Renewable Energy for a Madison Area Community Development Project

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Prepared by:
Madison Area Community Land Trust

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Executive Summary

This research project examines the relationship between energy efficiency, renewables and affordability by evaluating a model base-case home design for the Madison Area Community Land Trust's (MACLT) latest development site. Our "whole house system" approach to home design emphasizes affordable renewable technologies, green building and energy efficiency elements that should also be useful to area builders for improving their new housing designs.

Questions we researched include:

- As incremental energy benefits are obtained, what impact does improved energy performance have on initial affordability as well as long-term payback?
- Is there a point of diminishing return for including renewables and green building materials as part of an affordable housing design?
- Could we also ascertain any "soft monies" (in the form of grants, rebates or energy efficient mortgages) that would enable us to finance the inclusion of renewables into affordable housing units?

To conduct our analysis we used the most recent version of REM/Rate software, a program that models the complex interactions between improvement measures in house design. REM/Rate is designed to evaluate existing homes but can also serve to evaluate homes from construction plans for the purpose of establishing energy rebates or making energy-efficient mortgage calculations. As such it provides a common reference point for energy performance.

To examine different energy efficiency rating effects on affordability, we conducted a series of five modeling runs using the same base-case house design and compared the resulting improved energy efficient scores against the cost of energy improvements. The model house is a 1300-square feet (net interior space), multi-level 3 bedroom unit with 2000 square feet of conditioned space including an unfinished basement. The model house does not include a garage.
For purposes of evaluating passive and active renewable technologies, we structured our model runs such that we could determine the incremental energy benefits and associated costs of incorporating greater levels of renewable components for each consecutive model design.

To reflect systems that go beyond typical building practices (equivalent to our **LowMarket** run) in terms of energy performance at reasonably affordable cost, we compared all other model results against those of **LowMarket**. Three modeling runs significantly reduce the space heating load and total energy need. These are: **GoodPractice** (better insulation and doors, efficient space and water heating, natural gas appliances and heat recovery ventilator, total Home Energy Rating System (HERS) score of 89.0); **PassiveSolar** (adds Faswall foundation wall, active solar domestic hot water heating and interior mass, HERS score of 94.8); and **ActiveSolar& Hydronic** (adds Larsen truss and cellulose insulation wall section, active hydronic space heating and additional thermal mass, HERS score of 96.6).

The **GoodPractice** model house cuts the design space heating load to 18.6 kWh, below half that of **LowMarket** (38.1 kWh) for an added building cost of approximately $5100; after rebates the total cost translates to a *savings of $2,318* from the cost of building the **LowMarket** version. The **PassiveSolar** model design space heating load is further reduced to 16.1 kWh at an additional cost of just under $11,800; after rebates the difference is just under $4,200 with a simple payback of 6.9 years. The **ActiveSolar& Hydronic** model achieves a space heating load of 15.7 kWh for an additional building cost of $33,300 beyond **LowMarket**; after rebates the additional cost is $25,605 with a simple payback of 37.8 years. For MACLT, this last model cost is not affordable for our clientele.

We hoped to design a "whole house system" which emphasizes energy efficiency and inclusion of renewable technologies through an appropriate design that would limit annual energy needs for each home to 3000 kWh (10.24 MMBtu). Photovoltaics (PV) ideally would generate at least half the energy needs of our model units and still be affordable for our low and moderate income clientele. However, due to MACLT's affordability agenda we could not justify renewable technology costs beyond active solar domestic hot water and hydronic space heating systems. **ActiveSolar&Hydronic**, the best rated unit in this analysis, is 27.36 MMBtu over our target energy budget of 10.24 MMBtu; **PassiveSolar** is 40.06 MMBtu over budget; **GoodPractice** is 63.06 MMBtu over budget; and **LowMarket** is 113.96 MMBtu over our target budget.

This analysis demonstrates that from an affordability perspective, active renewable technologies beyond domestic solar hot water are still beyond the price range that would allow inclusion in affordable new house construction. From an energy performance perspective we have demonstrated that many energy efficient components can be included in design and construction with significant energy impacts above and beyond what is typically built, and still be affordable *if* the difference in cost is offset with assistance through energy-related rebate programs. At a minimum, new homes should be designed to include the elements that comprise the **GoodPractice** model which, with rebates, achieves an actual cost savings for the homeowner and an energy benefit for the community. If rebate programs could be extended to provide an additional $4,200 of funding, the best value in terms of cost and energy impact is the **PassiveSolar** model which would save low and moderate income homeowners over $600 per year in energy related costs.

Introduction

"An emerging new paradigm in real estate development defines a good development as one that reduces impacts on air, water, traffic, resource consumption, landfills and open space. It reduces ethnic and economic segregation, and the destruction of the host ecosystem. A good development increases open space, housing and employment diversity, transit options, the quality and quantity of public spaces, local recycling, safety, quality of life, community wealth, resource efficiency and access to needed services."

- **William S. Becker**, Center of Excellence for Sustainable Development, article from *In Business Magazine*, Sep/Oct 1997 (quoted with permission)

Our interest in pursuing this research project was kindled by the recognition that buildings not only affect our health, productivity and personal budgets but also have a direct impact on the environment through our use of land, space, and energy. The Madison Area Community Land Trust's (MACLT) clientele are low and moderate income households in Dane county. We are therefore extremely motivated to examine good development practices and whether these could occur in a sustainable yet affordable manner. This translates to "whole systems" thinking, a concept that entities in the local area have not yet embraced. This evaluation project hopes to promote "good development" practices that can be applied around the state while also being realistic about associated costs and recognizing long-term benefits.

Project Description

The original goal of this research project was to evaluate a mix of energy systems in the context of a "whole house system" design, emphasize renewable technologies, green building and energy efficiency elements that area builders could then use to improve new housing design. Also, the MACLT was interested in exploring the impact of energy efficient house designs on affordability. A Steering Committee was convened to provide building and energy expertise. An initial target energy budget for the research project was set at 3000 kilowatt hours (or 10.239 MMBtus)[1] per dwelling unit annually, with a renewable system design expected to provide at least 80% of the energy budget. We also hoped to determine, if time and money allowed, potential development costs, operation and maintenance costs, annual energy production estimates, payback period and mortgage impact, and to present summarized information in the form of a comparative renewable technologies matrix.

After substantial data gathering we shifted our research emphasis to examine the relationship between energy efficiency, renewables and affordability by evaluating a base-case home design that could serve as a model for the MACLT's latest development site. Specifically, we felt that utilizing a building design matrix for purposes of evaluating energy performance benefits was

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[1] Based on 3,413 Btus per kWh

inappropriate in the context of comparing different building materials and renewable energy technologies with dissimilar performance criteria. Themes such as daylighting, passive and active solar space heat, photovoltaics, active solar domestic hot water, radiant heat, green building materials, passive cooling, appliances and other new construction materials have several technical options unique to each. To compare these themes and technologies in a consistent and meaningful manner (initial cost, subsidies available, annual energy reduction expected, embodied energy and market availability) proved beyond the scope of the research grant funding.

To conduct our analysis we used the most recent version of REM/Rate software, a modeling program designed to evaluate existing homes and propose energy-related improvements. Although not intended as a full-function design tool, REM/Rate can also function to evaluate homes from constructions plans for the purpose of establishing energy rebates or making energy-efficient mortgage calculations. As such it provides a common reference point for energy performance.

To arrive at the score for a home, the software internally compares the home to be modeled with a standard minimum "reference" home identical in size and shape to the modeled home. The reference home is assigned a Home Energy Rating System (HERS) rating of 75. This number is arbitrary and is used simply because 75% is the traditional "minimum passing grade" from our school days. Some lenders can now qualify an applicant's home for an energy efficient mortgage, recognizing the savings in home energy use and reducing the monthly mortgage payment accordingly. This allows a homeowner to stretch their financing capacity.

Description of Modeling Runs

The REM/Rate software models the complex interactions between improvement measures in house design. Comprehensive training with the software as well as a thorough understanding of heat flow modeling and practical construction are necessary to achieve realistic modeling results. The software allows for both Simplified and Detailed inputs and provides Libraries of typical building materials and components with which to model the house. For this study, only the Detailed inputs were utilized and some custom Library entries were added.

To examine different energy efficiency rating effects on affordability, we conducted a series of five modeling runs using the same base-case house design and compared the resulting improved energy efficient scores against the cost of energy improvements. The model house is a 1300-square feet (net interior space), multi-level 3 bedroom unit with 2000 square feet area of conditioned space including an unfinished basement. The model house does not include a garage. Each of the modeling runs builds upon this base configuration. **Table 1** (on page 4) presents a summary of the model run elements.

An important long term affordability feature of this model design is inclusion of a basement that allows the homeowner to add living space at minimal cost by "building in" (remodeling existing unfinished space) with self-help labor rather than "building out" (constructing an addition with new foundation and structure, etc.) with expensive contract labor. Because of its capacity to provide more living space some time in the future, we assumed a fully conditioned basement to identify the total energy load for modeling purposes.

The **CodeMinimum** column characterizes a conventionally designed home with no effort to include energy efficient components beyond those minimally required by Wisconsin code. The HERS score is 79.0 for this modeling run, just slightly above the 75.0 base rating. This model run is included for illustrative purposes since local builders almost always exceed these specifications.

The **LowMarket** column characterizes common low-end building practices with slightly more efficient space and water heating systems along with the addition of some compact fluorescent lighting. These minor changes have no positive impact on design space heating load but improve the HERS score from 79.0 to 79.7. For local builders, this level of building practice is more common. With a score less than 86, this model house does not qualify for any energy related rebates.

For the **GoodPractice** run the ceiling, above-grade and foundation walls are all better insulated, the windows and doors are all energy efficient, and a heat recovery ventilator is added to achieve reduced infiltration and good air quality. The space and water heating systems are far more efficient, and we've switched from electric to natural gas appliances. As the HERS score bumps up to 89.0, these few measures cut the design space heating load and total energy used by *more than half* that of the previous modeling run for approximately $5100 additional up-front cost from that of **LowMarket**. Available rebates for energy conservation measures actually lower the cost of the house *below* that of the LowMarket house. (See **Table 2**, page 5)

The **PassiveSolar** run includes a higher R-value Faswall foundation wall, active solar domestic hot water heating and interior mass in the form of tile. The HERS score increases to 94.8 and the design space heating load decreases. The cost difference from **LowMarket** for this model is just under $11,800; after available rebates the difference is just under $4,200.

The **ActiveSolar&Hydronic** column adds a Larsen truss and cellulose insulation wall section, active hydronic space heating and brick for additional thermal mass for a HERS score of 96.6. The design space heating load moderately decreases from that of **PassiveSolar**. This model's additional cost beyond **LowMarket** is $33,300, nearly triple the cost difference between **LowMarket** and **PassiveSolar**. After rebates the additional cost is $25,605.

Cost Analysis

A powerful feature of REM/Rate is the Improvement Analysis, which allows improvement measures along with associated cost and energy characteristics to be entered and evaluated. Cost savings versus investment can be analyzed in several ways. The Improvement Analysis cannot, however, be run simultaneously for multiple houses so this feature was not utilized for this study. Instead, we chose to model each house in its entirety and to separately calculate "whole house system" costs. A local building firm with more than 20 years of experience provided us with a house cost estimate for a build-as-designed unit. **Table 2** provides a cost summary for the five model runs. **Attachment A** -- Cost Spreadsheet, itemizes the components and associated costs for each model run. With respect to "Green" features, the choices would add to the costs presented below, as itemized in the cost spreadsheet.

Table 1: REM/Rate Summary

Energy Feature	CODEMINIMUM	LOWMARKET	GOODPRACTICE	PASSIVESOLAR	ACTIVESOLAR &HYDRONIC
HERS Score	79.0	79.7	89.0	94.8	96.6
Ceiling w/Attic	R38; 2x4" 24" on center U=.026	R38; 2x4" 24" on center U=.026	R50; raised heel truss; 24" on center U=.020	R50; raised heel truss; 24" on center U=.020	R50; raised heel truss; 24" on center U=.020
Above Grade Walls	R11; 2x4" 16 on ctr U=.087	R11; 2x4" 16 on ctr U=.087	R19; 2x6" 16 on ctr R7.5; U=0.038	R22; 2x6" 16 on ctr R7.5; U=0.036	R34; Larsen truss; cellulose; U=.029
Foundation Walls	R 5.0	R 5.0	R 15	R 22 Faswall	R 22 Faswall
Doors	R 2.1	R 2.1	R 5.0	R 5.0	R 5.0
Windows: Double Wood Operable	U=.56	U=.56	LoE/Argon U=0.36	LoE/Argon w/storm U=.30	LoE/Argon w/storm U=.30
Slab Floors	Uninsulated R 0	Uninsulated R 0	Uninsulated R 0	Insulated R 5	Insulated R 5
Infiltration	0.40	0.40	0.10	0.10	0.10
Heat Recovery Ventilator	No	No	Yes	Yes	Yes
Heating Efficiency AFUE	78	80	92	96.5	96.5
Nat.Gas Water Htg Effic.	0.50	0.55	0.65	0.65	0.65
Set Back Thermostat	No	No	Yes	Yes	Yes
Lighting	21 Incandescent	5 Incandescent 16 Compact Fluores.	5 Incandescent 16 Compact Fluores.	5 Incandescent 16 Compact Fluores.	5 Incandescent 16 Compact Fluores.
Appliances: Oven/Range, Clotheswasher	Electric	Electric	Natural Gas	Natural Gas	Natural Gas
Active Solar	None	None	None	Domestic hot water	Domestic hot water & hydronic heat
Interior Mass	None	None	None	Tile	Tile & Brick
Design (peak load) Space Heating (kBtu/hr)	38.1	38.1	18.6	16.1	15.7
Annual Load (MMBtu)	Heating 60.9 WaterHtg 22.5	Heating 62.5 WaterHtg 20.6	Heating 28.0 WaterHtg 15.3	Heating 20.2 WaterHtg 3.8	Heating 13.0 WaterHtg 0
Annual Consumption (MMBtu)	Heating: 78.1 Water Htg: 29.6 Ltg&Appl: 20.0 Total: 127.7	Heating: 78.2 Water Htg: 27.1 Ltg&Appl: 18.9 Total: 124.2	Heating: 26.1 Water Htg: 23.6 Ltg&Appl: 23.6 Total: 73.3	Heating: 20.8 Water Htg: 5.9 Ltg&Appl: 23.6 Total: 50.3	Heating: 14.0 Water Htg: 0.0 Ltg&Appl: 23.6 Total: 37.6
MMBtu over goal of 3000 kWh (10.24 MMBtu)	+ 117.46 MMBtu	+ 113.96 MMBtu	+ 63.06 MMBtu	+ 40.06 MMBtu	+ 27.36 MMBtu
Pollution Reduction (lb/yr)	None	None	Carbon 1658.5 NOx 8.1	Carbon 2391.4 NOx 11.6	Carbon 2637.4 NOx 12.8

Table 2

Summary of Energy Costs

Annual Energy Costs	CodeMinimum	LowMarket *	GoodPractice	PassiveSolar	ActiveSolar &Hydronic
Heating (therms)	$ 418	418	140	111	75
Water Heating	$ 159	145	126	32	0
Lights & Appliances	$ 394	374	338	185	185
Service Charges	$ 90	90	90	90	90
Total Annual	**$ 1,060**	**1,027**	**694**	**419**	**350**
Average Monthly	$ 88	86	58	35	29
% Reduction From Average Monthly	----	----	32.6 %	59.3 %	66.3 %
Total Cost of House	$ 110,710	110,860	115,942	122,643	144,165
Cost after Rebates	----	----	$ 108,542	115,033	136,465
Cost Beyond LowMarket	----	----	$- 2,318 (savings!)	4,173	25,605
Simple Payback for Cost Increase			----	$ 608/yr = 6.9 yrs	$ 677/year = 37.8 yrs

* Since LowMarket is closest to the norm locally, all costs are compared against this model run.

Utility costs were modeled using MG&E as the default electric and natural gas provider. Electricity rates include $0.0640 per kilowatt hour (kWh) from October through May and $0.0745 per kWh from June through September with a $4.00 per month service charge. For natural gas the cost is $0.5358 per therm from January through December and has a service charge of $3.50 per month.

To address the issue of initial affordability these runs are discussed in terms of affordability for a low to moderate income family as defined by HUD, along with various programs available locally to help offset the initial cost of energy efficient components. HUD defines a low to moderate income family as one whose total household income is at or below 80% of the applicable county median income, adjusted for size of household. In Dane county, this means that the total household income for an eligible family of four currently cannot exceed $43,500; however, this figure is expected to increase slightly after January, 1998.

Another consideration is the issue of land cost. Although the MACLT removes land cost from the purchase price to make the homes more affordable, there is still the matter of a monthly ground lease fee that must be added to the figures listed in **Table 2**. Land acquisition and infrastructure costs vary by project, making the amount of the ground lease fee difficult to predict in advance. Furthermore, for any development financed in whole or in part with funds from the federal HOME program, the cost (land and buildings) cannot exceed $121,030. Since the MACLT expects to use HOME funds for the Troy Court development project, the numbers in **Table 2** would need adjustment to reflect the monthly ground lease fee paid to the MACLT by the homeowner. There is a real need to recognize improved energy efficiency efforts and lower monthly costs in the federal HOME program. Until such time, however, we may not be able to build above **GoodPractice** (after rebates) using federal HOME monies.

Madison Gas & Electric's (MGE) Affordable Housing Grant Program offers funding for energy conservation improvements to be installed as a part of housing rehabilitation or development projects which, upon completion, will provide more affordable housing for low-income households. For single family dwellings with owners or rent-to-own tenants, each living unit must be occupied by a person or family intending to own the dwelling and must have a household total gross income for the previous calendar year of at or below 80% of the county median income. For non-profit organizations, MGE will fund up to 100% of the cost for predetermined, installed weatherization and Indoor Air Quality measures, with a maximum cap of $7,000 per project for new construction. (The term "project" is interpreted as the unit or number of units served by the same central heating system.) Eligible measures in these modeling runs include:

- Insulation: ceilings, walls, foundations, floors, pipes or ducts, water heaters
- Lighting modifications: controlling lamp operations (timers, sensors, etc.); replacement of lamps,ballasts,or fixtures with more efficient sources
- New furnaces (forced-air system in this case) must meet a 90% efficiency requirement
- Domestic hot water heaters must meet the following energy factor requirement minimums: 30-49 gallons Direct Vent, .58 Energy Factor (GoodPractice & PassiveSolar qualify)
- Window and door installations: storm windows; prime exterior doors with an R-value of 5.0 or greater
- Miscellaneous measures include caulking and weather stripping and Air-To-Heat Exchangers at least 70% efficient (GoodPractice and above efficiencies are 80%)

The Home Performance Rating Rewards Program offered by the Department of Administration, Wisconsin Energy Bureau provides rewards for both existing home energy improvements and new construction practices. The rewards are based on scores received from post-construction Blower Door tests. Based on their HERS scores, the eligible reward for the **GoodPractice** run would total $550; for **PassiveSolar**, $760; and for **ActiveSolar&Hydronic**, a total of $850. The cost of conducting a Blower Door test for our models would be $150, reducing the value of these rewards to $400, $610 and $700, respectively.

Energy Efficient Mortgages are currently offered by two local banks. These stretch the debt ratio by approximately 2% through Fannie Mae. A homebuyer with a current monthly debt load not exceeding $290 per month could qualify for an additional $10,250 of mortgage financing (7.625% for 30 years at $72.50 more per month).

The Wisconsin Housing and Economic Development Authority (WHEDA) has a Homebuy program that stretches the debt ratio for first time homebuyers by approximately 5% using a lower interest rate and a higher debt ratio. The same homebuyer with a current monthly debt load not exceeding $290 per month would qualify for an additional $27,250 of mortgage financing (7.0% for 30 years at $181.25 more per month).

The contrast between Energy Efficient Mortgages (EEMs) and the Homebuy program ($17,000) is striking in terms of affordability, even though EEMs are designed to help with energy efficient improvement costs. The implications for affordability are obvious: improve the rates within the context of EEMs and/or find ways to recognize energy efficiency through WHEDA.

Review of REM/Rate

Although REM/Rate supports solar space heating and solar domestic hot water systems, it cannot directly model photovoltaic (PV) systems. It is not clear how a rating of 100 is possible (i.e., no grid energy used) as REM/Rate cannot yet model PV systems either as existing equipment or as an improvement. The only method we identified for making REM/Rate reflect the renewable energy contribution is to treat the energy generated from the active solar heating system as a percent change in the cost of electricity from the local utility. However, we discovered that when conducting multiple runs, any change in the utility rate is global to the software and affects all other runs across the board. This phenomenon may be addressed in a future software update.

The REM/Rate software does not calculate a low rate of infiltration when entered as a "User Estimate" and does not tell the modeler that the software is ignoring this input. Instead, infiltration must be entered as a rate verified by a "Blower Door Test." The effect on the rating and calculated energy performance can be significant.

While REM/Rate allows the user to model the energy impact of lights and appliances on total energy performance, it appears that the Lights and Appliances feature is not well integrated in the program. We received inconsistent results with different model runs using an identical lights and appliances package. This lack of integration was verified by the software developer and should be addressed in a future software update. In the meantime, it's not entirely clear how the software is calculating the interaction between the lights and appliances and the total heating load. As the house envelope load decreases, the contribution of lights and appliances becomes more significant and the lack of integration (by the software) becomes more of a concern.

Summary

Our original goal was to create a house design that would limit annual energy needs for each home to 3000 kWh at an affordable cost. Due to MACLT's affordability agenda we could not justify renewable technology costs beyond active solar domestic hot water and hydronic space heating systems (i.e., for photovoltaic systems). **Table 1** shows that even **ActiveSolar& Hydronic**, the best rated unit in this analysis, is 2.5 times higher than this kWh target in terms of annual energy consumption, even though it is two-thirds more efficient than the commonly-built

LowMarket house. The **GoodPractice** unit is 50% more efficient than **LowMarket**, the **PassiveSolar** unit is 65% more efficient, and **ActiveSolar&Hydronic** is 70% more efficient than **LowMarket**.

With respect to cost, **GoodPractice** appears within the realm of MACLT affordability at $115,942 prior to rebates and looks even better at $108,542 after rebates. Even more interesting, the **GoodPractice** unit with its rebate-qualifying energy efficient elements would save $2,318 more than building the **LowMarket** unit. Also with **GoodPractice,** the homeowner's average monthly energy cost would be lowered from $86 to $58, a 32.6% reduction in average monthly cost from that of **LowMarket**.

The **PassiveSolar** house came in at $122,643 with rebates reducing this to $115,033, also within the realm of MACLT affordability and the HOME cap. Average monthly energy costs are reduced from $86 to $35, a 59.3% reduction from **LowMarket**. For an additional $4,200 above the **LowMarket** unit, **PassiveSolar**'s improved energy performance is a significant benefit for a low or moderate income household.

The most challenging model from an affordability perspective is **ActiveSolar&Hydronic**. An initial cost of $144,165 is reduced after rebates to $136,465, but even prior to land costs this price exceeds the HOME cap of $121,030. The resulting average monthly cost is reduced by an additional 7% from that of **PassiveSolar** for an additional cost of $25,605. This additional cost appears to be the point of diminishing return as far as these REM/Rate models are concerned.

In developing these models and assigning costs to these "whole house systems," we cannot stress strongly enough the important role that rebates play in terms of making the cost of these units more affordable. The MG&E rebate at $7,000 per unit, especially, has the greatest potential impact for enabling more energy efficient units to be constructed for low and moderate income clientele. This analysis has clearly revealed the importance of rebates with respect to initial affordability of units intentionally designed to reduce energy needs over the long term. Various community entities (CDBG, MG&E, WHEDA, local lenders, etc.) could actively commit to ensuring that sources of funding are available for better designed, affordable units that incorporate renewables and ultimately benefit the community at large through conservation of precious resources.

Considerations Beyond this Report

The costs of design and construction, the availability of more ecologically appropriate materials, and the greater utilization of energy analysis tools are challenges to affordable, more ecologically sound housing that this analysis attempts to address. Simply put, "green" housing is better-built housing in the context of a more thoughtfully conceived neighborhood. A well-constructed dwelling with lower energy costs and lower maintenance requirements means a dwelling is more affordable in the long term yet more expensive to build initially. There are other, perhaps larger, impediments to sustainable development that lie outside the scope of this report. Further study is necessary on the sustainability impacts of:

- zoning ordinances, existing master plans, transportation planning practices and standards;
- greater housing densities through better design to provide close access to places and services that are needed daily and which slow urban sprawl;
- density and its relationship to neighborhood perception, costs of utilities, emergency and other services;
- solar access site design vis-a-vis zoning regulations;
- real estate and financing practices; and
- perceptions of home buyers and perceptions of risk on the part of developers for projects that deviate somewhat from their experience of "the market".

These issues are especially crucial regarding affordable housing. The focus on simple payback as the sole criteria for making energy or "green building" decisions is not only shortsighted but also inaccurate because it does not take into account the deep subsidies historically in place (in the U.S. at least) for fossil fuels. Mortgages which allow a slightly greater debt-to-income ratio in anticipation of lower expenditures on energy are one tool to make this adjustment, but are only a beginning. The community would benefit from intentional application of sustainable design elements, and the local utility would also benefit from the reduced energy loads as more of the GoodPractice and above units are constructed.

The goal of the MACLT in implementing the findings of this research is to attempt to address comprehensive sustainable building practices beyond energy conservation. The Steering Committee conceived the idea of a Guidebook that could be used in directing builders towards "sustainable" materials and practices that are practical and relatively affordable. Sustainable materials and practices are defined generally as having low energy consumed in the manufacture, transportation and use; exhibiting low toxicity and no pollution in manufacture or use; using recycled material in content; and having recyclability at the end of a product's working life. Currently the Guidebook exists in draft form only and is organized into the following categories: House Design, Job Site, Construction, Mechanical System, Electrical System, Appliances, Sample Wall Sections, Site Plan, Source of Materials, and Reading List.

The Energy Center of Wisconsin is assembling a green building products binder, begun with information assembled from the 1996 Green Builders Conference in Austin, Texas. The Energy Center expects to provide this products and services directory on the internet.

Glossary

AFUE: Annual Fuel Utilization Efficiency; includes adjustments for standby losses, inherent inefficiencies, seasonal performance fluctuations, etc.

Annual Load: A combination of total heating, cooling and water heating energy use in terms of MMBtu per year.

Design Load: For purposes of this report, the heating design peak load of the building.

kBtu: 1000 British thermal units; the amount of energy needed to raise one pound of water by one degree Fahrenheit.

kWh: kilowatt hour is a term referring to 1000 watts used for one hour drawn from the local utility grid.

Heat Recovery Ventilator: mechanical air exchanger that passes incoming air through a heat exchanger and transfers some of the heat from outgoing air into the incoming air without mixing air streams.

Home Energy Rating System: a service developed to provide uniform, reliable and unbiased information to homeowners and buyers with regard to the existing energy efficiency of a home and the potential for cost-effective improvements. HERS are often linked to special financing arrangements such as Energy Improvement or Energy Efficient Mortgages as an incentive for homeowners to act on recommendations provide by the home energy rating.

Hydronic Heat: use of fluid (usually water or glycol mix) to deliver heat; a boiler or solar panels may be used to heat the water.

Larsen Truss: a parallel-chord truss (visualize a ladder with vertical rails and horizontal rungs) generally made of 2 x 2 or 2 x 4 lumber rails joined by plywood gussets or 2x lumber pieces fastened with truss-plates. Can be used as wall studs or added to the exterior of the wall in a retrofit. Greater insulation thicknesses are thereby possible using smaller, lower-grade lumber.

MMBtu: million Btus.

Raised Heel Truss: similar to a standard roof truss in shape except with a larger dimension at the end that rests on the exterior wall. The extra space allows additional depth of ceiling insulation.

R-value: term for thermal resistance to heat transfer through any material or building component. The higher the number, the greater the resistance to heat flow.

Therm: 100,000 Btus; used when referring to natural gas use.

U-value: heat transfer coefficient calculated as Btus per hour per square foot of surface area; the inverse of thermal resistance (1/R value).

Attachment A:

REM/Rate Reports

ENERGY STAR HOME REPORT

Date:	November 08, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	CODEMIN.BLG	Rating Date:	

Modified End-Use Load (MMBtu/year)

	Energy Star	*As Designed*
Heating:	32.9	48.7
Cooling:	0.0	0.0
Water heating:	14.6	22.6
Total:	47.5	71.3
Rating:	**86.0**	**79.0**

This home DOES NOT meet the modified end-use load requirements for an Energy Star Home.

Pollution Prevented through Energy Star Upgrades

Type of Emissions	*Reduction (lb/year)*
Carbon (C)	0.0
Sulfur Dioxide (SO2)	0.0
Nitrogen Oxides (NOx)	0.0

The energy savings and pollution prevented are calculated by comparing the As Designed home to the Energy Efficient Reference Home as defined in the "Guidelines for Uniformity: Voluntary Procedures for Home Energy Ratings," August 1996, prepared by the HERS Council.

ENERGY COST AND FEATURE REPORT

Date:	November 08, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	CODEMIN.BLG	Rating Date:	

ANNUAL ENERGY COSTS		**codemin**
Heating	$	418
Cooling	$	0
Water Heating	$	159
Lights & Appliances	$	394
Service Charges	$	90
Total	$	1060
Average Monthly	$	88

ENERGY FEATURES

Ceiling w/Attic	R38 Attc (2x4 24oc) U=0.026
Vaulted Ceiling	None
Above Grade Walls	R11 (2x4 16oc) U=0.087
Foundation Walls	R-5.0
Doors	R-2.1
Windows	D W Op U=0.560
Window Shading	H: None C: None
Frame Floors	None
Slab Floors	UninsulatedR-0
Infiltration	H: 0.40 C: 0.40 ACHnat
Infilt. Measure	Blower door test
Interior Mass	None
Heating System	Fuel-fired air distribution
Heating Efficiency	78.0 AFUE
Cooling System	None
Cooling Efficiency	0.0 SEER
Ducts	Uninsulated
Water Heating	Conventional, Gas
Water Heating Efficiency	0.50 EF
Active Solar	None
Sunspace	No

Notes: Where feature level varies in home, the dominant value is shown.

PERFORMANCE SUMMARY

Date:	November 08, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	CODEMIN.BLG	Rating Date:	

		codemin
Annual Load (MMBtu/yr)		
Heating		60.9
Cooling		0.0
Water Heating		22.5
Annual Consumption (MMBtu/yr)		
Heating		78.1
Cooling		0.0
Water Heating		29.6
Lights & Appliances		20.0
Annual Energy Cost ($/yr)		
Heating	$	418
Cooling	$	0
Water Heating	$	159
Lights & Appliances	$	394
Service Charges	$	90
Total	$	1060
Design Loads (kBtu/hr)		
Space Heating		38.1
Space Cooling		0.0

Utility Rates:

Electricity: MG&E/Elec

Gas: MG&E/Gas

ENERGY STAR HOME REPORT

Date:	November 08, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	LOWMRKT.BLG	Rating Date:	

Modified End-Use Load (MMBtu/year)

	Energy Star	*As Designed*
Heating:	33.2	48.8
Cooling:	0.0	0.0
Water heating:	14.6	20.7
Total:	47.8	69.4
Rating:	**86.0**	**79.7**

This home DOES NOT meet the modified end-use load requirements for an Energy Star Home.

Pollution Prevented through Energy Star Upgrades

Type of Emissions	*Reduction (lb/year)*
Carbon (C)	0.0
Sulfur Dioxide (SO2)	0.0
Nitrogen Oxides (NOx)	0.0

The energy savings and pollution prevented are calculated by comparing the As Designed home to the Energy Efficient Reference Home as defined in the "Guidelines for Uniformity: Voluntary Procedures for Home Energy Ratings," August 1996, prepared by the HERS Council.

ENERGY COST AND FEATURE REPORT

Date:	November 08, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	LOWMRKT.BLG	Rating Date:	

ANNUAL ENERGY COSTS		**lowmrkt**
Heating	$	418
Cooling	$	0
Water Heating	$	145
Lights & Appliances	$	374
Service Charges	$	90
Total	$	1027
Average Monthly	$	86

ENERGY FEATURES	
Ceiling w/Attic	R38 Attc (2x4 24oc) U=0.026
Vaulted Ceiling	None
Above Grade Walls	R11 (2x4 16oc) U=0.087
Foundation Walls	R-5.0
Doors	R-2.1
Windows	D W Op U=0.560
Window Shading	H: None C: None
Frame Floors	None
Slab Floors	UninsulatedR-0
Infiltration	H: 0.40 C: 0.40 ACHnat
Infilt. Measure	Blower door test
Interior Mass	None
Heating System	Fuel-fired air distribution
Heating Efficiency	80.0 AFUE
Cooling System	None
Cooling Efficiency	0.0 SEER
Ducts	Uninsulated
Water Heating	Conventional, Gas
Water Heating Efficiency	0.55 EF
Active Solar	None
Sunspace	No

Notes: Where feature level varies in home, the dominant value is shown.

PERFORMANCE SUMMARY

Date:	November 08, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	LOWMRKT.BLG	Rating Date:	

		lowmrkt
Annual Load (MMBtu/yr)		
Heating		62.5
Cooling		0.0
Water Heating		20.6
Annual Consumption (MMBtu/yr)		
Heating		78.2
Cooling		0.0
Water Heating		27.1
Lights & Appliances		18.9
Annual Energy Cost ($/yr)		
Heating	$	418
Cooling	$	0
Water Heating	$	145
Lights & Appliances	$	374
Service Charges	$	90
Total	$	1027
Design Loads (kBtu/hr)		
Space Heating		38.1
Space Cooling		0.0

Utility Rates:

Electricity: MG&E/Elec

Gas: MG&E/Gas

ENERGY STAR HOME REPORT

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	GOODPRAC.BLG	Rating Date:	

Modified End-Use Load (MMBtu/year)

	Energy Star	*As Designed*
Heating:	32.5	19.0
Cooling:	0.0	0.0
Water heating:	14.6	17.9
Total:	47.1	36.9
Rating:	**86.0**	**89.0**

This home meets the modified end-use load requirements for an Energy Star Home.

Pollution Prevented through Energy Star Upgrades

Type of Emissions	*Reduction (lb/year)*
Carbon (C)	1528.3
Sulfur Dioxide (SO2)	0.0
Nitrogen Oxides (NOx)	7.4

The energy savings and pollution prevented are calculated by comparing the As Designed home to the Energy Efficient Reference Home as defined in the "Guidelines for Uniformity: Voluntary Procedures for Home Energy Ratings," August 1996, prepared by the HERS Council.

REM/Rate - Residential Energy Analysis and Rating Software v8.2(

This information does not constitute any warranty of energy cost or savings.

ENERGY COST AND FEATURE REPORT

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	GOODPRAC.BLG	Rating Date:	

ANNUAL ENERGY COSTS		**goodprac**
Heating	$	163
Cooling	$	0
Water Heating	$	126
Lights & Appliances	$	331
Service Charges	$	90
Total	$	710
Average Monthly	$	59

ENERGY FEATURES	
Ceiling w/Attic	R50 trusses 24oc U=0.020
Vaulted Ceiling	None
Above Grade Walls	R19 2x6 16oc R7.5 U=0.038
Foundation Walls	R-15.0
Doors	R-5.0
Windows	Dbl/LoE/Argon - Wood U=0.360
Window Shading	H: None C: None
Frame Floors	None
Slab Floors	UninsulatedR-0
Infiltration	H: 0.10 C: 0.10 ACHnat
Infilt. Measure	Blower door test
Interior Mass	None
Heating System	Fuel-fired air distribution
Heating Efficiency	92.0 AFUE
Cooling System	None
Cooling Efficiency	0.0 SEER
Ducts	Uninsulated
Water Heating	Conventional, Gas
Water Heating Efficiency	0.65 EF
Active Solar	None
Sunspace	No

Notes: Where feature level varies in home, the dominant value is shown.

PERFORMANCE SUMMARY

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	GOODPRAC.BLG	Rating Date:	

		goodprac
Annual Load (MMBtu/yr)		
Heating		28.0
Cooling		0.0
Water Heating		15.3
Annual Consumption (MMBtu/yr)		
Heating		30.4
Cooling		0.0
Water Heating		23.6
Lights & Appliances		23.2
Annual Energy Cost ($/yr)		
Heating	$	163
Cooling	$	0
Water Heating	$	126
Lights & Appliances	$	331
Service Charges	$	90
Total	$	710
Design Loads (kBtu/hr)		
Space Heating		19.8
Space Cooling		0.0

Utility Rates:

Electricity: MG&E/Elec
Gas: MG&E/Gas

ENERGY STAR HOME REPORT

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	PASSOLAR.BLG	Rating Date:	

Modified End-Use Load (MMBtu/year)

	Energy Star	*As Designed*
Heating:	32.5	13.1
Cooling:	0.0	0.0
Water heating:	14.6	4.5
Total:	47.1	17.6
Rating:	**86.0**	**94.8**

This home meets the modified end-use load requirements for an Energy Star Home.

Pollution Prevented through Energy Star Upgrades

Type of Emissions	*Reduction (lb/year)*
Carbon (C)	2394.1
Sulfur Dioxide (SO2)	0.0
Nitrogen Oxides (NOx)	11.6

The energy savings and pollution prevented are calculated by comparing the As Designed home to the Energy Efficient Reference Home as defined in the "Guidelines for Uniformity: Voluntary Procedures for Home Energy Ratings," August 1996, prepared by the HERS Council.

ENERGY COST AND FEATURE REPORT

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	PASSOLAR.BLG	Rating Date:	

ANNUAL ENERGY COSTS		**passolar**
Heating	$	112
Cooling	$	0
Water Heating	$	32
Lights & Appliances	$	331
Service Charges	$	90
Total	$	565
Average Monthly	$	47

ENERGY FEATURES

Ceiling w/Attic	R50 trusses 24oc U=0.020
Vaulted Ceiling	None
Above Grade Walls	R22 2x6 16oc R7.5 U=0.036
Foundation Walls	R-22.0
Doors	R-5.0
Windows	D W Op (LoE/Ar w/St) U=0.300
Window Shading	H: None C: None
Frame Floors	None
Slab Floors	R5 Under Slab, 13'R-5.0 Under
Infiltration	H: 0.10 C: 0.10 ACHnat
Infilt. Measure	Blower door test
Interior Mass	Tile
Heating System	Fuel-fired air distribution
Heating Efficiency	96.5 AFUE
Cooling System	None
Cooling Efficiency	0.0 SEER
Ducts	Uninsulated
Water Heating	Conventional, Gas
Water Heating Efficiency	0.65 EF
Active Solar	DHW heating only
Sunspace	No

Notes: Where feature level varies in home, the dominant value is shown.

REM/Rate - Residential Energy Analysis and Rating Software v8.2(

This information does not constitute any warranty of energy cost or savings.

PERFORMANCE SUMMARY

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	PASSOLAR.BLG	Rating Date:	

		passolar
Annual Load (MMBtu/yr)		
Heating		20.2
Cooling		0.0
Water Heating		3.8
Annual Consumption (MMBtu/yr)		
Heating		21.0
Cooling		0.0
Water Heating		5.9
Lights & Appliances		23.2
Annual Energy Cost ($/yr)		
Heating	$	112
Cooling	$	0
Water Heating	$	32
Lights & Appliances	$	331
Service Charges	$	90
Total	$	565
Design Loads (kBtu/hr)		
Space Heating		16.1
Space Cooling		0.0

Utility Rates:

Electricity: MG&E/Elec
Gas: MG&E/Gas

This information does not constitute any warranty of energy cost or savings.

ENERGY STAR HOME REPORT

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	ACTSOLHY.BLG	Rating Date:	

Modified End-Use Load (MMBtu/year)

	Energy Star	*As Designed*
Heating:	32.4	11.1
Cooling:	0.0	0.0
Water heating:	13.1	0.0
Total:	45.5	11.1
Rating:	**86.0**	**96.6**

This home meets the modified end-use load requirements for an Energy Star Home.

Pollution Prevented through Energy Star Upgrades

Type of Emissions	*Reduction (lb/year)*
Carbon (C)	2537.7
Sulfur Dioxide (SO2)	0.0
Nitrogen Oxides (NOx)	12.3

The energy savings and pollution prevented are calculated by comparing the As Designed home to the Energy Efficient Reference Home as defined in the "Guidelines for Uniformity: Voluntary Procedures for Home Energy Ratings," August 1996, prepared by the HERS Council.

REM/Rate - Residential Energy Analysis and Rating Software v8.2(

ENERGY COST AND FEATURE REPORT

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	ACTSOLHY.BLG	Rating Date:	

ANNUAL ENERGY COSTS		actsolhy
Heating	$	93
Cooling	$	0
Water Heating	$	0
Lights & Appliances	$	331
Service Charges	$	90
Total	$	513
Average Monthly	$	43

ENERGY FEATURES

Ceiling w/Attic	R50 trusses 24oc U=0.020
Vaulted Ceiling	None
Above Grade Walls	R34 (Larsen/cellulos U=0.029
Foundation Walls	R-22.0
Doors	R-5.0
Windows	D W Op (LoE/Ar w/St) U=0.300
Window Shading	H: None C: None
Frame Floors	None
Slab Floors	R5 Under Slab, 13'R-5.0 Under
Infiltration	H: 0.10 C: 0.10 ACHnat
Infilt. Measure	Blower door test
Interior Mass	Tile
Heating System	Fuel-fired hydronic distribution
Heating Efficiency	75.0 AFUE
Cooling System	None
Cooling Efficiency	0.0 SEER
Ducts	None
Water Heating	Integrated, Gas
Water Heating Efficiency	0.82 EF
Active Solar	DHW & space heating
Sunspace	No

Notes: Where feature level varies in home, the dominant value is shown.

PERFORMANCE SUMMARY

Date:	November 07, 1997	Rating No.:	
Owner's Name:	MACLT	Rating Org.:	
Property	Troy Drive	Phone No.:	
Address:	Madison, WI	Rater's Name:	
		Rater's No.:	
Builder's Name:	Unknown		
Weather Site:	Madison, WI	Rating Type:	
Builder's File:	ACTSOLHY.BLG	Rating Date:	

		actsolhy
Annual Load (MMBtu/yr)		
Heating		13.0
Cooling		0.0
Water Heating		0.0
Annual Consumption (MMBtu/yr)		
Heating		17.3
Cooling		0.0
Water Heating		0.0
Lights & Appliances		23.2
Annual Energy Cost ($/yr)		
Heating	$	93
Cooling	$	0
Water Heating	$	0
Lights & Appliances	$	331
Service Charges	$	90
Total	$	513
Design Loads (kBtu/hr)		
Space Heating		15.7
Space Cooling		0.0

Utility Rates:

Electricity: MG&E/Elec

Gas: MG&E/Gas

Attachment B:

Cost Spreadsheet

Cost Spreadsheet

Base cost of $112,560 from Don Simon quote of $111,900 with the following adjustments:

- $300 for cabinets/countertops; - $240 for eliminating dishwasher allowance

+ $800 for extra drywall for windows and doors

+ $400 Roper 14.4 cu.ft refrigerator

Some numbers are "backed out" features, not included in CodeMinimum or LowMarket

Energy Feature	Codemin	LowMkt	GoodPractice	PassiveSolar	ActSol&Hydr
Base cost	112560	112560	112560	112560	112560
Active Solar Heating System					16600
Ceiling cellulose @ R-50				382	382
Ceiling fans (2)				600	600
Cellulose, blown in exerior, extra					2369
Clotheswasher, Kenmore	400	400			
Clotheswasher, Creda Horiz.Axis				950	950
Clotheswasher, Frigidaire HAxis			800		
Doors, R5			300	300	300
Double Stud Exterior Walls					1552
Fiberglass, Sidewall R22				400	
Fluorescent Fixtures		-100			
Furnace Upgrade			300	1150	1150
Heat Recovery Ventilator			1982	1982	1982
Interior Thermal Mass, added				1152	1920
No jamb extenders @ Sidewalls	-1200	-1200			
Rim joist insulation, upgrade				60	60
Roof Energy Trusses	-200	-200			
Slab Insulation				325	325
Solar Domestic Hot Water w/75 gal.				1800	
Storm panels for windows				495	495
Water Heater	-350	-100			
Windows	-500	-500			
Windows, Marvin Integrity				487	
Windows, Marvin Full Line					2920
Total Costs ($)	**110710**	**110860**	**115942**	**122643**	**144165**
MGE Rebates			-7000	-7000	-7000
Home Performance Rating Rewards			-550	-760	-850
Add $150 for cost of test			150	150	150
Totals with rebates considered $	**110710**	**110860**	**108542**	**115033**	**136465**

Appliances:

Roper refrigerator costs $54 per year, uses 620 kWh annually.

Creda uses no more than 16.9 gallons of water per wash, comparable to Frigidaire's energy performance

Frigidaire clotheswasher is horizontal axis, costs $23 per year, uses 264 kWh annually

Green Options

Feature	Unit Price	Model Cost
Cabinets/countertops with no formaldehyde		
low-VOC adhesives and coatings		
Engineered wood products: roof & floor trusses		200
Flooring: granulated debris	$2/sq.ft	
Hardwood floors		
Linoleum		
Paints, plant based		300
Plumbing: Hubless cast iron		*1943*
Roofing with recycled content		
Panel system: Eiger Shake Co.	*$2.20 /100 sq.ft*	
PVC siding roof material	*$42-$45/100 sq.ft*	
Siding: Fiber-Cement vs. vinyl		*2600*
Tile: Iron Rock industrial scrap	*$1.25/sq.ft*	
Tierra Classic waste glass		
Waste recycling bins		*100*

Attachment C:

Outline Specifications

Design Coalition, Inc.
2088 Atwood Avenue
Madison, WI 53704

608 / 246-8846 (voice)
608 / 246-8670 (fax)
designco@execpc.com (email)

Outline Specification for:

MACLT Green Housing Project — Base House
Madison, Wisconsin

Note: This outline specification is not a final construction specification. It is intended to establish the quality level of a basic house for energy analysis and cost estimating purposes only. It is subject to change and may not include all elements necessary to the project.

A description of the size and various options for the base house, and the added or deducted costs is provided in the report. The base house described by these outline specifications is roughly similar to the **GoodPractice** house model.

DIVISION 1—GENERAL

Construction: By general contractor with coordination of all subcontractors. Utility services and temporary heat, if any, included in the contract sum.

DIVISION 2—SITE WORK

Excavation: All site clearing, excavation, backfilling and rough grading necessary to complete the project, including foundation and all below-grade utilities.

Landscaping: Finish topsoil grading to proper elevation and seeding. Provide protection for any trees and root systems to be retained until the completion of construction. No allowance for plant materials.

Paving: Poured 5" concrete walks and slabs at entry and exit doors; 48 sq.ft. included. 16' x 35' driveway and 20' x 10' apron included.

Demolition: (none anticipated).

DIVISION 3—CONCRETE

Poured concrete: Unreinforced footings, 8" reinforced foundation walls (2-#4 bars @ top and bottom of wall), 3" floor slabs @ basement.

DIVISION 4—MASONRY (No Work in this Division)

DIVISION 5—METALS

Superstructure framing: FHA steel posts at basement.

Railings, interior: Oak for clear finish in metal brackets on 1x 4 oak backer

DIVISION 6—WOOD & PLASTICS

Wall framing: 2x6 @ 16" o.c. at exterior, with pre-insulated headers by Superior. 2x4 @ 24" o.c. at interior.

Wall sheathing: LP 'InnerSeal' OSB sheathing.

Floor framing: 2 x 10 floor joists on Micro=Lam girder. Wood stud bearing walls.

Floor system: 3/4" plywood T&G subfloor. 1/4" luan underlayment @ resilient flooring

Roof framing: Wood trusses, 24" o.c.

Roof deck: LP 'InnerSeal' 5/8" OSB sheathing

Interior Trim: Clear Red Oak, contemporary, for transparent finish, no stain

Exterior trim: #2 pine. Aluminum soffits

Exterior deck: Pressure-treated wood

DIVISION 7—THERMAL & MOISTURE PROTECTION

Insulation: R-11.6 extruded polystyrene insulation at foundation wall; R-19 fiberglass at walls; R-38 blown-in cellulose at roof

Roofing: Seal-down, Class C, 3-tab shingles on #15 paper, with a 25 year guarantee.

Siding: Double-vinyl, 4" exposure

Fascia and Drip edge, Gutters and downspouts: Prefinished aluminum.

DIVISION 8—DOORS & WINDOWS

Windows: Vedder clad wood double-hungs and fixed, weatherstripped, clear insulating double glazing with low-E coating, screens. Assume 85% operating sash.

Entry and Exit Doors: Insulated metal with wood frame, weatherstripping.

Interior Doors: Flush hollow-core red oak for transparent finish w/ with wood frames.

Door Hardware: Locksets and latches: F-series by Schlage. Lever handles throughout. 1-1/2 pair pin hinges at doors.

Attic access door: Insulated type

DIVISION 9—FINISHES

All walls and ceilings: 1/2" gypsum wall board, secured by screws, painted; 'orange-peel' texture at all locations. Type X @ fire-rated partitions and ceilings.

Paint & transparent finish: Low-VOC water-borne acrylic.

Doors: @ Wood doors: 2 coats clear water-borne acrylic urethane finish over sealer coat. At exterior steel doors: 2 coats exterior enamel.

Base, typical: 3" Oak for clear finish.

Base at toiletrooms: 6" cove glazed ceramic tile

Carpet (50% of total area): residential grade level-loop nylon, allowance of $17 per square yard, installed with pad.

Resilient Flooring, including bathrooms: (20% of total area): Sheet linoleum, residential grade.

Wood Flooring,Living & Dining rooms: (30% of total area): Oak, clear finish.

Stair tread and riser cover: Carpet with pad.

DIVISION 10—SPECIALTIES

Window treatments: none.

Toilet Accessories: Mirrors and cabinets, grab bars, towel, soap and toilet tissue dispensers; allowance of $300.

Closet shelving: Metal, 'Closet Maid'

DIVISION 11—EQUIPMENT

Equipment included: Range, refrigerator, dishwasher, clothes washer & dryer. Gas and electric supply provided as required. No disposal.

DIVISION 12—FURNISHINGS

Cabinets in Kitchens: Wall and base cabinets: Allowance of $3,700 provided. Countertops and shelving at kitchen: Triple-cove plastic laminate on particle board, standard colors and matte surface.

DIVISION 13—SPECIAL CONSTRUCTION

(No work in this Section)

DIVISION 14—CONVEYING SYSTEMS

(No work in this Section)

DIVISION 15—MECHANICAL

Plumbing

Construction drawings and specifications will indicate fixture type and locations. The detailed DWV and supply system design, and submittal for permit will be the responsibility of the Contractor. Copper supply piping throughout. Two alternate prices for DWV systems were provided: 1) PVC waste piping throughout, or, 2) PVC waste piping at exterior locations (below grade) only. (Note: PVC is a less environmentally sound product). 40 lineal feet of sewer and water supply piping assumed from City mains.

Sink @ kitchen: Average quality residential type, double-compartment 20 ga. stainless steel with Moen Chateau kitchen faucet.

Water closets: by Mansfield, white, water-saving per Code.

Tub/Shower modules: Fiberglass with non-pressure balanced Moen Chateau faucet, showerhead

Laundry: Mustee laundry sink with Delta faucet, automatic washer hook-up. Schier floor drain.

All other bathroom lavatories: Cast resin-stone one-piece on vanity cabinet, with Kohler Trend faucet.

Water heaters: Natural gas by State, Ruud or Rheem, 40 gallon capacity.

Hose Bibbs: Two, at exterior

Sump Pump: Myers, connected to foundation drains, with sealed sump pit (for future potential installation of radon mitigation system).

Heating

Forced-air heating: Direct-vent furnace with sheet-metal ducts, diffusers and related accessories. Detailed system design will be responsibility of the installing subcontractor. Computerized setback thermostat.

Heat recovery ventilating system: New Aire HE-110, with exterior wall vent caps and sheet metal and flex-duct returns from kitchen and bathrooms, supply to the furnace return plenum.

DIVISION 16—ELECTRICAL

System Design: 100 amp, single phase service.

Light fixture allowance: $500.

Smoke Detection System: located per code. Photoelectric type detectors (non-radioactive) provided, 120 VAC, interconnected.

Phone system: Two jacks.

Cable TV system: Two jacks.