Green building policy options for reducing greenhouse gas emissions:

Analysis and Recommendations for the City of Santa Rosa

Eric Wanless
LEED Accredited Professional
Norwest Consulting

A report commissioned by the Accountable Development Coalition

September 2007

Executive Summary

The built environment represents a significant source of greenhouse gas emissions, and green building requirements are therefore a critical tool in reaching state and local targets for emissions reductions. This report examines what reductions in CO_2 emissions could be achieved from various standards for new construction, makes recommendations on what minimum green building standards should be, and addresses concerns related to the adoption of a mandatory green building ordinance.

Specifically, this report makes the following findings and recommendations:

- Reaching the City's climate protection goal of reducing greenhouse gas emissions to 25% below 1990 levels by the year 2015 will require the City to lower emissions *from buildings alone* by over 293,000 metric tons of carbon dioxide. As a metric, a reduction of just 10,000 metric tons of CO_2 is the equivalent of retiring 1,300 cars.
- In order to even approach this goal, the City must adopt an aggressive, mandatory green building standard for both new construction and retrofits and remodels.
- There are significant jumps in the modeled reductions in CO_2 emissions that are achieved when setting the minimum standards for all new construction at:

    - 100 points under 2007 Build it Green guidelines for residential construction
    - 39 points under Leadership in Energy and Environmental Design (LEED) criteria for commercial construction

- Because such a substantial percentage of modeled CO_2 emissions during the 2007-2015 time period will come from *existing* buildings, it is critical that a green building policy include not only standards for new construction, but also comparable requirements for new retrofits and remodels.
- Build it Green criteria for 2007 as opposed to 2005 should be utilized for residential construction. The 2007 standards require construction to achieve a minimum of 15% above Title 24 energy efficiency standards.
- For LEED certification levels Gold and lower, the cost premium of building "green" is generally less than 2% of total construction costs. Up to and including Gold level LEED, there is no correlation between the level of LEED certification and per-square-foot construction cost.
- As past studies have found, integrating green building design represents a highly cost-effective investment, yielding a 20% net return on an initial investment of less than 2%.
- This analysis details the reductions in greenhouse gas emissions that could be realized from increased energy efficiency alone, and due to time constraints, does not include modeled reductions in CO_2 emissions that could be realized from other benefits of green building design.
- Features that would result in addition reductions in greenhouse gases include: on-site electricity generation, water efficiency/conservation, building material reuse, greater access to mass transit, and renewable and/or sustainably harvested building materials.

Acknowledgements

The Accountable Development Coalition's initiatives would not be possible were it not for the expertise and dedication of an extraordinary group of individuals and organizations, including: Center for Community Innovation, Daisy Pistey-Lyhne, Dennis Rosatti, the Great Communities Collaborative, Greenbelt Alliance, Guy Connor, Julia Prange, Nick Caston, Sabrina Ross, Scot Stegman, and the Transportation and Land Use Coalition (TALC).

We are extremely grateful to our major funders for sharing in our vision: Rick Theis, the San Francisco Foundation, and the Transportation and Land Use Coalition (TALC). Special thanks also goes to many other for their generous financial support, including Kaiser Permanente, Michael Allen, North Bay Labor Council, Sonoma, Mendocino and Lake County Building Trades Council, and Veronica Jacobi.

For their talent, diligence, and commitment to sustainability, a debt of gratitude to all staff and members of the Accountable Development Coalition.

Accountable Development Coalition

1.0 Introduction

The analysis presented in this report attempts to quantify the greenhouse gas emission reductions associated with a green building ordinance in the City of Santa Rosa (Santa Rosa or City). Two potential green rating systems were evaluated: the US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) New Construction (NC) version 2.2 system was applied to commercial new construction and Build it Green's (BIG) GreenPoints rating system was applied to residential new construction.

While it is abundantly clear that green buildings use less energy, and therefore emit fewer greenhouse gases than conventional buildings, very little literature exists that explicitly addresses greenhouse gas emission reductions associated with green buildings.[1] It is important to note that the analysis conducted in this study focused only on the greenhouse gas emission reductions associated with on-site energy efficiency in new residential and commercial construction.[2] *Passive solar design, efficient water use, materials and resource conservation, waste diversion, and many additional aspects of green building will contribute significantly to greenhouse gas reductions.*

An effective green building ordinance is a critical component to reducing greenhouse gas emissions in Santa Rosa. Equally, if not more important, is the need to reduce the energy use and greenhouse gas emissions associated with existing buildings. The vast majority of building related greenhouse gas emissions in Santa Rosa in the 2007-2015 and 2007-2020 timeframe come from existing buildings. Fortunately there are several efforts underway in the state of California to address the energy use and greenhouse gas emissions associated with existing buildings. Significant potential exists for Santa Rosa to build on and aide in these efforts.

Before interpreting the results presented in this analysis it is important to note that there are many large uncertainties existing in the underlying data. The results are indicative only and should not be treated as absolutes; at best, they are order of magnitude approximations. The largest uncertainty in the calculations comes from the lack of specific information regarding the energy performance of homes rated under the GreenPoints rating system. The method used to estimate GreenPoints contributions is described in the assumptions and methodology section of this report. Additional uncertainty stems from the estimation of how many points will be achieved in the various categories of the respective green building rating systems. Despite these uncertainties it is apparent that an ordinance that holds new construction to a higher green building standard will generate more greenhouse gas emission reductions than a lower standard.

[1] LEED rated green buildings typically reduce energy use by an average of 36 percent; see: Katz, Gregory H. "Green Building Costs and Financial Benefits," Capital E, 2003. By their very nature, the minimum requirements of many green building rating systems demand reduced energy use compared to conventional homes. Note that several efforts are currently underway to quantify the greenhouse gas impacts of building green. The results of these efforts are expected by spring of 2008.

[2] Evaluation of a potential "upper bound" of emission reductions also looked at on-site renewable energy generation.

2.0 Results

2.1 Greenhouse Gas Reductions Associated with Onsite Building Energy Use

Table 1 below presents greenhouse gas emission reductions in Santa Rosa, compared to a business as usual baseline, for a residential green building ordinance based on the GreenPoints rating system. Table 1 also presents an equivalent "Cars Taken Off the Road" value for each point level.[3] All emission values in this report are given in metric tons of CO_2 equivalent. Note that without mandating that the minimum requirements needed to be labeled "green" under the GreenPoints rating system are met there is no guarantee of greenhouse gas emission reductions for lower point levels. For instance, it may be possible to achieve 50 points in the GreenPoints rating system without reducing on-site energy use at all. Mandating the minimum GreenPoints requirements for all residential new construction would guarantee at least 6,000 metric tons of greenhouse gas reductions in 2015 and 9,400 metric tons in 2020.

Table 1: Residential New Construction Building Greenhouse Gas Emission Reductions Due to Energy Efficiency

GreenPoints Level	Metric Tons of GHG Reductions		Cars Taken Off the Road	
	2015	2020	2015	2020
50	7,000	11,000	1,300	2,100
90	8,000	13,000	1,500	2,500
100	10,000	15,000	1,900	2,800
120	11,000	18,000	2,100	3,400

Table 2 below presents the greenhouse gas emission reductions in Santa Rosa from a commercial green building ordinance based on the LEED NC v2.2 rating system. The approximate LEED level is shown for the point levels evaluated, however, this is an approximation only, as the values were not constrained by the minimum certification requirements in LEED NC v2.2.[4] Note again, without mandating that the minimum requirements of the LEED NC v2.2 are met there is no guarantee of greenhouse gas emission reductions at lower point levels. Mandating the minimum requirements for LEED NC v2.2 certification would guarantee at least 1,000 metric tons of greenhouse gas emission reductions in 2016 and 1,600 metric tons in 2020.

Table 2: Commercial Building Greenhouse Gas Emission Reductions due to Energy Efficiency

Approximate LEED Level	LEED NC Point Level	Metric Tons of GHG Reductions		Cars Taken Off the Road	
		2015	2020	2015	2020
Not Certified	**20**	1,500	2,400	300	500
Certified	**26**	1,800	2,800	300	500
Silver	**33**	2,000	3,200	400	600
Gold	**39**	2,600	4,000	500	800

[3] The "Cars Taken Off the Road" value is based on the assumption that gasoline contains 25lbs of CO2 equivalent per gallon and that average vehicle fuel economy is 25 mpg.
[4] See the page 9 for the minimum LEED NC v2.2 requirements for certification.

The baseline greenhouse gas emissions due to the use of electricity and natural gas in residential and commercial buildings are shown in Figure 1 below. In 2000, 64 percent of building related greenhouse gas emissions were generated by residential buildings, with the remaining 36 percent being generated by commercial buildings.[5]

Figure 1: Santa Rosa Residential and Commercial Buildings
Baseline Greenhouse Gas Emissions

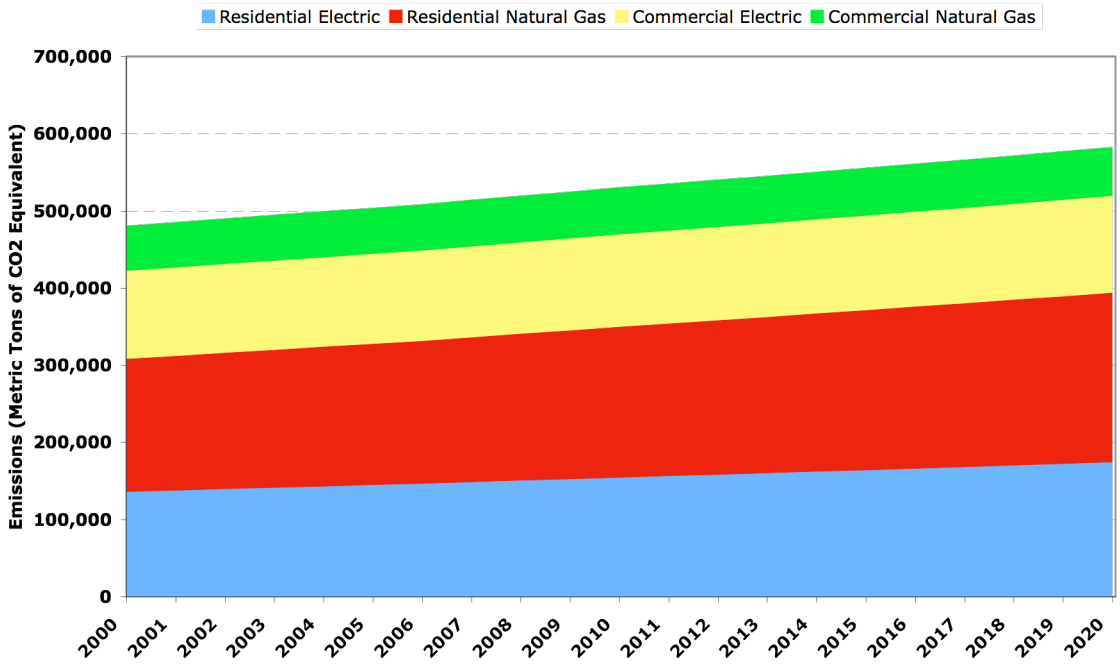


Figure 2 and Figure 3 below show the effects of the most aggressive green building ordinance modeled on both residential and commercial total greenhouse gas emissions. While the emission reductions associated with a given green building ordinance may be significant, the ordinance must be extremely aggressive to offset growth in the commercial and residential building sector. The most aggressive scenarios modeled show a 5% reduction in residential building emissions and a 2% reduction in commercial building emissions in 2020 compared to the 2020 business as usual baseline.

[5] Greenhouse gas emissions from residential and commercial buildings in 2000 in Santa Rosa totaled 1.5 million metric tons of CO_2 equivalent. This value was scaled to Santa Rosa from the Sonoma Country greenhouse gas inventory using year 2000 US Census data for both Sonoma County and the City of Santa Rosa.

Figure 2: Residential Building Greenhouse Gas Emissions

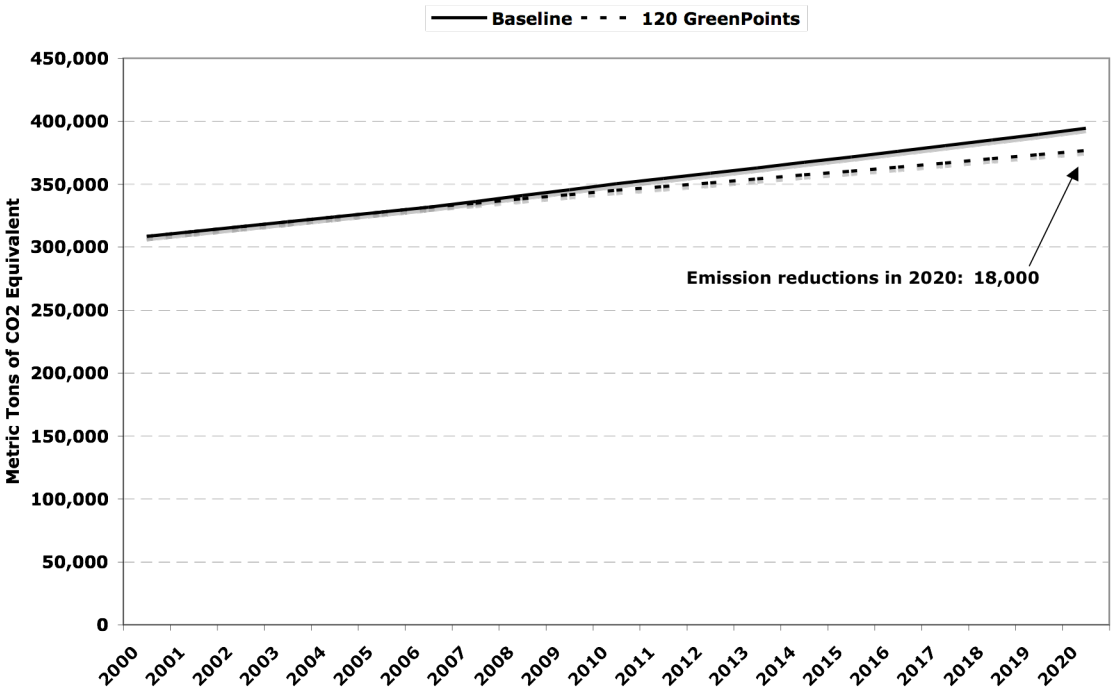


Figure 3: Commercial Building Greenhouse Gas Emissions

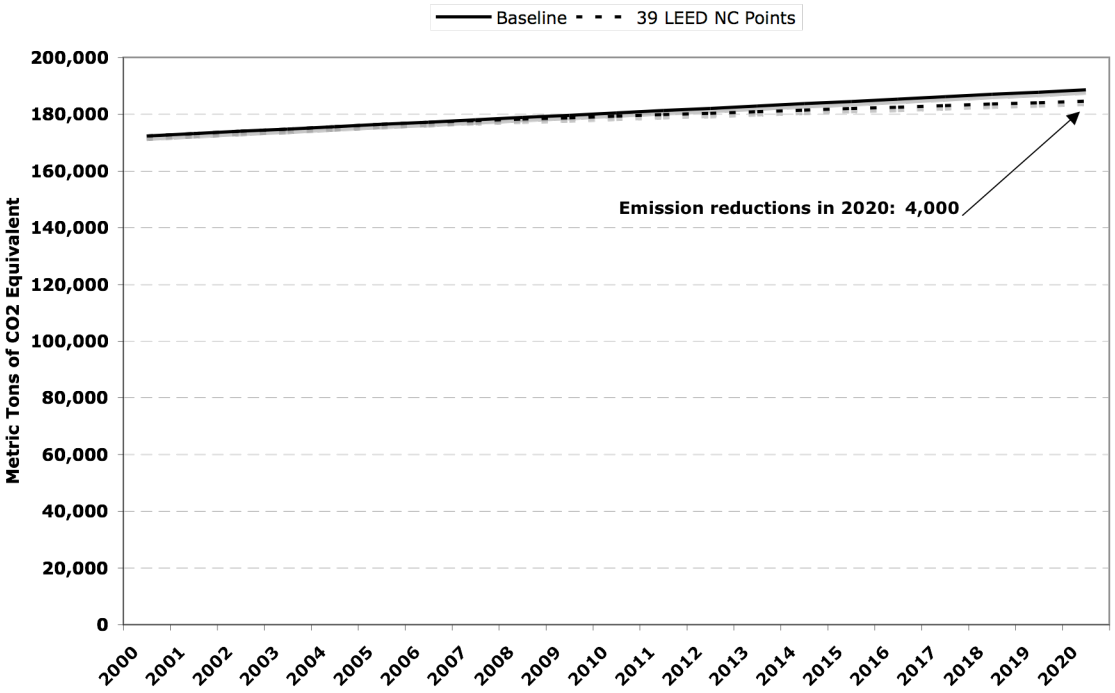


Table 3 below compares the greenhouse gas emission reductions due to the most aggressive ordinances that were evaluated in this analysis to a 25 percent below 1990 emission level goal for residential and commercial buildings in Santa Rosa. It is important to note that while the values presented in Table 3 may seem dire, green

building ordinances are an important component to greenhouse gas emission reductions. The most aggressive ordinances modeled reduced greenhouse gas emission growth in the residential and commercial building sector from 2007 to 2020 by nearly 30 percent. It will be very difficult for a green building ordinance alone to significantly offset total greenhouse gas emissions associated with buildings. The ordinances modeled in this analysis were applied only to new construction. *Achieving significant reductions in greenhouse gas emissions in the building sector will require aggressive building standards and an aggressive program for increasing the energy efficiency in existing buildings.*

It is very likely that the City of Santa Rosa will find both funding and implementation support with Pacific Gas and Electric (PG&E) in developing programs that target existing buildings. A critical component of the California Public Utilities Commission's (CPUC) draft decision for 2009-2011 utility energy efficiency programs is the coordination of these programs with local governments.[6] Additionally, the CPUC is recommending the adoption of initiatives that will lead to net-zero energy consumption in new residential homes by 2020 and net-zero energy consumption in new commercial properties by 2030.[7]

Table 3: Comparison of Greenhouse Gas Emissions to Potential 2015 City Goal in the Residential and Commercial Building Sectors

(Values in Metric Tons of CO2 equivalent)	**2015 Business As Usual**	**2015 City Goal** (1)	**2015 City Goal Reductions** (2)	**2015 Aggressive Ordinance Reductions** (3)
Residential	372,000	177,000	195,000	11,000
Commercial	184,000	86,000	98,000	2,600
Total	556,000	263,000	293,000	13,600

(1) The "2015 City Goal" represents a 25% reduction from 1990 levels in the given building sector.

(2) City goal reductions reflect the difference between 2015 business as usual emissions and the City goal.

(3) Aggressive ordinance refers to the most aggressive ordinances modeled: 120 GreenPoints for residential buildings and 39 LEED NC v.2.2 points for commercial buildings.

Subsequent analysis was conducted to determine the impact of an extremely aggressive green building ordinance on greenhouse gas emissions in Santa Rosa. Table 4 below presents the emission reductions due to energy efficiency and on-site renewable energy production required to meet the hypothetical ordinance.[8] In some sense, the values represent an upper bound for what may be achieved in addressing greenhouse gas emissions associated with new residential and commercial construction. Note again, that these emissions reductions reflect only implementing a high degree of energy efficiency

[6] See: "Draft Interim Order on Issues Relating To Future Savings Goals and Program Planning for 2009-2011 Energy Efficiency and Beyond," R.06-04-010, September 2007. http://www.cpuc.ca.gov/EFILE/PD/72819.pdf.

[7] Ibid.

[8] This calculation assumes that residential and commercial new construction will exceed Title-24 by 50% and 42% respectively and that onsite renewable power will supply 90% and 12.5% of electricity needs for residential and commercial new construction respectively. These values reflect the maximum achievement levels in the LEED NC v2.2 and GreenPoints rating systems.

and on-site renewable energy generation. Significant additional greenhouse gas emissions reductions may be achieved through the attributes of green buildings that were not evaluated in this study. [9]

Table 4: Maximum Emission Reductions Associated With Onsite Energy Use for Residential and Commercial New Construction*

(Metric Tons of CO2 Equivalent)	**2007-2015**	**2007-2020**	**Proxy Point Level**
Residential	28,000	44,000	251 GreenPoints
Commercial	3,400	5,400	69 LEED NC Points
Total	**31,400**	**49,400**	
Cars Off The Road	**6,000**	**9,000**	

* Note that this is not a true maximum; only the impact of aggressive energy efficiency and on-site renewable energy generation were evaluated.

2.2 Additional Greenhouse Gas Emission Reductions

The analysis presented in this report model only the effects of potential green building ordinances on greenhouse gas emissions associated with onsite electricity and natural gas use from new construction. *There is significant additional greenhouse gas reduction potential associated with green buildings including those realized through passive solar design, on-site renewable energy generation, water efficiency/conservation, building material reuse, greater access to mass transit, and renewable and sustainably harvested building materials.* As an example, the potential greenhouse gas emission reductions associated with water conservation and efficiency is presented below.

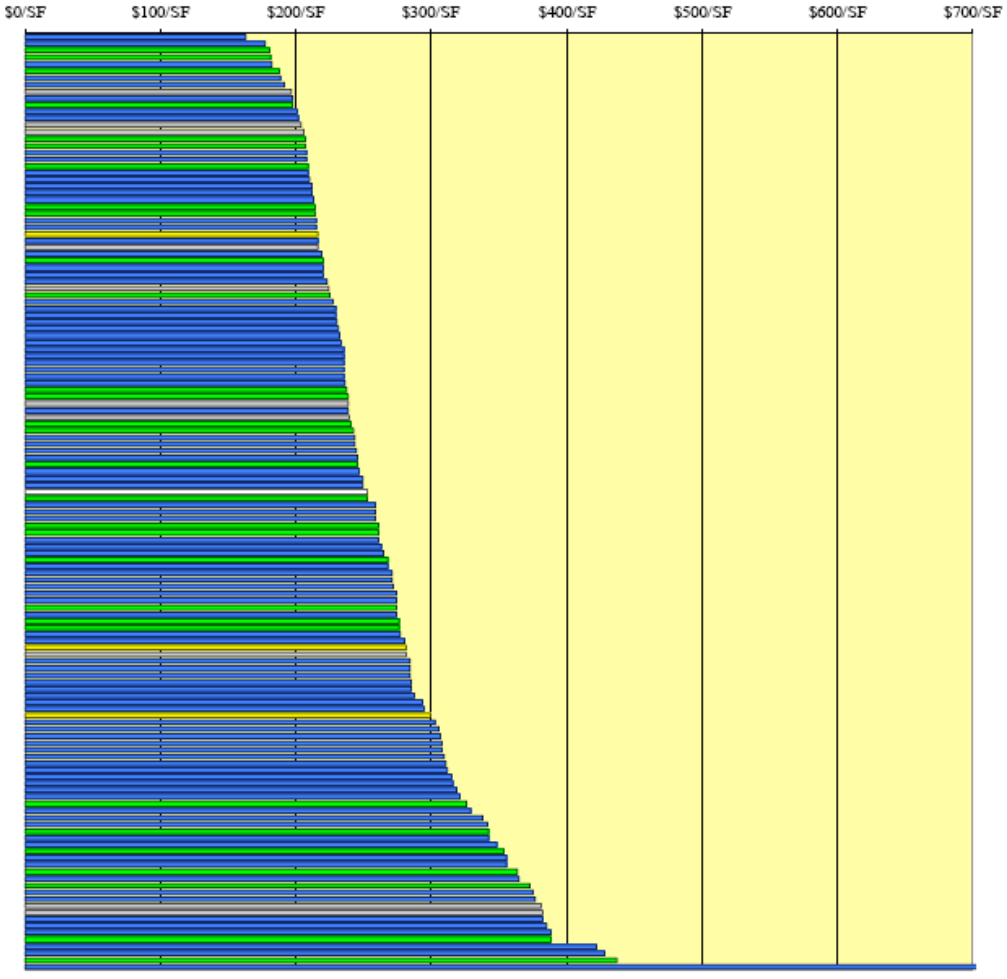
Currently the CPUC is evaluating the connection between saving water and saving energy (and by extension, reducing greenhouse gas emissions) in several investor owned utility pilot programs.[10] In a recent report prepared for PG&E to inform these pilots, it was found that the energy intensity (amount of energy per volume of water) of water used (or wasted) in Santa Rosa is more than 7,400 kWh per acre-foot.[11] Energy is used to convey, treat, use, and dispose of water. This equates to nearly 2.5 metric tons of greenhouse gas emissions for every million gallons of water used in Santa Rosa.[12] Currently more than 8,500 million gallons of water are used in Santa Rosa each year.[13] Both the GreenPoints and LEED NC v2.2 rating systems contain water efficiency and conservation components. Any points earned in these categories will lead to reduced greenhouse gas emissions.

[9] For example in Rocky Mountain Institute's headquarters building, situated at 7,000 feet near Aspen, Colorado, 99% of the heating demand is provided by passive solar design and electricity is provided almost exclusively by on-site solar panels, essentially making the building a net-zero energy user. See: http://www.rmi.org/images/PDFs/AboutRMI/RMI_HqBldgVisitorsGuide.pdf for more information.
[10] CPUC A.07-01-027, 2007.
[11] Green Building Studio, "Supply and Demand Side Water-Energy Efficiency Opportunities Final Report", February 2007, p. 7.
[12] This value assumes a grid intensity of 0.73 pounds of greenhouse gas emissions per kWh.
[13] Supra at note 11, p. 45.

2.3 The Perceived Additional Cost of Green Buildings

There is the widespread perception that green buildings are more expensive than traditional buildings to construct. While it is indeed the case that obtaining official certification from such rating systems as LEED often generates additional cost through non-trivial application and processing fees, it is not evident that that building green costs more. Figure 4 below displays the cost per gross square foot to construct 138 buildings. The blue bars are conventional buildings, the green bars are LEED NC Certified buildings, the silver bars are LEED NC Silver buildings, and the gold bars are LEED NC Gold buildings. As shown in the figure, there is no apparent relationship between the cost of construction and green building practices. In fact, the study that generated this graph found no statistical difference between the cost of green and conventional buildings.[14] A follow on study completed in 2006 found the same: that there is no significant difference in the average costs for green buildings compared to non-green buildings.[15]

Figure 4: Cost per Gross Square Footage of 138 Buildings



[14] Matthiessen, Lisa Fay and Peter Morris, Davis Langdon, "Costing Green: A Comprehensive Cost Database and Budgeting Methodology," July 2004, pp. 18-19.
[15] Davis Langdon, "Cost of Green Revisited: Reexamining the Feasibility and Cost Impact of Sustainable Design in the Light of Increased Market Adoption," July 2007, p. 3.

Investing in green building is a sound financial practice. In a report completed in 2003 for the California Sustainable Building Task Force (established by Governor Schwarzenegger) it was found that "integrating 'sustainable' or 'green' building practices into the construction of [California] state buildings is a solid financial investment. In the most comprehensive analysis of the financial costs and benefits of green building conducted to date, [the] report [found] that an upfront investment of less than two percent of construction costs yields life cycle savings of over ten times the initial investment."[16]

It is likely that more aggressive levels of green building certification add an initial cost premium to new construction. In a survey of 33 LEED registered projects it was found that more aggressive levels of LEED certification: LEED Gold and LEED Platinum add 1.8% and 6.5% to building costs respectively.[17] However, the small sample size of LEED Gold and Platinum buildings (7 in total) makes it difficult to infer an accurate cost premium from the study.

3.0 Recommendations for a Minimum Ordinance

BIG's GreenPoints and LEED NC v2.2 are two well known green building rating systems that will be useful in setting a green building ordinance in Santa Rosa. The GreenPoints system is well suited to residential new construction. While the USGBC is in the process of adopting a LEED New Homes rating system it is not currently in place. However, the USGBC has the long established LEED NC rating system for commercial new construction and renovation. It is my recommendation that a minimum point level on the GreenPoints system be set as the residential new construction ordinance and that a minimum point level on the LEED NC v2.2 system be set as the commercial new construction ordinance.

In order to guarantee energy savings and thereby greenhouse gas emission reductions, it is important that a minimum threshold be set for the Santa Rosa green building ordinance that is more than a simple point level in the GreenPoints and LEED NC v2.2 rating systems. At the very least, I strongly recommend that the Santa Rosa green building ordinance be based on fulfilling the minimum requirements set in the GreenPoints and LEED NC v2.2 rating systems. The minimum requirements for these rating systems are listed below. Elaboration on the LEED NC v.2.2 minimum requirements can be found on the USGBC LEED website.[18]

GreenPoints Minimum Requirements

- Divert at least 50 percent of construction waste by weight from the landfill through recycling or reuse;
- Exceed California Title-24 by a minimum of 15 percent;
- Incorporate the GreenPoint Rated Checklist in construction documents;
- Achieve at least 30 points in the energy category, 5 points in the indoor air quality/health category, 6 points in the resources category, and 9 points in the water category.

[16] Katz, Greg, Capital E, "The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force," October 2003, p. v.
[17] Building Design and Construction, "White Paper on Sustainability," November, 2003.
[18] See: https://www.usgbc.org/FileHandling/show_general_file.asp?DocumentID=1095

LEED NC v2.2 Minimum Requirements

- Pollution prevention during construction;
- Building energy system (HVAC) commissioning;
- Exceed California Title-24 by a minimum of 14 percent;
- Provide space for storage and collection of recyclables;
- Achieve a minimum threshold for indoor air quality;
- Minimize tobacco smoke pollution;
- Achieve a minimum of 26 points for LEED certification.

In addition to meeting these minimum requirements I strongly encourage you to set the green building ordinance to be at least the following:

Residential New Construction: 100 points using the GreenPoints system;
Commercial New Construction: 26 points using LEED NC v2.2.

I believe these point levels represent a somewhat easily achievable ordinance and will lead to significant greenhouse gas reductions. Note that in the case of LEED NC v.2.2 it may be appropriate to require that the minimum threshold be met, and that a given level of points be achieved using the LEED framework rather than mandating formal LEED certification be obtained. The formal LEED certification process may add as much as $44,000 to commercial projects due to USGBC fees.[19]

[19] See: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=65

4.0 Assumptions and Methodology

4.1 Establishing energy savings for LEED NC v.2.2 point levels

In order to estimate the energy savings above California Title-24 for varying amounts of LEED NC v.2.2 points, 27 LEED Certified projects in California were evaluated.[20] The evaluation was restricted to LEED Certified projects at the time of this analysis because it was believed that an ordinance for higher levels of LEED certification was unlikely, and therefore a more robust analysis of lower LEED point levels would be more valuable.

The point breakdown between the six LEED NC categories (Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovative Design) along with energy savings above code was recorded for each of the certified projects. The average percentage distribution of points in each category was then computed and used to attribute point levels in each category for any given LEED NC point rating.

A matrix of point distributions in each category was developed for 0 through 69 LEED NC points using the aforementioned percentage distributions. This allowed for the estimation of Energy and Atmosphere points achieved for a given total LEED point value. Using these values, the author developed the assumptions shown in Table 5 based on personal experience with the LEED rating system and based on the certified project case studies that were evaluated:[21]

Table 5

LEED Points in Energy and Atmosphere Category	% Above Title 24
1	10.5%
2	14.0%
3	17.5%
4	21.0%
5	21.0%
6	24.5%
7	28.0%
8	31.5%
9	35.0%
10	35.0%
11	38.5%
12	42.0%
13	42.0%
14	42.0%
15	42.0%
16	42.0%
17	42.0%

[20] There are 27 template case studies for LEED Certified projects in California on the USGBC LEED Certified Project Website.

[21] The author is a LEED Accredited Professional and has completed several LEED NC templates. See statement of qualifications for more information.

There are 17 points available in the LEED NC v2.2 Energy and Atmosphere category. 10 of these points are available through exceeding California Title 24 building energy code. 3 are available through on-site renewable power generation, 1 through enhanced building commissioning, 1 through enhanced refrigerant management, 1 through measurement and verification of building energy performance and 1 through the purchase of green power to meet the building energy needs.

It was assumed that:

- the first 4 points in the Energy and Atmosphere category are awarded for exceeding Title 24;
- the 5th point is awarded for the purchase of green power or enhanced refrigerant management;
- the next 4 points were awarded for exceeding Title 24;
- the 10th point was awarded for the purchase of green power or enhanced refrigerant management or enhanced building commissioning
- the next 2 points were awarded for exceeding Title 24;
- the remaining points were awarded for onsite green power generation.

4.2 Establishing Energy Savings For GreenPoints Point Levels

Unfortunately, the same body of case studies that exists for LEED commercial buildings does not exist in the public domain for GreenPoints rated homes. In order to attribute energy savings with a given level of GreenPoints it was assumed that the same percentage of points was achieved in the GreenPoints Energy category as is achieved in the LEED Energy and Atmosphere category. The justification for this assumption is subsequently described.

Table 6 below displays the percentage composition of total possible points for LEED NC v.2.2 and GreenPoints.

Table 6: Comparison of LEED NC and BIG GreenPoints Rating Systems

Build It Green "GreenPoints" Rating System

Category	Community	Water	Energy	Resources	IEQ	TOTAL
Possible Points	4	43	96	66	42	251
% Of Total	2%	17%	38%	26%	17%	100%

USGBC LEED New Construction Rating System

Category	SS	WE	EA	MR	IEQ	ID	TOTAL
Possible Points	14	5	17	13	15	5	69
% Of Total	20%	7%	25%	19%	22%	7%	100%

The energy category represents the largest number of possible points in both rating systems. Further, exceeding Title 24 offers the largest single point opportunity in the energy categories for both systems. Additionally, when the common categories relating to Water, Energy, Resources and Indoor Environmental Quality are compared alone, the Energy categories represent 39% and 34% of the points for GreenPoints and LEED respectively.

Given the similarities of the Energy categories in both ratings systems, the assumption was made that the same percentage of points achieved in the LEED energy categories (as calculated based on the 27 certified LEED project data points) would be achieved in the energy category of the GreenPoints rating system.

4.3 Baseline Greenhouse Gas Emissions

Greenhouse gas baseline emission data for residential and commercial buildings was available for 1990 and 2000 for Sonoma County.[22] The greenhouse gas emission data was scaled to Santa Rosa by normalizing emission data by population and then extrapolating to Santa Rosa total emissions using US Census data for Sonoma County and the City of Santa Rosa.

Baseline greenhouse gas emissions from residential and commercial buildings were generated as follows:

Total residential housing units by housing unit type in Santa Rosa in 2006 was obtained through the US Census. Housing units were grown at 1.5% per year from 2000-2010 and 1.3% per year from 2010-2020.[23] Energy intensities for residential hosing units were applied to the data.[24] Emission factors were applied to estimated electricity and natural gas use in the residential sector. The factor used for electricity was 0.73lbs of CO2 equivalent per kWh.[25] The factor used for natural gas was 13.45 lbs of CO2e per therm.[26] The annual emissions between 2000 and 2006 were linearly interpolated whereas the emissions from 2006 on were grown using the aforementioned growth rates.

The likely square footage growth rate of commercial space in Santa Rosa is assumed to be 100,000 sqft per year for general commercial and 30,000 sqft per year for retail space.[27] Energy intensities for commercial buildings were applied to this growth rate.[28] The emissions factors noted above were applied to the calculated commercial energy growth values and then added to the 2000 greenhouse gas inventory values.

Note that Title-24 improvements were not modeled in this analysis. The California Energy Commission updates title-24 every three years with the next update scheduled for 2008. Updates typically increase the energy efficiency of new construction in California. The impact of such increases in baseline efficiency may slightly reduce the absolute emission reduction values shown in this report. In the "order of magnitude" analysis presented here the effects of Title 24 updates are likely trivial.

---

[22] Climate Protection Campaign, "Greenhouse Gas Emission Inventory for All Sectors of Sonoma County," January 2005, p.17.
[23] Growth rates for residential housing as reported in the Santa Rosa General Plan.
[24] Kema, Residential Appliance Saturation Survey, 2003: http://www.energy.ca.gov/appliances/rass/index.html
[25] Sonoma County Greenhouse Gas Inventory, p. 15.
[26] Pacific Gas and Electric emission factor for natural gas. http://www.pge.com/about_us/environment/calculator/assumptions.html
[27] Growth rates estimated by Chuck Regalia, Santa Rosa Director of Community Development.
[28] Itron, California Commercial End-Use Survey, March 2006: http://www.energy.ca.gov/ceus/index.html

4.4 Commercial Building Emissions Reductions For a Given LEED Point Level

Emissions reductions for a given point level were calculated by applying the percent above Title-24 value for the given point level to the annual greenhouse gas emission growth associated with commercial buildings in each year. These modified annual additions were then used to construct a greenhouse gas emission trajectory for commercial buildings for a given point level.

4.5 Residential Building Emission Reductions for a Given GreenPoint Level

The LEED point system and the GreenPoint system point levels were matched as follows: 1 total LEED NC point = 1 total GreenPoints point; 69 total LEED NC points = 276 GreenPoints points. The scales were assumed to be equally linear between their point bounds meaning that for a given GreenPoint level, an equivalent LEED NC point level was calculated. The values for percentage above Title-24 were then matched to the GreenPoint system using the proxy LEED NC point values for a given GreenPoint point value.

Emissions reductions for a given GreenPoint point level were calculated by applying the percent above Title-24 value for the given GreenPoint level to the annual greenhouse gas emission growth associated with residential buildings in each year. These modified annual additions were then used to construct a greenhouse gas emission trajectory for residential buildings for a given GreenPoint level.

5.0 Statement of Qualifications

Eric Wanless
LEED Accredited Professional
Norwest Consulting
ewanless@norwestconsulting.com

Eric Wanless has been working in the renewable and efficient energy field for more than six years. As a fellow with the Rocky Mountain Institute (RMI), he developed carbon mitigation strategies for multi-billion dollar firms and conducted extensive research on automated demand response technologies for the investor owned utilities in California. Mr. Wanless has expertise in California energy and climate policy gained while working for the Natural Resources Defense Council (NRDC). He is also an expert in green building design. In addition to his experience using the LEED rating system to evaluate several buildings, he taught efficient and renewable energy system design and green building fundamentals at Stanford University. Mr. Wanless received his B.S. in Civil and Environmental Engineering and M.S. in Energy Engineering, both from Stanford University.