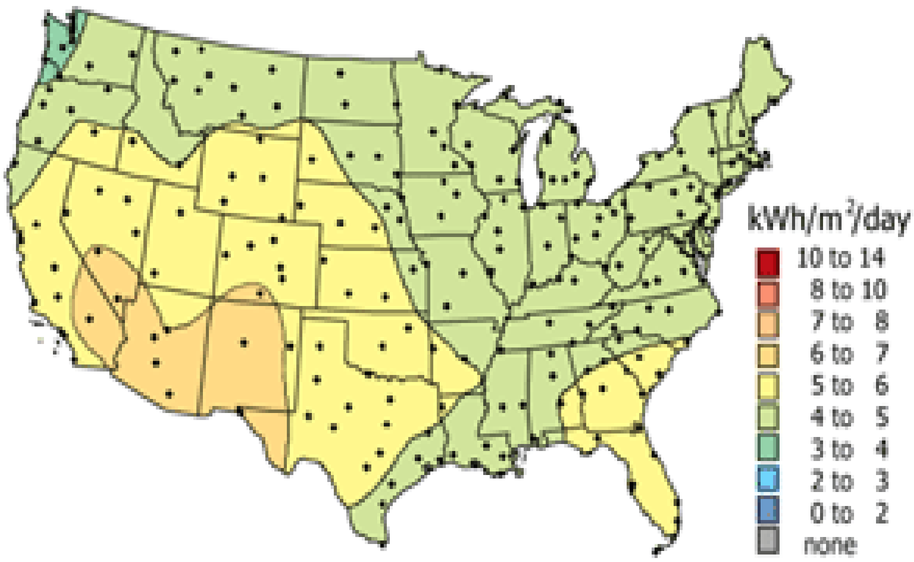


**Figure 1.** Annual average daily solar radiation per month, using a flat-plate collector facing south at a fixed tilt equal to the latitude of the site. Boulder and Colorado receive 5-6 kWh/m$^2$/day, making solar power a viable choice. Adapted from (National Atlas, 2006).

## Your System Size: Small

You can fine tune your system size using the pull-down menu below, and then click on "Recalculate" to see the adjusted cost and savings.

3 kw | Recalculate

### What it costs

| | |
|---|---|
| Retail Price | $27,000 |
| Rebates | $13,500 |
| Tax Credits | $2,000 |
| **Final System Cost:** | **$11,500** |

| **What you save** | **Monthly** | **Annually** |
|---|---|---|
| Electricity Production | 351 kWh | 4,223 kWh |
| Bill Savings | $21 | $257 |
| Tax Savings* | $21 | $247 |
| **Bill Reduced By** | **21%** | **21%** |

### Geographic Details

**City:** Boulder
**State:** CO

### Sunlight intensity:

The sunlight intensity in your area is rated: **Excellent**

### Environmental Benefit

Per year, this system will eliminate the production of

| | |
|---|---|
| 5,255 lbs of | CO2 |
| 20.7 lbs of | NOX |
| 23.1 lbs of | SO4 |

**This is equivalent to planting 1 acre of trees**

**Figure 1**. Sample cost quote for a 3 kW solar cell system. Adapted from: BP Solar, 2005.