Implementing Plan C – conservation, curtailment and cooperation

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Saving Energy the “Passive Way” – Lessons from a Recent Home Retrofit

By Megan Quinn Bachman

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at Murphy and his wife Faith Morgan of Community Solutions knew a little about retrofitting buildings for low-energy use when they decided to turn their small 100-year-old carriage house into an artist’s studio and apartment.

After they learned how the new German “Passive House” concept can reduce energy consumption in existing buildings by up to 80 percent, they decided to find out – and share with others – how much energy they could save in their 1,000-square foot, two-story building, once used by horses and buggies.

“A Passive House is a very well-insulated, virtually air-tight building that is primarily heated by passive solar gain and by internal gains from people [and] electrical equipment,” according to Katrin Klingenberg of the Urbana, Illinois-based Passive House Institute U.S. With reduced energy losses, Passive Houses can be heated with an extremely small external source or none at all.

“At first I was skeptical about the Passive House concept,” said Morgan, board president of Community Solutions, a non-profit in Yellow Springs, Ohio, which educates about household sector solutions for dealing with climate change and the peak and decline of world oil production. “To not have a furnace in a house in Ohio seemed impossible,” she said.

With the world facing the end of cheap energy as well as the prospect of catastrophic climate changes, Community Solutions believes homes that use little energy will be critical in mitigating these twin challenges. Yet conventional methods for reducing home energy use do not approach the 80 – 90 percent reduction targets of the Passive Houses, nor do they even approach the efforts made during the 1970s energy crisis.

So-called “green building” and energy efficiency programs for new homes like the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) certification and the U.S. ENERGY STAR qualified homes only save, on average, about 25 – 30 percent of the energy used in a typical building, according to Community Solutions.

Linda Wigington, a manager at Affordable Comfort, Inc., another organization promoting deep energy retrofits, said, “Recently much of the emphasis for low energy homes in the US has focused on expensive mechanical and renewable systems, such as geothermal heat pumps and solar photovoltaic arrays without substantially reducing the energy load through much higher levels of insulation and air tightness.”

Wigington commended Community Solutions for its effort to demonstrate the potential to focus first on load reduction. “A smaller and less expensive renewable energy system can make a bigger impact when the load is reduced first,” she said.

The building had never before been a living space and it had no floor, foundation, electricity, plumbing, or utilities. In some places, the structure was leaning up to 12 inches. Because of the unfinished condition of the building, German Passive House principles could be incorporated from the outset.

“It was clear at the beginning that we would need thicker walls, floors, ceilings and roofs – in essence, thickening the building envelope,” said Murphy, Community Solutions’ Executive Director. Rather than using conventional 2x4 single-wall construction, they built two 2x4 walls separated by a five- to ten-inch space, making the walls nine to fourteen inches thick. As a result, the walls continued on next page
had an estimated R-value, a measure of the rate heat energy is transferred through a material, of between R-30 and R-40, far exceeding the building code standard.

To minimize heat loss through the floor, they decided to build a floor on top of the existing slab. First, plastic and two inches of rigid foam were put down over the slab. On top of the foam, 2x8 floor joists were installed, supported by ledgers on the exterior walls. Fiberglass insulation was placed between the joists.

As a result of this layering the floor was raised 12 inches, which changed the ceiling height from eight and a half feet to seven and a half feet. The result was an R-value of more than R-30 for the floor, nearly three times as much as the R-11 called for in the building code. The ceiling of the first floor was also insulated to minimize both sound and heat transfer between the first and second floors. This was done to allow division of the building into two apartments and allow independent control for any HVAC systems.

Insulating the walls and ceiling proved difficult due to the limited local availability of materials and installers and the challenges of finding reliable data. “You have to get past the rumors and marketing hype,” said Murphy, who is also a former builder and building software company owner. “Deep retrofits using optimum insulation are uncommon in the industry,” Murphy added. “Until consumers request well-insulated houses, builders will not offer this as an option.” Different types of insulation were therefore used in different walls of the house to gain experience with insulation types and methods.

On most of the walls, damp spray cellulose was applied, which doesn’t settle as dry cellulose tends to do and is both fire-retardant and insect-resistant. “An advantage over spray foam is that cellulose is made from natural materials rather than petrochemicals and there is significantly less energy used in the manufacturing process,” Morgan said. And it takes about the same amount of time to install as other types of insulation. Cellulose is also less expensive.

In sections of the wall deeper than 14 inches, and in the ceiling, damp spray cellulose could not be used, as it would fall out, according to the installers. Instead, dry blown-in cellulose was used in the walls, and standard fiberglass in the ceiling, which have a comparable R-value. The R-value of the ceiling ended up being about R-40.

Wigington, in her analysis of the building, suggested that an inch or two of spray foam applied on the inside surface of the exterior sheathing (between the studs) would have prevented air movement in the wall cavity, making it warmer. This would also help minimize the potential for wintertime condensation in the cavity. Other builders suggested that caulking the joint where the framing met the sheathing, or placing strips of vinyl against the exterior sheathing, would reduce air loss.

Wigington also expressed the need to pay attention to the quality of the cellulose insulation installation. “One criticism of cellulose is that it can settle over time. To prevent this it needs to be blown in at a high density,” she said, adding, “One way to assess the quality of an insulation contractor is to ask them to verify the installed density of the material. If they can’t do that, get a different contractor.”

Good quality windows and doors were the next consideration. While the double-paned (or double-glazed) high performance windows selected are an improvement over most windows, they were not up to Passive House standards, which call for triple-paned windows with an R-value of eight, much higher than the R-3 of most high performance windows sold in the U.S. and the ones used in the retrofit.

However, the windows chosen were made of solid vinyl, which does not transfer heat as readily as wood. The builders also insulated around the outside of the windows.

“The more windows, the more heat loss,” said Chris Glaser, the contractor hired for the project.
Thus, few windows were included in the plans, especially on the north side of the building. Though placing windows for solar gain was a consideration, it proved difficult due to the location of the building and the abundance of trees on the southern exposure.

The doors were rated at R-15, much higher than standard doors, Glaser said. The dual-glazed windows in the doors also had internal shade mechanisms between the panes of glass which can be used to gain heat or prevent heat loss, depending on the season and time of day.

After creating a thick and well-insulated building envelope and ensuring high quality windows and doors, Glazer focused on making the house as tight as possible to prevent any heat from leaking out of the building. Foam was sprayed in large cracks and caulk was used extensively – between the siding and the stud, around doors and windows, and wherever there were penetrations for wires, plumbing, and other ducts. In addition, aluminum taping was used on all corners and windows and the back side of the exterior siding was painted to seal the wood.

To measure the tightness of the building and to identify remaining leaks, a blower-door test was performed. A portable, calibrated fan mounted in the building’s door created a pressure difference between the inside and outside of the building equal to a 20-mph wind on all sides of the building. The air leakage rate was 480 cubic feet per minute at 50 Pascals of pressure (480 cfm50). “This is the lowest reading I’ve had on a two-story house this size,” said Bob Klahn, a Yellow Springs-based home energy consultant. “I would’ve expected double that.”

In existing homes being addressed using a comprehensive whole house approach such as Home Performance with Energy Star, 1000 cfm/1000 square foot is a common benchmark. This house exceeded that two-fold! However, the carriage house’s measure of air tightness did not meet the Passive House standard, developed and regulated by Passive House Institute U.S. The institute requires a 1,000-square-foot building to achieve approximately 100 cfm50 or less, five times as tight. To ensure air quality in such a tight house, an air-to-air heat exchanger, another Passive House stipulation, was installed. “Most houses get their ventilation through air leakages, which can pick up contaminants on the way,” Klahn said. Air-to-air heat exchangers are a much more efficient way of bringing fresh air into the house, as the heat is transferred from the air leaving the house to the air coming in on cold days. Because of this, Passive Houses often have better indoor air quality than conventional buildings, and fewer problems with condensation and nail-popping, two problems caused by a tight house.

Still, the retrofit project had its share of challenges. A lack of early planning led to cost and time overruns. In all, the project cost around $100 per square foot and took six months of full-time work for the crew of three – aided by various sub-contractors – to complete. However, that cost includes the extensive structural work as well as the plumbing, electric and utilities installation which might account for up to 25-40% of the square foot cost. Most homes would not have this additional expense in a simple retrofit. In addition, Murphy and Morgan found it difficult to keep ahead of the builders in trying to provide information for such an innovative deep retrofit project. “Knowledge of the Passive House is scattered around

How Will You Save?
Contractor Chris Glaser suggested the carriage house will use about 70 less energy; about 20 percent of the savings will result from the energy-efficient windows and doors, 40 percent from the new walls and their insulation, and the rest from insulating the attic and crawl space and reducing leaks.

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Plan C: Individual and Community Survival Strategies for the Energy Crisis

This year’s conference, held in Yellow Springs, Ohio since 2004, will take place in Rochester, Michigan. Several hundred community activists, sustainability educators and lifestyle change advocates are expected at the annual event, this year co-sponsored by Michigan-based Upland Hills Ecological Awareness Center.

Participants will learn how to cut their household energy use and create resilient, sustainable communities to weather the coming economic and ecological storms. Sessions will cover survival strategies for growing food, creating local food security, home retrofitting for low energy use, and education for communities to prepare for the difficult times ahead.


There will also be workshops and panels, Connection Café roundtables with area experts, an eco-tour slide show, screenings of award-winning films, entertainment, tours of local sustainably-designed buildings, a Green Living Expo and healthy, shared meals.

Other conference speakers include Katrin Klingenberg, director of the Passive House Institute U.S., an organization promoting super-efficient, carbon-neutral, cost effective building; Peter Bane, editor of Permaculture Activist magazine; Pat Murphy, author of Plan C: Community Survival Strategies for Peak Oil and Climate Change; Christopher Bedford, President of the Center for Economic Security and the Sweetwater Local Foods Market; John Richter, co-founder of the Institute for Sustainable Energy Education and former president of the Great Lakes Renewable Energy Association; and Megan Quinn Bachman, Outreach Director of Community Solutions.

Get complete information and register for the conference online at www.planconference.org, call 248-693-1021 or e-mail info@planconference.org.

Peak Debt

The true crisis may be the inability to afford the dwindling oil.

By Rob Content

Members of Community Solutions have distinguished themselves by their willingness to support the study of problems that many of their neighbors might regard as obscure, exaggerated, or even manufactured. Such problems might also have been assumed to be of the far-distant, “not-in-my-lifetime” category.

Together, fossil fuel depletion and climate change lead the list of these problems. Both share a quality captured by the word “peak.” Peak Oil names the period of time during which the global petroleum production system reaches its maximum capacity to bring oil to the market. Peaks in natural gas and coal production lie ahead as well. Climate change can also be understood as a peak, namely the maximum capacity of the ocean and atmosphere to serve as a safe sink for carbon emission pollution.

These two peaks are closely interconnected since it is primarily through the burning of fossil fuels that man-made climate change has been induced. However, as Richard Heinberg pointed out recently, the relationship is not linear. On the contrary, the warming of the atmosphere seems to have begun a process of acceleration partly independent of cutbacks in fossil fuel emissions, as the northern permafrost regions melt and the methane trapped there is released.

Over the last five years, the effort to educate an often unwilling population on these two peaking problems has generated an impressive store of books, films, and conference proceedings. That work continues today at organizations such as ASPO-USA, Post-Carbon Institute, and our own.

But while that work has been proceeding, yet a third peaking problem has caught up to us. And this one is unlikely to be a stranger to your neighbors.

Our friend Thomas Quinn called this month to urge us to turn our attention to what he’s calling “peak debt.” As we began to take Tom up on this, we discovered passages like the following:

Peak Oil (and peak gas, coal etc.) is a very real issue. But, by a very wide margin, it’s not the most pressing, or the worst, issue the world will face in the short term, say the next 5 years. This is because long before the availability of energy becomes a real problem, the availability of money to pay for the energy will be. And if the number of people who can afford to pay for gas, and heating oil, and electricity, declines, and does so at an increasing pace, energy availability turns into an afterthought, and even a moot point, for the time being.

Recent increases in the price of gasoline, home heating fuels, and electricity had not escaped our notice, of course. In fact, we’ve experienced a broader willingness to consider our concerns about Peak Oil now that increasing energy costs have become a clear trend, reported in the mainstream media and felt in the wallet. But the peak debt challenge
has set us to some further thought about how we can best be of service to our members, neighbors, and fellow citizens.

First, we ask ourselves if it’s true that many among us will soon be so lacking in income or savings that “energy availability turns into an afterthought.” Grim though it is, the current financial crisis seems a necessary correction to an extended period of growth and “prosperity” (albeit largely concentrated among the already prosperous). The boom and bust cycle is a familiar aspect of capitalist markets.

Against a broader historical background, today’s level of national debt is challenging, but not unprecedented and in fact only of average size. Or is today’s debt crisis in fact something new because of the advanced state of globalization, the failure of governments to maintain regulatory systems sufficient to protect their citizens, and the continuing rapid expansion in the number of human beings who need to be fed?

We are still exploring the answers to this question. One thing we are sure of is that from the Community Solutions perspective, a most troubling feature of peak debt is its implications for inequity. Our presentations on Peak Oil and climate change over the years have paid considerable attention to global inequity. Financial irresponsibility and market manipulations, with taxpayers shouldering the burden of subsequent bailouts, have increased inequity in the United States.

Our message for some time now has focused on voluntary curtailment of household expenditures. On the transportation side, we have made the case for downsizing personal vehicles, increasing passenger miles by ride-sharing, and traveling when possible by foot and bicycle.

Our housing recommendations have spanned the gamut from deep retrofitting for those with sufficient resources, to the lowest of low-tech solutions pioneered by members Larry Halpern and Gail Kean. During the cold months, Larry and Gail wear warm clothes inside, put fabric-filled pop-in frames into their windows, and block off sections of their house from use. Just this month, they have achieved the long-sought goal of reducing their home electricity use to zero.

When it comes to food, we have been advocates of shopping at farmers’ markets, subscribing to Community Supported Agriculture (CSA) farm shares, and making nutritious choices low on the food scale.

All of these approaches involve reductions in personal fossil fuel consumption and so in carbon emissions. But they also promote a healthier and less costly style of life for the individuals who embrace them. In that sense, we have been advocating a way of life in which the pursuit of wealth is minimized, and happiness is thereby increased.

If peak debt forces toward significant curtailment of their energy use, a decline in consumption-driven behavior may yield an involuntary increase in healthful physical activity. An involuntary increase in happiness might not be far behind. —

Rob Content is the Program Manager for Community Solutions.
excesses of the 1920s which led to the October 1928 crash of the stock market. This was followed by the passage of The Glass-Steagall Act in 1933 which prohibited a bank from offering investment, commercial banking and insurance services. This act also established the Federal Deposit Insurance Corporation (FDIC) and included banking reforms designed to control speculation.

Glass-Steagall was repealed by the Gramm-Leach-Bliley Financial Services Modernization Act, signed into law by President Clinton in 1999. This opened up competition among banks, securities companies and insurance companies and allowed bank holding companies to own other financial companies. While the oil companies, power companies and car companies were threatening our life support systems, the banks and securities company were threatening our economic support systems.

John Michael Greer has pointed out that our solutions to Peak Oil and climate change are always proposed within the context of a free market. But our unfettered capitalist system is not going to help us. He notes, “Track the economic history of the United States in the 20th century, for example, and an interesting pattern emerges. Until the 1920s, a free market ideology far more principled than its current equivalent dominated American politics; government kept its hands off business until the crash of 1929 and the Great Depression made that politically impossible. During the Depression years, politicians imposed an alphabet soup of regulations on the American economy, and those remained in place until the early 1980s, when most of them were removed. If the myth of the market is to be believed, the American economy should have been more prosperous before the mid-1930s and after the mid-1980s than in the intervening period.

“The problem, of course, is that this isn’t what happened. Until the 1930s, the American economy was racked at regular intervals by a disastrous cycle of booms and busts that drastically limited American prosperity and made severe economic depressions a frequent experience. As the New Deal took hold, the economic cycle damped down to livable levels, and the United States entered the longest period of general prosperity in its history. That prosperity waned in the 1970s as US oil production peaked and began to decline, but the deregulation of the 1980s did not bring it back. For most Americans, per capita income in constant dollars has declined since the early 1970s, and many other measures of effective wealth have slumped accordingly; the rate of infant mortality in America today, for example, is roughly on a par with that of Indonesia.”

Our consumption must decline to survive Peak Oil and climate change. And we need some model (we suggest community!) to replace the competitive way of living that is generating monstrous levels of inequity.

— Pat Murphy

**Community Food: A Progress Report**

My wife and I made progress producing food in our home gardens this summer, and are now busy on evenings and weekends preserving much of the surplus. We are new to growing, and still at an early stage in carrying out a seasonal effort to store the harvest. So we’ve also bought up extra dried beans, grains, pasta, and canned goods when the price was right at our local markets. Between the preserved food and the extra purchases, we calculate that we’ve stored enough to feed ourselves until the next summer harvest begins. If there is no food emergency between now and then, we are prepared to eat solely from our own provisions.

A food supply emergency seems unlikely to us, especially in the short term. Particular emergencies often arrive unexpectedly. But it is prudent to anticipate that some emergency or other will occur. We should therefore prepare for emergencies in advance. That is why we’ve decided to become prepared for a food emergency now.

We aren’t sure whether any of our friends or neighbors have made the same decision. For that reason, we recently made a one-time purchase of a much larger stockpile of food. This was expensive. We paid $10,000 for an inventory calculated to feed ten people for one year. This is food we have purchased as individuals. Our plan is to offer it to others in our community if it is needed in the year ahead.

A clear disadvantage of this plan is that the canneries are located on the west coast. Here at Community Solutions, our approach to food is focused on the benefits of dietary change and of local production. Our emergency food was grown and processed far from where we live. It was shipped to us by truck more than 2000 miles. As we look ahead to maintaining the same level of supply, we will seek to find producers and processors nearby.

In the meantime, we are letting people know that when food is needed, we will have a supply to provide. We are inviting people over to see what we have done in the way of growing food and preserving excess, and to share our plans to keep expanding the garden’s capacity in the years ahead. We’re also showing off the stock of stored foods.

Discussing what we each have to offer seems to have helped our community understand the scope of the need, should a food emergency actually occur. As part of these discussions, we are also learning to identify who will be in the best position to offer other needed resources in an emergency.
the country and Europe,” Murphy explained.

“We have no regrets, because we learned a lot and it will be a demonstration for what other people can do,” Morgan said. “My advice to others wanting to do this is don’t just start – plan first.” Glaser agreed. “The more you can plan ahead, the more cost savings can be realized in the construction project,” he said.

Glaser suggested some interview questions for potential retrofit contractors. “Ask about the R-values for windows, walls, ceiling, and floors, the quality of the windows, and how they deal with details like small penetrations and balloon framing,” he said. People also choose a contractor based upon their experience and personality, and how involved they want to be in the project. “To save money, people can do some work themselves. With coaching, they can do demolition and help with insulation and caulking,” Glaser said. This could save 10 – 20 percent of the cost.

Another compromise was making the house all-electric with an electric baseboard heater, which emits about twice as much carbon dioxide per million BTUs as a natural gas furnace. However, efforts were made to keep the heating load as small as possible, so this may not be a problem.

In addition, photovoltaic panels could one day be installed to handle the load of the electric heater, refrigerator, stove, and other appliances. This may be preferable to depending on natural gas, since supplies are projected to dwindle rapidly in North America over the next few decades.

Glaser, who worked inside the building comfortably with just a space heater throughout the winter, estimates the building will use about 70 percent less energy than a typical 1,000-square-foot house. He suggests about 20 percent of the savings will result from the energy-efficient windows and doors, 40 percent from the new walls and their insulation, and the rest from insulating the attic and crawl space and reducing leaks.

Preliminary testing of the building showed that it was only using 12 kilowatts per day to keep it at 59 degrees Fahrenheit when the average outside temperature was 41 degrees. When the building is complete this may decrease due to fewer leaks and more appliances and body heat to keep it warm.

In addition to requiring little energy to operate, the building’s construction also utilized local and recycled materials, which reduced its embodied energy. Local walnut, pecan, and hickory were used for the window trim and cabinets.

“Changing the building envelope – including the structure, windows, and doors – was the big investment,” Murphy said. “Because this building will last 100 years and energy costs are unknown in just 30 years, it will be a valuable piece of property,” he said.

For those who are unwilling or unable to build interior or exterior walls to thicken the envelope of their homes, Murphy suggested a variety of cost effective energy retrofits, including lighting upgrades (changing to compact fluorescents or LEDs), air sealing, and insulating the wall and attic.

“We know now we can reduce the energy use of buildings by 80 – 90 percent,” Morgan said. And with the growing need to reduce carbon dioxide generation and energy because of climate change and fossil fuel depletion, models like this deep energy retrofit and the Passive House will be critical, according to Morgan.

“I feel a tremendous ease because we learned a lot and it will be a demonstration for what other people can do,” Morgan said.

Megan Quinn Bachman is the Outreach Director for Community Solutions.

For more information on saving energy in existing homes visit the following websites:
Passive House Institute U.S.: www.passivhouse.us
Affordable Comfort, Inc.: www.affordablecomfort.org
Passivhaus Institute (Germany): www.passiv.de

A New Idea – Locality-Dependent Energy

As we learn more about energy and how to reduce its use, new ways of looking at things must be developed. One example is the local nature of energy generation and conservation.

In an article in the Dec/Jan 2008 issue of Fine Homebuilding entitled, “Solar Energy: Why it’s better than ever,” by Scott Gibson, a graphic shows the cost of a solar system in five different areas of the county. A 4-kilowatt (kw) photovoltaic (PV) system was installed at each of the five locations. The estimated installation price of the system was $36,000, which is about $9 per kw, a typical price for installing solar systems in the U.S. However, the energy produced with the same equipment from the five locations varied as shown in the following table:

<table>
<thead>
<tr>
<th>City</th>
<th>Energy Produced</th>
<th>Ratio – Seattle to Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seattle, WA</td>
<td>3,880 kwh</td>
<td>1.00</td>
</tr>
<tr>
<td>San Diego, CA</td>
<td>5,994 kwh</td>
<td>1.54</td>
</tr>
<tr>
<td>Columbia, MO</td>
<td>5,282 kwh</td>
<td>1.36</td>
</tr>
<tr>
<td>Concord, NH</td>
<td>4,943 kwh</td>
<td>1.27</td>
</tr>
<tr>
<td>Tampa, FL</td>
<td>5,455 kwh</td>
<td>1.41</td>
</tr>
</tbody>
</table>

This points out that an energy generating source of a particular capacity varies with location. Natural gas burned in any of these cities will have the same energy output. But it is different in different places for solar and wind.

Another example, in the Journal of Light Construction, June 2008, points out that replacing single pane windows with double-pane low-e windows in a typical 2,000 square foot house will result in annual savings of just $125 in a mild climate like California’s but $340 in a severe climate like New England’s.

This shows the complexity of trying to determine solutions to energy problems. When it comes to renewables such as wind and solar, the return on investment is dependent on the location. The same device is used but the energy generated varies. This is not true for coal and natural gas plants, even though plants closer to coal fields have some shipping advantage.

At the same time the conventional ways of calculation either a return on investment or a payback period need rethinking. Today a typical analysis for upgrading windows or adding a solar PV system calculates the energy saved, multiplies that value by the price of energy, uses some Net Present Value algorithm and then come up with a payback in years or a return on investment (ROI) in percents. But rarely do the equations include a steady increase in the price of energy.

This is further complicated by the fact that people do not stay very long in the same house. Thus, the housing market does not typically incorporate the potential savings in energy for the future.

How best to model this complex information? We’ll be looking for answers and will report back.
Special Membership Offer

For a limited time, you can become a Community Solutions member and receive a copy of Community Solutions Executive Director Pat Murphy’s new book, *Plan C – Community Survival Strategies for Peak Oil and Climate Change*, for a combined cost of just $50. In addition, as a member, you’ll receive *New Solutions* to keep you up to date on what we’re doing and to help you make informed decisions about how best to adapt to a low energy life.

**Please send me a copy of Plan C and enter me on your membership roll. I authorize/enclose payment of $50.**

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- Street address ___________________________________________________________________
- City __________ State/Province __________ Zip/Postal ______________
- Email address ____________________________________________________________________

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