



BENHAM

COMMUNITY ENERGY INITIATIVE

A preliminary report to the City of Benham, Kentucky

MIT Community Innovators Lab

September 2008

Benham Community Energy Initiative
A preliminary report to:

Mayor John Dodd
the Benham City Council
the Benham Power Board
and the People of Benham, Kentucky

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This is a follow-up to a previous report, “Wind Options: A Study of Energy Ownership Models”, written in the fall of 2007. A team from the Community Innovators Lab at MIT has been working with members of the Benham community to better understand the city’s energy consumption and help explore approaches to efficiency and locally generated clean electricity that have proven successful in other towns.

With the participation of:

Kentuckians for the Commonwealth (KFTC)
and
MACED, the Mountain Alliance for Community Economic Development

Thanks to:

Monk Falls, Benham City Council
George Massey, Benham City Council
Doug Robinson, Benham City Council
Eddie Creech
Roger Raleigh
The Benham Garden Club
Martin Richards and Colleen Unroe, KFTC
Jason Bailey and Josh Bills, MACED
Amber Bradley and Alexa Mills, MIT Community Innovators Lab

and many citizens of Benham including Roy Silver and Benham City Councilman Carl Shoupe

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SUMMARY

This brief report is intended to be a reference point for a growing community dialogue on energy issues in the City of Benham. Over the spring and summer of 2008, a number of residents have discussed how Benham, a community of 550 in the coal-filled mountains of southeast Kentucky, can be a leader rather than a victim of future energy trends. In addition, these residents have begun to explore ways that a local initiative focused on energy could become part of a broader strategy for local community revitalization and economic development that has been underway in Benham in recent years. The report is divided into the following sections:

- A profile of Benham's energy usage, including trends in electricity consumption, information about the community's population, and a description of the town's unique architecture and history.
- An exploration of different project scales, and different types of implementation. An energy initiative could focus on the city's municipal power purchases, on the consumption of individual residents and buildings, or on the community as a whole.
- A discussion of ideas relating to energy efficiency, with suggestions about the easiest and most effective strategies.
- A discussion of ideas about renewable energy generation.
- A brief list of recommended next steps to begin making decisions that represent the community.

This report summarizes ideas generated by Benham residents to date, and is meant to stimulate future discussions. It presents some pros and cons of different options, rather than recommending a list of answers. Many of the ideas included here can be implemented almost immediately. Others will require more planning. Either way, decisions that are made now about the town's energy usage will affect all of Benham's residents for years to come, and call for a long-term partnership between the city's citizens and elected officials.

INTRODUCTION

Benham residents, owners of their own municipal power company, pay among the lowest electricity rates of any utility in Kentucky. However, these rates are rising, presenting the city and its residents with risk and uncertainty in the future. Like other towns, Benham could reduce the expected blow from future electricity rate increases (as well as offset increases in water, sewer, and other rates) by searching for economic benefits in either local energy production or a focus on energy efficiency.

Large businesses and governments around the country have recognized the future burden of energy costs as a serious issue. They have enacted low-cost fixes that will have large payoffs. The Whitesburg campus of Southeast Kentucky Community and Technical College in Cumberland is already saving \$10,000 per year through energy conservation measures. Yet for small businesses, towns, and individuals, it is not easy to devote time or resources to investigate energy-saving options.

Benham has several unique characteristics that might be advantages in implementing an energy efficiency or renewable energy program. Benham is lucky enough to control its own power supply through its Power Board. It is a small city, so changes in energy use could be easy to monitor and track. Benham was built as a coal camp with a relatively uniform housing stock, so the city could create an energy plan tailored to its unique architectural heritage.

An energy initiative in Benham could take many forms. It could focus on the city's public buildings and municipal power purchases, and seek to reduce public expenditures. The city could focus on helping individual homeowners and businesses make improvements to their own buildings that would significantly reduce the community's electric bills. Or, through the Power Board, Benham could investigate producing its own power through wind or solar energy – a strategy being followed by more and more towns across the country. Benham is not alone in facing these questions, as communities everywhere are looking at their utility bills and asking the same questions. With residents, local government, and community groups working together, Benham could be an example for towns around the state and nation seeking homegrown solutions to energy problems. What will this example look like? That is for the citizens of Benham to decide.

BENHAM ENERGY PROFILE

Coal-fired power plants provide 90% of Kentucky's electricity. As the price of coal rises, the increasing costs of electricity will begin to affect the state's residents. In 2007, Kentucky residential customers paid an average of 7 cents per kilowatt-hour (kWh) for electricity, still the 7th lowest rate among all states.¹ Despite these low prices, Kentucky's per capita consumption of electricity has been rising consistently from year to year, and was the 5th highest in the United States in 2005 (6,460 kWh). This is almost 50% higher than the U.S. average. Among the reasons for this high consumption is the reliance by many Kentucky families on electricity for home heating.²

Each of these trends is even more pronounced in Benham. The publicly controlled Benham Power Board purchases electricity from Kentucky Utilities for its 277 residential (and 12 commercial) customers. These residential customers paid one of the lowest electricity rates in Kentucky in 2006, the most recent year that data is available. At 5.4 cents per kWh, this was well below the state average. Yet the electricity consumption per Benham household has consistently been one of the state's highest. In 2006, Benham's electricity consumption per household was *a full 50% higher* than the next closest utility in the state.³ While 2006 might have been an aberration, there are many reasons why electricity use might be particularly high in Benham. Old uninsulated and leaky houses demand more electricity to heat and cool, residents have been steadily converting their homes to electric heat pumps, and there is no natural gas supply in town for heat or hot water.⁴ In fact, household increases in electricity use have kept the city's overall electricity use constant from year to year, even as Benham is expected to lose 13% of its population between 2000 and 2010.⁵

If electricity costs are considered in relation to household income, the rising electricity bills that Kentucky residents will face in coming years will become more and more significant.

¹ U.S. Energy Information Administration. Downloaded September 2008
<www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html>

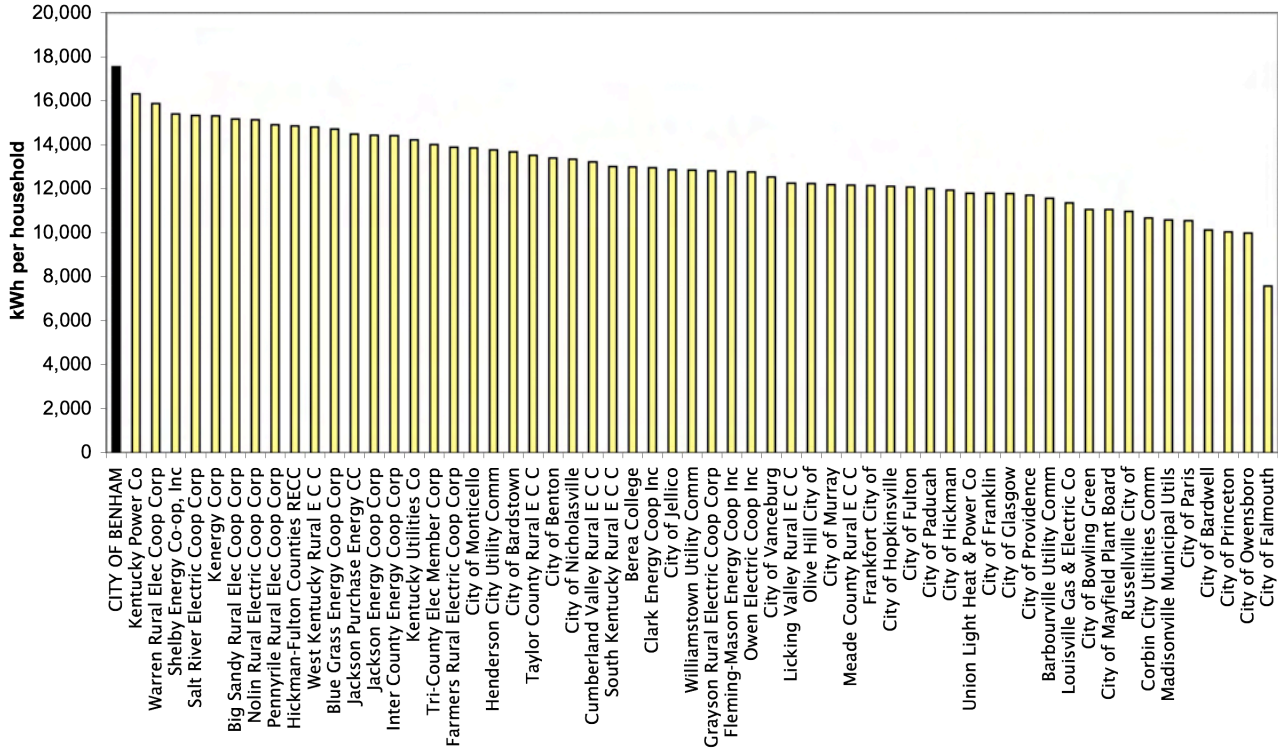
² U.S. Department of Energy. Downloaded September 2008
<apps1.eere.energy.gov/states/residential.cfm/state=KY>

³ U.S. Energy Information Administration. Downloaded September 2008
<www.eia.doe.gov/cneaf/electricity/page/eia861.html>

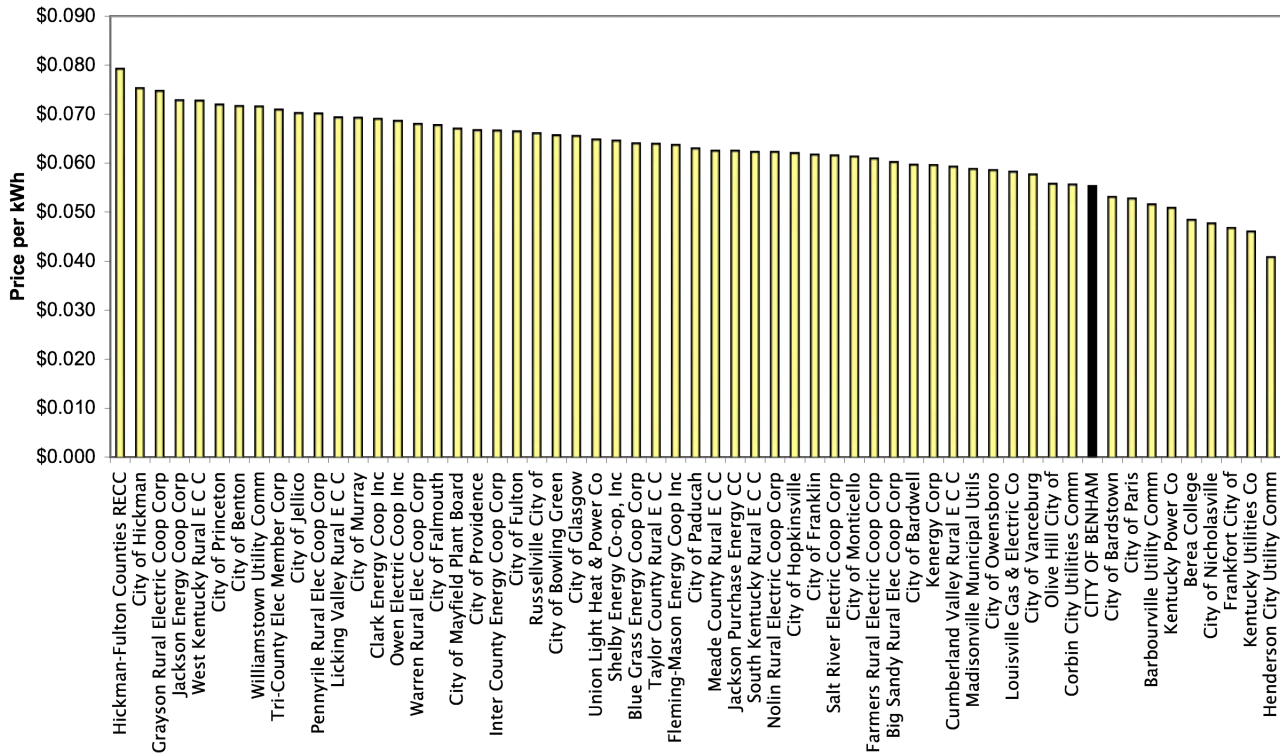
⁴ According to former Benham Power Board chair Roy Silver, the figures reported on Benham energy consumption likely overestimate actual use. High line losses contribute, but so does a metering system that charges the city based on peak energy usage, which is unusually high due to the town's overwhelming residential character. Nevertheless, the recorded electric consumption is still passed on to Benham residents.

⁵ Kentucky State Data Center estimate

Kentucky Residential Electricity Intensity (2003)



Kentucky Residential Electricity Rates (2003)



Kentucky electric utilities ranked in order of residential electricity consumption per household (top) and cost of electricity (bottom). Benham households (black bars) consumed 17,553 kWh each at a cost of 5.5 cents per kWh. (Source: U.S. EIA data)

Benham in particular is home to a high percentage of retirees and seniors on fixed incomes, who frequently consume more electricity for home heating. One quarter of Benham’s citizens are over the age of 60, many of whom have expressed that they have fewer incentives to make costly improvements to their homes that would require long payback periods. In addition, 48% of the city’s residents over the age of 21 are living with a disability, making it difficult in many cases to perform repairs in their homes without assistance.⁶

Yet Benham also offers a number of unique characteristics that make a community focus on electricity consumption particularly promising. Through the Benham Power Board, the city controls its own electricity supply, which could make it easier than in other towns to implement any renewable energy or efficiency program. The Power Board has the legal right to produce its own electricity, though it has not taken advantage of this in recent years, purchasing all of the town’s power from Kentucky Utilities. Finally, Benham is a small city of 550 residents, so any changes in energy use should be easy to track.

Another unique aspect of Benham is its housing stock. Benham was originally built and owned entirely by Wisconsin Steel, a subsidiary of International Harvester. The town was laid out beginning in 1911 as a “model” coal camp that would supply the company’s Chicago-based steel mill with high-grade coal for making farm machinery. A downtown of red brick buildings would be the commercial and social center of town, many of which still remain surrounding the park. The residential areas of the new town were laid out according to a



International Harvester built Benham beginning in 1911 as a “model” coal camp. Many of the houses were initially variations on a handful of basic types, with house size and location in town determined by the residents’ status in the mines, as well as race. (Sources: *coaleducation.org*, left, and *Southeast Kentucky Community College Archives*, right.)

⁶ Figures from the 2000 US Census

hierarchy of job status, race, and national origin, and the company tried to introduce variety in its housing stock to avoid the monotonous appearance of other camps. Although company officials were housed in somewhat larger and more elaborate houses, for the most part the homes were variations on the same basic models. The four-room bungalow was the most popular model among middle-income families, a wood-frame house with two bedrooms. Later, after 1918, many houses in “New Benham” west of town were built in a similar style, but some as duplexes with a central dividing wall. These housed mainly eastern European ethnic workers and other laborers in the mines. Along Looney Creek east of the town center, the homes were somewhat smaller, and primarily housed Benham’s black population.⁷

In 1961, the company decided to begin selling its houses off to Benham’s residents. Although population decline in the following decades has left only a fraction of the original houses still standing, many of Benham’s existing houses are these company-built homes with additions and alterations made over the years. Of the 288 total housing units in Benham, 248 are occupied. Ninety percent of these occupied housing units are owner-occupied, with the rest being rental units. Of the 220 owner-occupied units, 90% are single-family homes.⁸ While there is a good deal of variety in these homes, they also share many characteristics. Predominantly wood-frame construction with similar footprints, in many cases lacking insulation in walls or roofs, this housing stock presents the advantage that a community-wide energy plan could be designed to benefit a large number of homes.

“People, especially the retired folks, would be interested in a program to reduce energy bills.”

“My mom’s income has been cut in half, but her expenses have sure stayed the same.”

⁷ www.kingdomcome.org

⁸ Figures from the 2000 US Census

EXPLORING ALTERNATIVES

TYPE OF PROGRAM AND SCALE OF IMPLEMENTATION

On a national level, addressing our present energy and environmental crises will demand attention to both energy efficiency and alternative power sources. In order to gain control over its energy supply, Benham residents must also face both issues. Figuring out where to start, however, is challenging. What type of energy initiative is right for Benham? How big should this program be? Who will be responsible for managing its implementation?

The following pages outline a variety of specific ideas that Benham's residents have already suggested. These ideas are divided into two sections. First are a set of ideas that deal with improving the energy efficiency of Benham's existing buildings and operations. The second set of ideas deal with generating power locally to offset some of the city's present electricity purchases from Kentucky Utilities and keep more money in the local economy.

There are many other solutions that could be possible, as well. Some of these ideas will likely emerge during conversations in the coming months. However, a key question that Benham's citizens must answer is what scale and type of program they want to create:

- The first option is to empower **INDIVIDUALS AND BUSINESS OWNERS** to reduce their own energy use. Many homeowners have already expressed interest in reducing their energy bills and have asked for more information about their options. A group of citizens could organize an information campaign to help motivated individuals and organizations get the resources they need. Such a campaign could provide information about available subsidies for making home improvements or purchasing renewable energy systems. In addition, a group of organizers could help link individuals with organizations that already exist to provide technical assistance, loans, or services.
- Another alternative would be to focus on the city's **PUBLIC EXPENDITURES** on power purchases, and find ways to reduce these costs. A demonstration project at a prominent public building, such as City Hall, could make better use of tax dollars and also be an educational tool for children and visitors. Such a project could demonstrate techniques that could later be replicated around town. Given the City's difficulties in paying own electricity bills to the Power Board, a focus on energy efficiency in Benham's public buildings could help stabilize the town's budget in future years, especially as power costs increase.

- A third option would be to undertake a **COMMUNITY-WIDE EFFORT** that would benefit individuals as well as the city as a whole. This could take the form of a large-scale renewable energy project, whose economic benefits would be distributed across the entire community. Or Benham's citizens could work together to negotiate a low price for some of the energy efficiency measures described in the following pages. Innovative financing could be put in place to make the costs of such a program affordable to individual homeowners or businesses. Energy audits could be performed on all of the city's buildings. With support from the city's leadership, the community could partner with Kentucky Utilities or other outside groups that might be willing to invest in Benham as a model for other towns.

The ideas that follow were all suggested by Benham residents. This report was written to help broaden this dialogue and include more of Benham's citizens in the discussions. It is meant as a starting point, rather than a list of answers.



ENERGY EFFICIENCY

COMMON SENSE SOLUTIONS

In late June, several small discussions were held to learn the energy conservation ideas of Benham residents. These included home visits to discover the unique energy issues faced by residents with different types of homes, a variety of family sizes, ages, incomes, and parts of town. Separate conversations gathered initial feedback about the city's energy usage from four City Council members, Benham's Mayor and Power Board chair, and members of the Benham Garden Club, among others.

In these conversations, residents expressed unanimous interest in reducing the town's electricity usage and monthly bills, and a uniformly high level of familiarity with different energy conservation measures. Residents were receptive to – and in many cases excited by – an initiative that would allow them to make improvements to their homes, if cost and complexity were not barriers.

As some of Benham's homeowners have already discovered, simple fixes can have surprisingly large effects on energy bills, and need not be costly. Some of the simplest changes, including sealing around leaky windows and installing low-flow water fixtures, can pay back in a matter of months and save hundreds of dollars per year. Additionally, there are

programs in place at the state level that could help Benham, its homeowners, and its businesses make these changes, especially if the town can find ways to act collectively.

There were several common suggestions that arose during these discussions, and together they reveal much about the unique history of Benham's housing stock and public buildings. Among these possible strategies are these, ranked in order of how easily they can be implemented:

"Lots of people have been talked into heat pumps, which don't work well in these uninsulated houses."

"When I went down to City Hall to pay my bill, they asked 'What did you do to your house?' I said, 'Nothing, I just changed out the light bulbs [to compact fluorescents].' It really brought down the cost."

- Several members of the community mentioned compact fluorescent light bulbs as the first and most effective step they had already taken to reduce their energy bills. **CFLs** use a fraction of the electricity of an incandescent bulb, and can last many years before needing replacement. Although CFLs can be purchased at most hardware stores, ideas for bulk purchasing, distributing, and recycling⁹ lightbulbs were discussed. Members of the Benham Garden Club suggested that they could perhaps supply reduced cost bulbs at the Jailhouse shop as a way to publicize and kick start this effort.
- A similar program could be put in place for low-flow **WATER FIXTURES**. These can cost only a few dollars and will not only reduce household water use, but would greatly reduce the power necessary to heat water. The savings in electricity costs - not to mention the thousands of gallons of water per year - would pay back the cost of the fixtures in a matter of months. Installing low-flow aerators on kitchen and bathroom sinks (1.5 gallons per minute or less), and low-flow shower heads (2 gpm or less), is one of the most cost effective steps available to Benham residents. Companies like Niagara Conservation (niagaraconservation.com) and Ecotech (ecotechwater.com) offer high quality fixtures that do not noticeably sacrifice comfort or performance, and Benham could negotiate a bulk purchase price. Possible complications from Benham's hard calcium-rich water should be taken into account (see below).
- The largest sources of heat loss in most buildings are likely the cracks and holes around windows, doors, at floors and ceilings, and behind light sockets and pipes.

⁹ CFLs contain mercury and must be collected and disposed of properly, rather than in the garbage.

SEALING these gaps would be a quick, effective, and low-cost way to initiate a community energy project. A blower door test as part of an energy audit (see below) could quickly pinpoint problem areas. In addition, insulating hot water pipes, ducts, and hot water heaters, as well as checking and tuning up heating systems, should accompany any weatherization improvements.

- Purchasing efficient **APPLIANCES** with EnergyStar ratings should be considered when they need replacement. These appliances, which are often eligible for rebates, will save many times their increased purchase price over the life of the appliance. Refrigerators, clothes washers and dryers, and water heating are the most important items. To help homeowners with the initial investment cost for these appliances, the community could look into starting some type of revolving loan fund that would help purchase new equipment, and then be paid back with a portion of the energy savings.

Suggested First Step: ENERGY AUDITS

Many residents expressed interest in the idea of energy audits, which could assess existing energy leaks and inefficiencies in city buildings, homes, businesses, or churches. Using specially designed equipment, energy auditors can visit several homes per day, determine the most frequent problems in Benham's building stock, and suggest cost-effective solutions.

Funding for energy audits could possibly be obtained from **Kentucky Utilities**, which is required by the state of Kentucky to undertake **Demand-Side Management (DSM)** programs. KU offers home energy audits to its own customers for \$15, and has free weatherization programs that it makes available to seniors and low-income customers. The Benham Power Board could also engage **MACED** and Kentucky's Home Energy Assistance Program (**LIHEAP**) in helping develop a pilot project to assess buildings in Benham. MACED operates the **Energy Efficient Enterprises (E3)** project, which provides energy audits and loans to small businesses and nonprofits in southeast Kentucky. Another option is to start an energy-auditing business as a local enterprise, which could later serve other towns in the area.

- Better **INSULATING** existing buildings could have drastic results. Many of Benham's homes and other buildings are nearly 100 years old, yet only a portion of them have been fully insulated over the years. A coordinated effort involving multiple homes,

business owners, and perhaps city buildings could bring down costs for everyone. Blowing in new foam or cellulose insulation into walls, floors, and attics could be the quickest and most effective option. However, depending on existing conditions, blowing in insulation may not be possible and the alternative of removing plaster walls would be a major undertaking. A series of energy audits could recommend a strategy that would benefit the most homeowners. A second insulation strategy will be necessary for the brick buildings in Benham's historic district.

- The high level of **CALCIUM IN THE WATER** supply could be a potential barrier to low-flow water fixtures, and already requires residents to frequently drain their water heaters and replace scale-clogged and inefficient heating elements. An effort should be made to research solutions to this problem, which likely increases hot water heating costs by 25% or more. Various technologies do exist for homeowners, including ion-exchange water softeners and magnetic water treatment. However, ion-exchange results in additional salt in water (and wastewater), and the effectiveness of magnetic treatment is questionable.¹⁰ A more detailed analysis of Benham's water, as well as different treatment options, should compare the initial costs of water softening systems (either in individual buildings or at the town's supply) with the current costs of hard water.
- Some homeowners have replaced their roofs with **METAL ROOFS** that are more durable and reduce summer air conditioning bills by reflecting heat. When roofs need replacement, using metal roofs with high-reflectivity coatings could be a logical strategy. Perhaps the community could partner with contractors or nonprofits already doing home construction work in the area (Heritage Ministries) to investigate options for suppliers or coordinating bulk purchasing.
- Helping install **REPLACEMENT WINDOWS** that are more energy efficient is one of the more expensive suggestions, but negotiating for a reduced price for window purchase and insulation might be possible if enough residents were interested. Replacing windows, doors, and installing storm windows probably makes the most sense for those who have already improved their buildings' insulation and air sealing.

¹⁰ *Environmental Building News*. April 1, 2006. <www.buildinggreen.com>



(Photo: Coriolis Energy)

RENEWABLE ENERGY GENERATION

REDUCING RELIANCE ON IMPORTED ELECTRICITY

Another set of options involves locally generated clean energy. Since Benham controls its own power supply through its Power Board, it has a unique opportunity to generate electricity that many towns do not have. Potential renewable energy projects could range in scale from solar hot water heaters on residential rooftops, to a publicly-owned wind turbine to produce power for Benham’s water treatment plant, to a utility-scale wind power project on one of the mountain ridges above town. Any renewable energy option would require careful planning and a long-term commitment, and should be undertaken alongside energy efficiency measures in the short-term. Yet locally-owned electricity generation has the potential to dramatically reduce the amount of money flowing out of Benham to purchase electricity.

It is clear from conversations among Benham residents that a large renewable energy project would generate a great deal of excitement in town. Given how closely the city’s history is tied to the coal industry, the idea of generating clean power from available local resources symbolizes concepts of self-sufficiency that many residents would welcome. Beyond the symbolic value, however, the renewable energy ideas offered by residents need to be assessed in terms of Benham’s energy consumption and available resources to determine what options would be most effective.

Many communities across the country have turned to renewable power generation as a way to help balance and stabilize city budgets in response to the uncertainty of future electricity bills. In some cases, this has involved the cities directly building renewable energy plants and using them to offset the costs of their largest and most consistent electricity loads – frequently water or sewage treatment plants. In other cases, municipal utilities or

cooperatives of farmers or families have pooled resources to build renewable energy plants that will benefit the community as a whole. In other cases, cities have helped individual homeowners or businesses install solar panels on their own houses to reduce their individual electric bills. In each successful case, it took commitment by city leaders and a group of supportive citizens who were willing to invest years of effort in order to achieve success.¹¹

The following ideas were all suggested by Benham residents. None of these ideas have yet been tested for their economic feasibility in Benham, but it seems likely that many of them could be possible:

- The idea of a large-scale **WIND POWER** project on Black Mountain or another nearby ridge generated much excitement. Feasibility studies would be needed to test wind speeds at a variety of locations around town. The scale of any wind power project would depend on available sites, as well as the amount of money that Benham or any partners could raise. Potential drawbacks involve land ownership, available transmission lines, and uncertainty about local wind speeds. However, the US government has identified the region around Benham as having the most reliable wind speeds of any part of Kentucky. One or two large modern turbines could produce as much power as the City of Benham consumes in a year, though financing such a proposal would be challenging and preliminary studies would take at least a year to complete.
- A more modest renewable energy facility could offset some of the power consumed at Benham’s **TREATMENT PLANT**. As the largest consumer of power in town, requiring electricity 24 hours per day, feeding power directly to the plant could be cost effective. It is unclear whether wind speeds or solar access near the plant would make this feasible.
- Other residents discussed some of the old **MINE TUNNELS** in Benham and Lynch, which funnel winds at high speeds throughout the day and night. It is possible that a specially designed system could harness these winds to provide electricity.

“The oil companies are making billions off of us, and it’s about time we do something about it.”

“The main thing is not so much to save money, but not to depend so much on coal and foreign oil.”

¹¹ For details see “Wind Options: A Study of Energy Ownership Models”, MIT Community Innovators Lab, 2007.

- **SMALL WIND TURBINES** could make sense adjacent to certain city buildings or businesses. These turbines are much less favorable from an economic perspective than a large-scale wind turbine, but at certain wind speeds could still be profitable. At low wind speeds, the economics of these systems is not favorable. MACED is interested in helping Benham explore sites for small-scale wind turbines.

Suggested First Step: RENEWABLE ENERGY FEASIBILITY STUDY

A preliminary study should focus on steps the City of Benham can take at the community scale to generate its own power, which would be more cost effective than smaller-scale systems. The study should assess local wind and solar resources, compare different sizes of renewable energy projects to the town's consumption, and suggest financing options that would be most economically beneficial to the local community.

- Many homes in Benham have ideal solar access and could be good locations for rooftop-mounted **SOLAR HOT WATER** systems. These systems rely upon full sunlight, so would only make sense on certain homes. Additionally, they would probably not make sense on businesses, churches, or public buildings, unless they have significant hot water heating needs. MACED has been assisting finance and install these systems, and would be interested to test the feasibility in Benham's residential neighborhoods.
- Several people suggested that the existing underground mine network could be used to provide natural **GROUND-SOURCE HEATING** to Benham's buildings. This is obviously a complex proposition, but is worth mentioning.
- A public building, such as Benham's historic City Hall, could be used as a demonstration project for **SOLAR PHOTOVOLTAIC PANELS** or other renewable energy systems. A demonstration project at City Hall could also include energy efficiency measures, such as new insulation, replacement windows, or other strategies prescribed by a complete energy audit. An energy demonstration project at City Hall could demonstrate the city's leadership, while also saving tax dollars for Benham's citizens.

A COMMUNITY-BASED APPROACH

RECOMMENDED NEXT STEPS

1. Continue developing a more detailed baseline understanding of Benham’s electricity usage, both at a city-wide scale and individual building level. To tailor an approach best-suited to Benham, more data will need to be analyzed on the city’s residential and commercial structures, as well as public buildings, street lights, and other uses.¹²
2. Broaden the conversation to include more of the city’s residents. Host a community-wide meeting to discuss energy issues and get feedback on this report.
3. Decide whether to focus on the energy consumption of city government, a program to help individual homeowners and businesses, or a broader project that would benefit the entire community.



Benham and Lynch residents discussed energy issues at a roundtable meeting in late June.

4. Determine the proper balance between a focus on energy efficiency, energy generation, or a hybrid of both options.
5. Set long-term goals and short-term priorities.
6. Seek out partners beyond the community.
7. Embark on an initial project.

¹² Unfortunately, privacy concerns have kept the Power Board from sharing much of this information, and the data in this report relies upon only aggregated data reported to Kentucky Utilities and the U.S. Government. Understanding how power consumption fluctuates according to season, building size, family size, and other variables will allow better recommendations to be made. A number of households have already given permission for their energy bills to be analyzed, and the electricity consumption of Benham’s public buildings should also be part of this picture. The City should help facilitate this process.



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2008