Solar Roof Data Project: Arcata, California

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1. Introduction

1.1 Abstract

Domestic oil production has already peaked (1970/1971 according to the Hubbert peak oil curve), but use is increasing, leaving the United States more reliant on foreign sources of energy. If begun now, the transition away from fossil fuels would be easier. To address the mandate set forth by Advisory Proposition B (1980) and to assist City compliance with policy RC-8 of the Energy Resources Management Section of the Arcata General Plan: 2020, a need exists for a solar audit of the City of Arcata and to provide the resultant data to interested governmental, nonprofit and community agencies. In order to reasonably decide what steps to take, several problems will have to be addressed, including the actual capability of the City of Arcata to produce enough energy to meet the grid-based needs of its constituents and the cost of doing so.

Accurate/workable estimations of applicable roof areas for PV panels (i.e. open solar windows) and potential electricity generation from said PV systems were found. By combining the physical measurement of a random sampling of residential structures with the GIS mapping technology, we were able to analyze the accuracy of the each measurement technique and provide more accurate estimation of the true optimized power generation potential inherent in the residential infrastructure of Arcata. Our calculation of available area appropriate for solar power generation is dually applicable to, and useful for, current energy potential analysis, dependent upon contemporary photovoltaic technology, as well as future energy potential studies, analyzing other solar utilization treatments.

For the GIS portion of chosen alternative, the total building footprint area, hereafter referred to as the total roof area, was 4,533,286.90 m^2 over a total of 6054 buildings. The 2000 U.S. Census shows the city of Arcata has 7,272 dwelling units and the 2002 Economic Census shows 472 business establishments. Extrapolating the total roof area over 7,744 units, assuming a linear relationship, results in a total roof area of 5,798,773.33 m^2.

1.2 Literature Review

The use of GIS methods in determining the amount of solar energy available from passive retrofit of buildings is currently in use around the world for both photovoltaic and domestic hot water use. One prominent program used in the U.K. is Solar Energy Planning (SEP). The popularity of such a program is based on its ability to perform the calculations based on relatively few pieces of information that can be obtained for most locations. The information required includes the annual mean daily irradiation on horizontal surface, the peak of the same, the collection area, orientation of the actual collector and loss coefficients (Gadsden et al, 2003). One energy model for use in the SEP considers the building footprint to be an adequate measurement for the total roof space (Gadsden et al^2, 2003).

One GIS study of solar radiation determined that the total solar radiation incident to the earth's surface is from 2000 to 3000 times the total world energy consumption (Rylatt et al, 2001). To determine how much of this solar radiation can actually be converted into useable energy for domestic and industrial use, Bent Sorensen at the Roskilde University in Denmark considered the data from satellite measurements of radiation and albedo in conjunction with weather and climate data from regions around the world. Then, he calculated the amount of area that could be used, 1% of the urban horizontal surface and .01% of the rural, and factored out PV loss coefficients and transmission losses. The final result for Region 1, the United States, is an annual average of 3040 GW (Sorensen, 2001).

2. Problem Discussion

2.1 Problem Background

According to the U.S. Energy Information Administration, energy consumption has increased exponentially since the industrial revolution; a process made possible by the ability to extract large quantities of energy from fossil fuels and create carriers that are both portable and versatile. This has resulted in environmental degradation, harm to human health and an ever increasing lack of energy security. Domestic oil production has already peaked (1970/1971 according to the Hubbert peak oil curve), but use is increasing, leaving the United States more reliant on foreign sources of energy. This links our energy security with the ability to manage foreign policy in areas of the world that have proven to be unstable. The current energy production and delivery system within the U.S. is controlled by a few megaliths of industry. With energy production and delivery concentrated, failures such as the one that occurred on August 14th, 2003 across the Northeast and Midwest United States and parts of Canada, can become more common (Li, 2004). Diversification and localization of energy resources, production and delivery can help relieve excessive burdens that cause such massive failure, and allow a community to choose its own methods and invest in itself.

Millions of dollars leave Arcata each year due to reliance on non-local energy suppliers whose centralized distribution model feeds energy to individuals through the power gird. The grid-based system benefits large corporations who buy energy from a multitude of domestic and international sources then distribute the resultant power through an interconnected network of power and gas lines. Currently, Arcatans send payment for the grid-supplied power to Pacific Gas and Electric, headquartered in San Francisco, who in turn acquires their energy from out-of-state and non-domestic sources. Reducing this amount would increase the amount of money available to stay within the community. The city currently utilizes nonrenewable resources, such as fossil fuels, with a smaller amount of renewable resources. The problem with relying on these sources is that they will eventually run out. If begun now, the transition away from fossil fuels would be easier. Initiating the community in the transition and increasing the amount of money staying in Arcata could strengthen the community (Appendix 1).

The idea of a community switching to a renewable energy portfolio is not so far fetched (Appendix 2). In 2004, the United States was the third largest market for photovoltaic (PV) panels, with California providing 2/3 of the total demand. Further, the market within the United States has shifted from the majority being small, off-grid PV applications to the majority being grid-connected applications (Jager-Waldau, 2005). However, there is still a cost gap between the generation of power by means of renewable resources and the heavily subsidized fossil fuel industry. The transition to PV-based energy production will require new equipment and planning. In order to reasonably decide what steps to take, several problems will have to be addressed, including the actual capability of the City of Arcata to produce enough energy to meet the grid-based needs of its constituents and the cost of doing so.

The Redwood Coastal Energy Authority (RCEA) and the City of Arcata's Energy Committee are the two most invested groups in the county working to find alternatives to the community's reliance on non-renewable resources. There has not been an in depth study on the total roof space and solar input available in the city of Arcata, and the RCEA and the Energy Committee do not have the resources available to them to conduct this study at this time. When presented with the idea of a solar roof audit, Jim Zoellick, Chair of the Energy Committee, was unsure of how such a task would be completed. However, multiple city and county departments, as well as non-profit groups, have expressed interest in the utility of the data.

2.2 Problem Statement:

There is a lack of data on the actual or estimated solar electrical energy generation potential inherent in the total available roof space of current structures or reasonably foreseeable development within Arcata, California.

To address the mandate set forth by Advisory Proposition B (1980)[1] and to assist City compliance with policy RC-8 of the Energy Resources Management Section of the Arcata General Plan: 2020[2], a need exists for a solar audit of the City of Arcata and to provide the

[1] Advisory Proposition B (Approved April 8, 1980)
"In accordance with America's renewed determination to be energy self reliant, be it resolved that the citizens of Arcata and their City government are committed to the enactment of conscientious energy conservation measures and the accelerated development and active promotion of same and economical alternative renewable energy sources for our community. Be it further resolved that the City government of Arcata support complete independence form nuclear power including the permanent closure of the Humboldt Bay nuclear power plant and its replacement by safe, clean and efficient generation sources more compatible with the resources and health and safety of the North Coast, such as conservation, solar power and generation from wood waste."

[2] Policy RC-8 (General Plan:2020)Energy Resources Management
"Reduce the net emission of greenhouse gasses from Arcata; reduce other negative impacts of energy production and use, including risks from nuclear power, air emissions, fuel spills, and wildlife and habitat destruction; reduce energy costs to the city and its residents, and increase the percent of energy purchases from sources within our region; increase the city's and nation's energy security and reduce our vulnerability to changes in energy availability and price; increase public awareness of energy issues and encourage an energy conservation ethic; monitor the cost and effectiveness of Arcata's action so we and others can learn from them; and implement Arcata's Advisory Proposition B."

resultant data to interested governmental, nonprofit and community agencies. The GIS data layers and our analysis will be made available through the internet, on an HSU sorrel account, and distributed electronically as a .pdf file to interested agencies.

3. Objectives (in order of priority)

- determine accurate/workable estimations of applicable roof areas for PV panels (i.e. open solar windows)
- quantify potential electricity generation from said PV systems
- disseminate material to interested agencies in a readable, easy to interpret document

The proposed solar audit will detail specific information concerning a community transition to photovoltaic (PV) power generation and reliance including: roof area estimates for the existing structures within the Arcata City limits, calculate solar electrical power generation from the given roof area (including efficiency and power generation data for photovoltaic cells from several different manufacturers), and make information available to interested agencies in a readable and easy to interpret document (Appendix 3).

It is this group's first priority to generate useable estimations of available roof space for the use of PV panels in the city of Arcata. Reaching this goal will make data available on the actual or estimated solar electrical generation potential inherent in Arcata's available roof space. This will be the most timely and involved task in an attempt to address Arcata's problem. It will require utilizing GIS software and taking field measurements. Because of the in depth nature of this goal we have decided to give it the utmost attention.

In an attempt to make data ready for implementation of alternative energy generation using roof space; it is this group's second priority to quantify potential electricity generation from PV systems. This will also require the utilization of GIS software, but it will not be as time consuming as the estimations of available roof space; this will have to be obtained before the group can begin the quantification of potential energy because the calculations will be derived from that data.

Disseminating materials to interested groups will be done when all other work has been completed. It is imperative that this information become available to those who need it in order to properly address the problem. The implementation of this goal will take the least amount of effort once all of the data and calculations are complete, for this reason it has been left for last.

4. Weighing Alternatives:

4.1 Alternative 1 - Rough Estimation

Under this alternative, group members would get permission from home owners to measure the length and width of their dwellings. Roof space would be calculated using the standard formula for area. We would not measure all houses in Arcata; there are approximately 7,261 houses in the city and it would be inefficient to measure all 7,000 some houses. Measurements would be taken for a variety of different house of varying size, shape and style. Houses would be grouped according to how many bedrooms they have. Measurements would be taken for ten houses and apartments from each category, and an average would be calculated, then an overall area would be extrapolated from that data.

Most roof area audits take into account angle of repose because it typically has an effect on the amount of energy that can be collected. We assume that roof slope will not be a factor in this case because new technology (active photovoltaics) make it possible to adjust the equipment in order adapt to seasonal changes in the suns direction.

4.2 Alternative 2 - Extrapolation from Preexisting Data

Alternative 2 is concerned with the estimation of available roof area in the City of Arcata appropriate for, and physically/logistically applicable to, the installation of photovoltaic arrays. The roof area data will be used to determine the possible electrical generation output from the given space available for solar arrays. This estimation of roof area would be extrapolated from existing data obtained from the City of Arcata Community Development Department and online sources. The data of concern for this estimate is the parcel size for each lot applicable to photovoltaic power generation (i.e. lots with an open solar window) within the City.

A random sample will be taken from the existing data to determine an average lot size. The lot sizes will be averaged to determine a mean lot area. Once an average residential parcel area has been determined, the percentage of lot area covered by building structures (the average footprint of all buildings) will be determined. This structure footprint data will be applied to the average lot size to determine the standard parcel area coverage by built structures.

For our analysis we will assume the parcel area coverage to be analogous to the roof area of a given structure. The estimated average lot coverage will be multiplied by the number of City lots with desirable physical characteristics to support PV power generation (southern exposures, open solar windows, etc.) to determine the approximate total area of the City that is covered by structures capable of supporting a productive PV system. The total coverage area will be multiplied by the electrical power generation potential (in Watts) and the energy conversion efficiencies (a manufacturer measured percentage) for several PV systems from different manufacturers. This will provide an estimate for electrical generation output from total roof area the available for solar arrays within the City of Arcata.

(Average parcel size determined from random sampling) x
(Mean footprint of built structures on sampled parcels)
= Total parcel area covered by structures

(Total Parcel area covered by structures) x
(Number of City lots capable of supporting PV systems) x
(PV system electrical power generation potential (in Watts)) x
(PV system energy conversion efficiency (percentage))
= Total PV electrical generation output from available roof area in the City of Arcata

4.3 Alternative 3 - GIS Modeling

Through this alternative, roof space available for PV panel placement in Arcata would be determined through the use of ArcGIS and its ancillary programs. The primary advantage of this alternative is the ability to quickly analyze various situations and conditions. In addition to this GIS software can be used to produce relevant statistics and graphical representations readily. Within the scope of this project, its primary disadvantage is the time required to digitize every suitable rooftop in Arcata. One way to reconcile this disadvantage would be to break the city into sections and digitize a randomly selected sample. Once the results of the samples have been gathered, we can apply them to the entire area. The options for digitizing are using DOQQ files from USGS, aerial photos, aerial photos overlain with building footprint GIS layers and satellite imagery. DOQQ images are useful for measurement purposes since they are photos at 1 meter resolution that have already been referenced to an orthogonal projection. Thus, a measurement taken across the surface can be relied upon to have minimal distortion.

4.4 Alternative 4 – Comparison of Previously Conducted Studies:

This alternative will use relevant studies that have already been completed to make an estimation of Arcata's potential solar roof space. The proportion of a given study's population size to its estimated power generation could be applied to the population of Arcata, resulting in Arcata's estimated power generation. It will solely rely on data from completed, published studies, found on the internet. To best implement this alternative, the model studies should be from a location with similar population, climate, elevation and sun exposure as that of Arcata. Time would be potentially saved, since these studies have already been done, but could also be consumed in searching for such studies on the internet. The resulting data from this application of information would be fairly inaccurate, and could not be used for a realistic application in Arcata.

4.5 Preferred alternative

Upon evaluation of the set of alternatives, our team chose to combine Alternative One with Alternative Three to produce a hybrid preferred alternative which was deemed most appropriate to implement. By combining the physical measurement of a random sampling of residential structures with the GIS mapping technology, we were able to analyze the accuracy of the each measurement technique and provide more accurate estimation of the true optimized power generation potential inherent in the residential infrastructure of Arcata. The physical measurement of structures will be extrapolated to the entire City of Arcata via power generation calculations developed by our team. The data gathered by on the ground observational sampling will provide the following information: the percentage of roof area on each individual structure available for PV arrays, the percentage of structures applicable (orientation, percentage of cover/solar energy obstructions) to significant PV power generation (i.e. south-facing roof, open solar window), the length and width of each structure. The GIS software will assign the sampling sites at random from the Arcata building footprint layer. This estimation is the most logistically feasible and will provide data of sufficient accuracy to provide meaningful potential solar power generation information. Possible weaknesses of this alternative include inaccuracies introduced into the larger estimation equation from possible measurement errors or GIS data inaccuracies.

5. Implementation Strategies

Our calculation of available area appropriate for solar power generation is dually applicable to, and useful for, current energy potential analysis, dependent upon contemporary photovoltaic technology, as well as future energy potential studies, analyzing other solar utilization treatments. The statistics generated by our study provide constructive inputs for calculations which look to improve current understanding of the various methods by which solar energy could be most efficiently and usefully utilized by the stakeholder population. The data could be equally applied to estimations of social utility resultant from solar energy driven passive solar hot water systems or potential photovoltaic power generation. Inevitably, nonrenewable energy sources, by their nature, will become economically unviable as inputs into electrical generation systems. Thus, it is both sensible and necessary to look for alternatives to such inputs. Solar energy provides an appropriate alternative to such finite natural resources, and thus has provided the impetus for this study. Now is the time to begin the conversion, as nonrenewable energy sources are currently available to facilitate the construction and manufacture of infrastructure of sustainable development which utilizes renewable energy inputs. Our study is concerned with the potential anthropocentric benefit of the application of such sustainable infrastructure to humanities' constructed environments.

Duty	Date Due	Responsible Party
Get random sampling data to group	April 10	Sarah
Create final data sheet	April 1	Scott
Publish data	May 10	Jen
Sample houses in field	April 17	All
Notify police about in field study	April 11	Brock
Generate total roof space from GIS (building footprint layer)	April 17	Sarah
Supplemental: PV panel options	April 5	Scott
Quantify solar potential usefulness scale numbers to use in field	April 11	All
Create data sheet for infield sample	April 10	All

6. Methods

The following assumptions were made regarding data collection and application. The GIS data layers and information are accurate. The building footprint is equal to the amount of roof space a building has. Observations of the solar windows in the field are consistent among individuals and accurate. The average solar radiation is accurate and provides a reliable estimate that is similar to daily measurements of solar radiation.

The first part of the preferred alternative relied on producing a data layer through GIS that would provide the building footprints within the City of Arcata's boundaries as an approximation of the roof space. Two data layers were acquired from the Arcata GIS Data Library; impervious surfaces and city boundaries. Both use the North American Datum, 1983 for elevation reference and both are projected to Lambert Conformal Conic, and equal-area type projection. No other metadata was available for these layers.

Fig. 1 GIS data layer representing all impervious surfaces

After adding these layers to a new project in ArcGIS 9.1, we selected only the building footprints using the "Select by attribute" query. These selected features were then converted into a separate layer representing just the building footprints.

Fig. 2 GIS data layer representing building footprints

Using the overlay tool "Clip", all building footprints within the Arcata city limits were selected and copied into a new data layer.

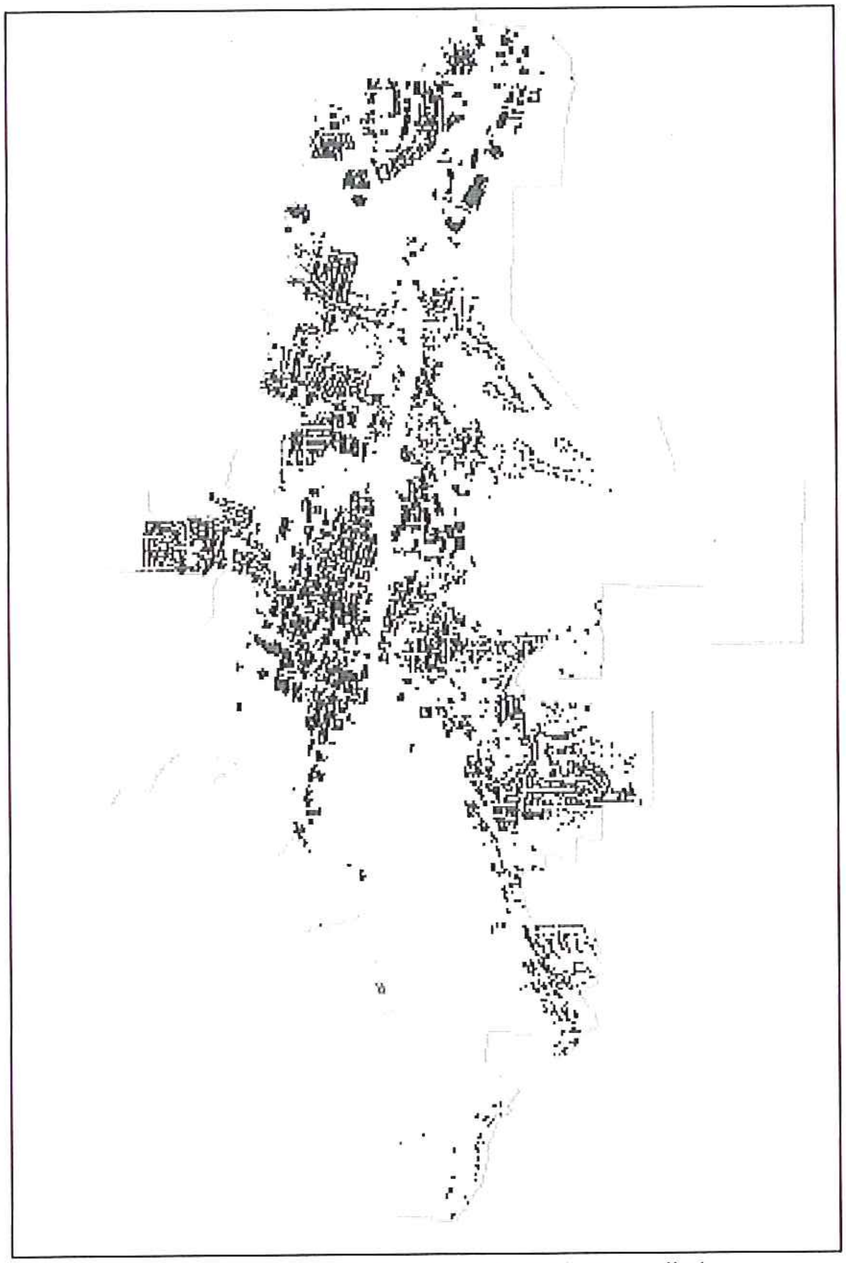


Fig 3. GIS layer representing footprints only within Arcata limits

From the data set generated by these processes, a random selection of 100 footprints was created using an internal ArcGIS random selection tool. Unfortunately, the building footprints had no addresses included, or even parcel numbers, in the attribute table. Using a street map, we used the random selection to mark the street. The second part of the preferred alternative was to visit buildings on the streets marked by the random selection. In order to preserve the randomness of the sample, we utilized a table of randomly generated numbers to select individual buildings once on a given street.

The ground survey was used to determine several factors. First, we were attempting to verify the ground truth of the GIS data. This was less feasible since we could not match up the buildings surveyed to the same buildings in the data layer. However, we were able to gather other useful information, such as the actual usable roof space and orientation of the roofs, that was not available within the building footprint data.

7. Results

For the GIS portion of this alternative, the total building footprint area, hereafter referred to as the total roof area, was 4,533,286.90 m^2 over a total of 6054 buildings. The mean size was 748m^2 indicating the presence of some very large buildings. The mode for the data set was 332.47 m^2, so the most common measurement is close to the average size for a residential dwelling.

Table 1: Summery of total roof area as determined by GIS study

Statistics Summary for GIS Layer		
	ft^2	m^2
Total roof space	14,872,988.52	4,533,286.90
Average	2,456.72	748.81
Mode	1,090.78	332.47
Percent usable (67.38% per ground survey)	10,021,419.66	3,054,528.71

The 2000 U.S. Census shows the city of Arcata has 7,272 dwelling units and the 2002 Economic Census shows 472 business establishments. Extrapolating the total roof area over 7,744 units, assuming a linear relationship, results in a total roof area of 5,798,773.33 m^2 (see Figure 2).

7.1 Roof Area Data Application to Photovoltaic Power Generation

It is necessary to relate the roof area data to various anthropocentrically useful applications so that the residents of the City of Arcata may understand the possible benefits from the solar energy insolation[3] gain incident on the many structures within the City. Beyond the basal biological significance of solar energy, solar energy insolation is directly applicable to both passive solar water heating and photovoltaic (PV) electrical generation systems[4]. For this study, we will concern ourselves solely with the latter use.

To determine the PV power generation potential we will utilize the following equation:

Equation for total electricity generation theoretically resultant from roof area data:

(Total City of Arcata roof area as determined by GIS study (in square meters)) **x**
(Percentage of total roof area applicable to PV power generation[5]) **x**
(PV system electrical power generation potential (in kilowatts)) **x**
(PV system energy conversion efficiency (percentage))
= Total PV electrical generation output resultant from available Arcata roof area

Energy Generation Equation Values (Values in bold are included in the equation):

Total City of Arcata Roof Area:

Table 1: City of Arcata Roof Area as Determined by GIS Study:

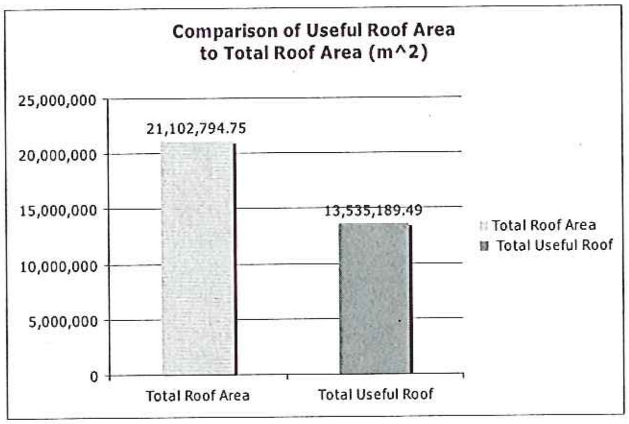
Statistics Summary for GIS Layer		
	ft^2	m^2
Total roof space	14,872,988.52	4,533,286.90
Percent useful roof area (67.38% of total as per ground survey)	10,021,419.66	3,054,528.71

[3] Insolation is defined as the amount of solar radiation (energy) which strikes a particular area (usually per square meter) typically measured in Watts.

[4] Photovoltaic cells are silicon-based semiconductor devices that convert solar radiation into direct current (DC) electricity. PV cells are comprised of thin layers of highly pure, boron and phosphorous-doped silicon wafers that are arranged into modules and arrays which produce electricity when solar energy strikes the surface of the PV cell. Electrical energy is produced when solar energy creates an electrical field that stimulates electrons near the boron and phosphorous-doped silicon junctions to move in a particular direction creating and electrical current. This electrical energy can then be used to power electrical loads or to charge energy storage devices. PV systems can be utilized for alternating current (AC) dependent loads (most conventional appliances) if a DC-AC power inverter is employed. PV systems can operate remote from or interconnected to a utility grid.

[5] Open solar window percentage determined by averaging useful roof percentages from random sample of Arcata structures

Figure 1: Comparison of total useful roof area to total roof area based on extrapolation of sampled structure solar window opening estimation all buildings within the City of Arcata



Total City of Arcata roof area as determined by GIS study: 4,533,286.9 m^2
Percentage of total roof area applicable to PV power generation: 67.38%
Total City of Arcata roof area useful for PV power generation: **3,054,528.71 m^2**

Thirty-Year (Averaged) Solar Radiation Data (Wh/m^2/year) for Arcata, Ca
(Data from National Renewable Energy Laboratory):
Solar Radiation Measurement for Fixed-Axis Flat-Plate Collector
Facing South at Fixed-Tilt of 41 Degrees: **20,841.5 kWh/m^2/year**

Solar Radiation Data for 2-Axis Tracking Flat-Plate Collector: **26,864 kWh/m^2/year**

PV System Electrical Power Generation Potential:
Fixed Mounted Array: x
Dual-Axis Tracking Array: x + (.29(x)) (29% higher collection efficiency than fixed array)

PV system energy conversion efficiency:
Amorphous Silicon Solar Cell Efficiency (low estimate): **0.08 %**
Silicon Solar Cell Efficiency (mid estimate): **0.12 %**
Multi-junction Concentrator Efficiency (high estimate): **0.3 %**

Total Theoretical Power Generation (kWh/year) resultant from Useful Arcata Roof Area:
Amorphous Silicon Solar Cell
Fixed Array: **5,092,876,808.757 kWh/year**
Dual-Axis Tracking Array: **6,564,548,741.235 kWh/year**
Silicon Solar Cell
Fixed Array: **7,639,315,213.136 kWh/year**
Dual-Axis Tracking Array: **9,846,823,111.853 kWh/year**
Multi-junction Concentrator
Fixed Array: **19,098,288,032.84 kWh/year**
Dual-Axis Tracking Array: **2,461,7057,779.632 kWh/year**

Total Electrical Energy Use (By Economic Sector) With in the City of Arcata (from the City of Arcata Greenhouse Gas Inventory and Forecast, 2000):

Agricultural:	6,212,901 kWh
Commercial:	71,546,118 kWh
Industrial:	46,093,457 kWh
Residential:	34,358,187 kWh
Total:	158,210,663 kWh

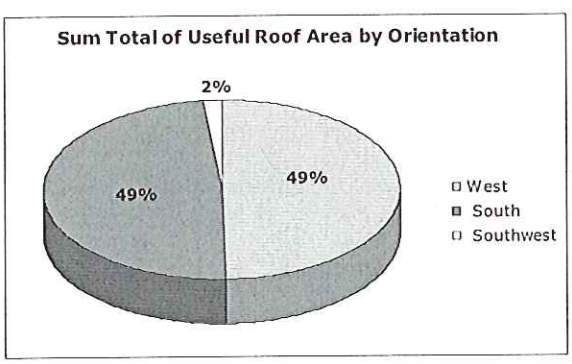
Analysis:

Based on analysis of the percentage of total roof area applicable to PV power generation within the City of Arcata, the annual solar insolation received by the City, and a range of PV system electrical power generation values and efficiencies, we can determine that the electrical needs of the City of Arcata could easily met by installing even the lowest efficiency fixed-axis solar collectors on only three percent of the structures within the city. If higher efficiency fixed-axis solar collectors were used the demands of the City could be met if solar collectors covered only two percent of the City's roof area.

Supplemental Information: Orientation of Structures

Based on the random sample completed by our group, we determined that it was equally likely to find a building oriented on the east-west axis (denoted as south facing to draw correlation to optimum solar gain) as it was likely to find a building on a north-south axis (west facing with relation to optimum solar gain) (see Figure 2). Based on information received from HSU Environmental Resource Engineering Department, we determined that the orientation of the structure would not significantly affect the amount of electrical energy generated by PV systems on structures with varying directional orientation.

Figure 2: Orientation of 100 sampled Arcata houses



8. Monitoring and Evaluation

For this project, there is no need for monitoring. Eventually, upon growth of the city, this data will become inapplicable as new construction projects are undertaken, and will need to be updated. This project can then serve as an example of how to collect and apply the necessary data.

The applicable roof space data for the city of Arcata will be distributed electronically, as a .pdf file, to the following interested parties: Schatz Energy Research Center, Redwood Coast Energy Authority, City of Arcata's Energy Commission, the Peak Oil Action Group of Arcata, and the Campus Center for Appropriate Technology (CCAT) at Humboldt State University.

9. Literature Cited

Bresee, Jennifer and David Room. "Powering Down America." 2005 http://www.globalpublicmedia.com/articles/533

Conducting a Local Energy Inventory. 05 Oct. 2005. Willits Economic LocaLization. http://www.willitseconomiclocalization.org/Papers/ConductingAnEnergyInventory.pdf.

Gadsen, S., Mark Rylatt and Kevin Lomas. "Putting solar energy on the urban map: a new GIS-based approach for dwellings." Solar Energy 74: 397-407, 2003

Gadsen, S., Mark Rylatt, Kevin Lomas and Darren Robinson. "Predicting the urban solar fraction: a methodology for energy advisers and planners based on GIS." Energy and Buildings 35: 37-48, 2003

Jack, Kathy. Community Greenhouse Gas Inventory and Forecast. City of Arcata: International al council on Local Environmental Initiatives Cities for Climate Protection Campaign. 2002.

Jager-Waldau, A. "Photovoltaics and renewable energies in Europe." Renewable & Sustainable Energy Reviews. 2005

Li, X. "Diversification and localization of energy systems for sustainable development and energy security." Energy Policy 33: 2237-2243, 2005.

McDonough, W. & Braungart, M. Cradle to Cradle. North Point Press: New York, 2002

Rylatt, M., S. Gadsen and K. Lomas. "GIS-based decision support for solar energy planning in urban environments." Computers, Environment and Urban Systems 23: 579-603, 2001

Scheide, R.V. "How Willits, California Plans to Beat the Coming Energy Crisis." http://www.metroactive.com/papers/sonoma/8.10.05/willits-0532.html

Sorensen, B. "GIS management of solar resource data." Solar Energy Materials & Solar Cells 67: 503-509, 2001

10. Appendix

10.1 Appendix One

Powering Down America: Local Government's Role In The Transition To A Post-Petroleum World

20 October 2005 Oil Relocalization Politics

In Brief: - *By Jennifer Bresee and David Room, Global Public Media*
Global Public Media is conducting a series of interviews with political leaders worldwide who are concerned about peak oil and who advocate immediate response and preparation. Global Public Media's sister organization, Post Carbon Institute, is developing a 'Powerdown-energy descent' relocalization policy platform starting with municipalities...

Cheap, energy-dense liquid fuels have enabled the human species to proliferate across the globe, and in the process the transport of people, products, and resources has become an inescapable part of normal life in industrialized nations. Thanks to cheap and abundant energy, the energy intensity of our normal lives is unprecedented. Now demand for liquid fossil fuels seems to be approaching if not exceeding supply. This narrowing gap between supply and demand has fueled a steep price jump, rocketing from $28 per barrel of crude in early 2004 to over $70 per barrel at the end of August 2005. Even if the current price spike abates, geology tells us that global extraction of oil will reach a peak or plateau (very soon according to a growing number of experts) and then go into inexorable decline, approximating the downside of a bell curve. This phenomenon is called "Peak Oil." The actual inflection point is referred to as "oil peak," and can be thought of as the point when about half of the original endowment of economically extractable oil on the planet has been burned.

After peak, our growing demand for oil and the multitude products for which it is a critical feedstock will necessarily go unsatisfied. Oil scarcity will also increase pressure on supplies and pricing of America's second most important energy source, North American natural gas, which is already often strained to its limits despite recent mild winters. Natural gas, which is a primary fuel for electricity generation and heating in many parts of the United States and a common industrial feedstock, has already seen production peak in North America. The global peak of natural gas production is extremely hard to predict - some say it decades away and others (with good reason) suggest that it might happen in a matter of years. For North America the key problem is that it now needs to import more and more natural gas from far away and often unstable or unfriendly places. Furthermore, the required infrastructure is complex, costly and takes years to build.

Once oil crests and goes into decline, much of today's global-scale transport, industry, and trade will become economically unviable. With the diminishing viability of global-scale human activities, local economies, transport, governance, and culture will become increasingly effective and necessary. As national and global-scale operations and institutions peter out in the face of energy shortages and price shocks, local and community-supported organizations will need to step up and assume responsibility for many social services like food security, transportation, and energy security. Relocalization of key activities and local provisioning could make the difference between a sustainable future and social breakdown. What is in question, at this juncture, is how much effort local governments will put in now, while energy is still relatively cheap and plentiful, to prepare for an energy-constrained future, and how hard we, as the constituents of local governments, are willing to push for timely and substantive action.

Today's global economic system and monoculture of consumption tie practically every aspect of human life at all levels of organization to cheap energy-dense fuels and petrochemicals, which means, more often than not, to oil. Many less industrialized nations are even more dependent on oil than the industrialized nations, which often have more diverse energy resources and infrastructures (e.g. hydroelectric, coal) and the funds to further expand on this diversity. In industrialized nations, individuals, families, neighborhoods, towns and cities, states, and non-governmental organizations are all dependent to a large extent on just-in-time access to cheap fuels and petrochemicals. For example, individuals who live in energy-intensive urban environments, such as residents of the average suburb or sprawling city, rely on cheap, energy-dense fuels to drive to and from work, to go out with friends and family, to take the kids to school, and for access to affordable food and consumer goods. Cheap petrochemicals are the raw materials for everything from roads and tires to computers, medicines, disinfectants, and food packaging. In many places, cheap fossil fuels enable homes and businesses to have running water, heat and electricity.

It takes a lot of energy and material to keep a city, suburb, state or nation habitable. Without a shift from reliance on cheap fuels and petrochemicals, future oil and gas shortages may incapacitate certain municipal services such as public transit, sanitation, and emergency medical services. Public transit relies on cheap fuel and subsidies for its very existence, as it cannot compete with privately owned transportation in today's car culture. Without adequate preparation and increased support, increasing costs due to high fuel prices may sound the death knell of many public transit systems. Medical and sanitation services rely on cheap fuel for the availability of supplies and personnel and to power medical technology. Cheap petrochemicals are the raw materials of just about everything - from medicines to plasma bags - that modern hospitals use. Without cheap fuel and petrochemicals, local and national law and emergency response organizations, global agribusiness, national and international disaster relief organizations, and national militaries (just to name a few of the types of large-scale organizations affected) will become very expensive to run, possibly prohibitively so.

Fortunately, not all political leaders are ignorant of or unwilling to address our energy predicament. To help spread the message of such leaders, Global Public Media is conducting a series of interviews with political leaders worldwide who are concerned about peak oil and who advocate immediate response and preparation. To support peak-aware politicians, Global Public Media's sister organization, Post Carbon Institute, is developing a "Powerdown" platform[1] as well as a program for local government to catalyze the powering down of their bioregion that includes transition and contingency planning, the oil depletion protocol, relocalization, and ecological city design.

National Responses are Few

The October newsletter of the Association for the Study of Peak Oil and Gas (ASPO)[2] reports that the French Prime Minister is the first world leader to publicly recognize peak oil. "We have entered the post-oil era", said Prime Minister Dominique de Villepin on September 1, 2005. "I want to draw all the consequences of this and give a real impulse to energy savings and to the use of renewable energies." Villepin promised that several million low income households would receive a 75-euro ($91.49) check and to boost the use of renewable energy.

As of October 2005, New Zealand has the only two national political parties worldwide that have openly taken a stand on Peak Oil.[3] Less than a year after initial communications with local activists Robert Atack and Kevin Moore, on 5 May 2005, Turiana Turia co-leader of the Maori Party issued a press release indicating that "all parties must wake up to this emerging crisis... Aotearoa[4] is economically dependent on continuing oil extraction from wells very far away, along thin vulnerable transit routes, to support our long-range exporting and global tourism, and underlie nearly all economic activity. All people of this nation, have the right to information and planning, to awaken them to the looming price hikes and shortages of oil for which there are no solutions known, only responses which may soften the blows."[5]

On August 18, 2005, the Green Party of New Zealand posted a Peak Oil Toolkit on their website which unequivocally dispels the myth of the magic solution and presents steps that can prepare the nation for energy descent such as a revenue neutral "feebate" for cleaner cars and increasing incentives for renewable energy.[6] Jeanette Fitzsimons, one of the New Zealand Greens' two Members of Parliament, says "give people the facts, let them go out and read the information for themselves, do some workshops and public meetings, have a bit of a road show, so that people have the tools that they need to make the right decisions… for their own lives."[7]

On the other side of the world, also on the national level, United States congressman Rep. Roscoe Bartlett (R, Maryland) has been repeatedly raising the issue of Peak Oil in his special order speeches.[8] More resources at the national level have not been mobilized because, according to Bartlett, politicians and industry are only focused on the near term. Politicians run for office every two to six years, and industry strives to keep the next quarter report positive for their Boards of Directors and their investors. The perception is that if a political or business leader takes the risk of supporting preparations for an energy-constrained future, voters and directors will simply find someone else who is willing to promise a future of growth and prosperity. Bartlett explains, "telling the American people that we've got to have some belt-tightening in the future, life is not going to go on quite like it's gone on now because oil is not forever. This is not a happy thing to tell people. I understand why politicians don't like telling people this."[9]

Remarkably, the Republican Bartlett suggests that America needs to redefine success. "Right now, success is judged by how much energy is used. Think about it, the person who is successful has a really big car; they take really expensive vacations; they have a really big house. We have got to have another yardstick by which we measure success because success can't continue to be measured by how much energy we use." He further laments, "we think God gave us the right to this quality of life."

After six months of being an indefatigable advocate of peak oil awareness and policy work including multiple special order speeches, a conference[10], pushing sane energy policies, sending peak oil posters and books to his colleagues[11], and a private conversation with President Bush[12], Bartlett remains the sole U.S. national politician to openly discuss peak oil.

Getting Started Locally: Transition Planning and Town Hall Meetings

According to Post Carbon Institute and other organizations focused on managing energy descent including Ecocity Builders, From the Wilderness, and The Community Solution, the most effective responses to our energy predicament will be place-based and community-supported. In this context, local government can play an important role in initiating projects and programs, removing obstacles and creating incentives, and fostering an environment of cooperation, experimentation, and urgency. Local government assuming this role is essential in large cities and metropolitan areas where grassroots organizing has not been able to mobilize large fractions of their electorate.[13] While most activity at the national and global levels consists solely of talk about the problem (which is valuable and commendable), some local and regional governments are talking about and actually implementing such responses.

Andrew McNamara, a member of the Queensland Parliament for Hervey Bay, Australia, has raised the issue of Peak Oil in his local, regional and national governments. In a recent interview, McNamara explains his motivation for addressing the problem of energy dependence.[14] "We're entirely road and rail dependent, and accordingly, it struck me that if the price of fuel doubled, and then doubled again and then doubled again, that the tourism industry, which provides the life blood of my town, would simply collapse. And, similarly, the issue of feeding a town like Hervey Bay becomes problematic... Locally, I think we're better than some, better than many larger cities, but our networks are built around cheap fuel, and if Peak Oil represents the end of cheap fuel, then it is a substantial threat to everything that happens in my part of the world. So again, the motivation was very simple."

Responding, however, to that motivation was not so simple. "At the heart of the Peak Oil story is that tomorrow there will be less of something, and that's a difficult sell for politicians. The way it works is that [as a politician] you promise more, not less." His less-kind colleagues in Parliament have dubbed his first Peak Oil speech in Parliament "Peak Career."

Despite the tendency of politics to punish bearers of bad news, McNamara continues to push for action and has established the Queensland Oil Vulnerability Task Force, "a task force across a number of departments to look at how vulnerable Queensland is to global oil depletion." McNamara is also pushing for expanded public transit and non-petroleum fueled transport in his constituency of Hervey Bay.

Similarly, a local law to create an energy shortage contingency plan has been sent to council in none other than New York City. The local law (Int. No. 374)[15] would define energy emergency response stages, a communication structure to alert the public, conservation strategies for city agencies and the private sector, and rules concerning energy usage and appropriate methods for enforcing such rules for each of the energy emergency response stages. Though this law does not mention peak oil and the authors may not necessarily have been peak aware, such laws can be entry points to get our energy predicament on the local government radar and open a can of worms that can no longer be ignored. In the context of an energy shortage contingency plan, thoughtful consideration of the likely ramifications of global oil peak on local energy availability and prices as well as on the costs and availability of goods from afar, could be the tipping point that springs local government into planning and even preemptive action.

The final speaker of the Petrocollapse conference[16] on October 5, 2005, chairman of Post Carbon NYC Dan Miner, called upon attendees and local peak oil activists to campaign for the energy contingency shortage plan with an amendment to address peak oil. Dan is doubtful that neighborhood grassroots organizing approach that is transforming towns in Northern California will be effective in New York City. "While our group has a good number of regular attendees, compared the vast population of the New York metropolitan area, we are not even microscopic" says Miner. "While many are aware of rising fuel prices, very few understand the full scope of the situation, and most are resistant or unwilling to prepare for the new energy paradigm, and we have to meet the people where they are. We have to gain leverage by partnering with organizations that can support parts of the peak oil message that overlap with a conventionally progressive, environmental mindset. We hope that by encouraging people to focus on concrete steps to conserve fuel in emergencies, they will be expanding their reality picture, so when financial pain increases, the seeds of greater awareness we are planting may yet sprout."

In the city of Sebastopol in Northern California, Mayor Larry Robinson has been instrumental in mobilizing his community to discussion of Peak Oil and action toward energy independence. Robinson told Global Public Media in a recent interview[17] that "what I'm trying to do as mayor is shape our future development as a city in such a way that it will minimize, to what ever extent it's possible, the impact of skyrocketing energy cost..." Robinson also said he uses his office as a "bully pulpit" to raise community awareness of Peak Oil and of the need for energy independence.

On September 21, 2005, Mayor Robinson convened a town hall meeting "Peak Oil - Adapting to an increasingly scarce energy supply". Over 200 people attended, mostly from Sebastopol and with contingencies from Santa Rosa and nearby towns. After an introduction by Mayor Robinson and a presentation by Richard Heinberg about local responses, attendees offered their ideas in a community brainstorming session covering both what the city of Sebastopol can do to prepare for oil scarcity and how can citizens support the city in this endeavor. The intention is to form two working groups of citizens and city employees to explore these issues on an ongoing basis. (Similarly, San Francisco Supervisor Ross Mirkirimi has requested a hearing on peak oil for the Board of Supervisors that is likely to occur in late October or early November 2005.)

When asked about political backlash from his open discussion of Peak Oil, Robinson said that while he has had plenty of backlash from his stance on other issues such as his opposition to the Iraq war, rampant corporatism, and sprawling development, this has not been the case with his discussion of Peak Oil. (Of course, reining in militarism, corporatism and sprawl are some of the best ways to mitigate energy consumption and dependence.) Robinson said of his experience talking about energy independence, "... even the business leaders in this community are realizing that we need to shift to a much more sustainable way of living, that we're all going to pay a high price if we don't. In fact, you know, the longer we wait to make that shift, the higher the price it's going to be, the much more suffering it's going to be in dislocation of people and resources, so I think this issue brings people together across the political spectrum."

One way that the city of Sebastopol has brought people together to work for energy independence is through the Solar Sebastopol program. Solar Sebastopol is a co-operative agreement between the city, private photovoltaic (solar power, or PV) vendors, the energy technology program at Sonoma State University, and individual citizens. It provides a database of rooftops in Sebastopol that are good candidates for PV installation and free appraisal by the PV companies. The goal of Solar Sebastopol is to, within the next year, install enough PV panels within the city limits to meet a third of the city's electricity demands. Robinson said that the problem with a big generator is that it is centralized, that "... somebody else is in control of our energy. Whereas a PV system on your rooftop or a small wind generator or a community owned generator puts the power literally in peoples own hands and that's both a more democratic way and I think ultimately safer and more sustainable."

The city of Willits, also in Northern California, is also working towards energy independence. Dr Jason Bradford, formerly of UC Davis, facilitated town meetings on Peak Oil after screenings of "The End of Suburbia." The meetings brought together the Willits Economic Localization (WELL) project, and resulted in the formation of ad-hoc groups of WELL members to address the problems of providing sustained sources of food, water, shelter, health and medicine, communal living and planning, and energy to the community of Willits. "Nobody has a full time job doing this, we're all volunteers, we all have our own lives", Bradford says about WELL. "So the trick is try to figure out how to create something new while you are still dependent on the old... that's very complicated... We have 60 people, 70 people showing up for meetings once or twice per month. They happen at the community center... City Hall just gives us free space."[18]

Along with WELL and the Willits Ad-Hoc Energy Group, City Councilman Ron Orenstein sponsored an energy independence report for the city of Willits. Entitled, "Recommendations towards Energy Independence for the City of Willits and Surrounding Community," the report paints a picture of an urban area that could, given timely action, adjust to expensive energy by achieving energy independence and emerge as a strong, organized and self-sufficient municipality. It also does not sugar-coat the consequences of apathy. The report states, "... if we want to be able to develop alternative sources of energy in order to maintain some semblance of our society today, we need to do so now while energy is still cheap and plentiful. We cannot afford to wait until fossil fuels decline to the point of severe economic impact - the changes to ensure our survival need to begin today. Those same fossil fuels we save by striving for energy independence today will provide the basis for sustaining agriculture and healthcare tomorrow."[19]

The report points out that, independent of issues oil peak and energy scarcity, the process of achieving energy independence can be positive stimulus for the local economy. "In presenting these potential steps that the city of Willits can take, every effort has been made to find ways that the transition results in revenue streams to the city and community, with the long-term objective being a stronger self-sustaining economy."

Small towns are not the only places where Peak Oil awareness is growing. John Hickenlooper, mayor of Denver, Colorado, is a retired petroleum geologist and has done much to prepare his city for the onset of energy scarcity. In a guest editorial for the online magazine terrain.org[20], Mayor Hickenlooper listed the environmental strides his city has taken. Among these are the use of environmentally responsible or energy-efficient technologies in the city's infrastructure, such as LEDs in traffic lights and biofuels for the city's fleet of vehicles. Denver sports two "national models" of infill development, one a former Air Force base and the other a former airport. The city has also begun work to institute green building standards, and has started work on "the most ambitious local transit project in our nation's history," a wide network of both light and commuter rail transit.

These actions address many common urban problems and would be beneficial to any urban center, independent of our oil and gas predicament. Not surprisingly, the aforementioned actions have thus far been implemented without public discussion of Peak Oil. Yet now the City of Denver is opening discussion of Peak Oil by co-sponsoring the World Oil Forum with the US chapter of the Association for the Study of Peak Oil (ASPO-USA). The Forum will be held on November 10th and 11th of this year. Mayor Hickenlooper, as well as an array of industry experts, political leaders, authors, and others, will speak at the conference.

Denver's World Oil Forum is set to address both global and local issues related to energy scarcity. Among the many topics covered will be, according to the conference's web site[21], an "exploration of policy options, especially at the municipal level." One of the goals of the conference is to help Denver to formulate effective responses to Peak Oil problems through better understanding of the issues. The conference hopes to show that "citizens, corporations, cities, and states can take intelligent actions now to prepare for more expensive petroleum and to mitigate the negative impacts of peak oil." Communities everywhere can benefit from Denver's efforts to open a dialogue on the issue of Peak Oil on the local level, if we, as community members, choose to follow up with our own local dialogues about our energy-constrained future.

Community discussion of the ramifications of global oil peak is a vital first step for making preparations for an energy-constrained future. Coverage of the possible effects is growing as the mainstream media begins to take notice, though the media has been unwilling to take a stand since there are credible talking heads on both sides of the "is Peak Oil for real?" fence. Along with the growing supply of cogent and accessible summaries of our oil and gas predicament on the web and print news, more ideas and working models for responses are surfacing. In addition to relocalization, two important mitigating responses are the Oil Depletion Protocol and reconfiguring our settlements to be ecologically, rather than just economically, effective.

Adopting the Oil Depletion Protocol

The Oil Depletion Protocol (otherwise known as the Rimini Protocol or Uppsala Protocol) is a global agreement conceived by Dr. Colin Campbell, founder of ASPO and first proposed at the 2003 Pio Manzu Conference in Rimini, Italy. It will be the central theme of the October 2005 Pio Manzu Conference.[22] Currently both Dr. Campbell and author Richard Heinberg have published articles and spoken extensively on the Protocol.[23] [24]

The protocol requires oil exporters to reduce exports by their national depletion rate and oil importers to reduce imports by the world depletion rate. Put simply, "depletion rate" is the total supply of oil that remains to be extracted, divided by the amount of oil extracted per year. Depletion rates would be used as percentages to determine how much a country must reduce its exports or imports. An exporting country would inventory all recoverable oil, divide this number by the amount of oil the country extracted in one year, and then reduce exports by that percentage.

Heinberg reported in August 2005 that worldwide, 944 billion barrels (Gb) had been extracted. The amount remaining in known fields is 772 Gb and the estimated amount yet to be found is 134 Gb, totaling 906 Gb yet to be extracted. Production of conventional oil in 2004 was 24 Gb, yielding a Depletion Rate of 2.59 percent (24/906).

As an example, Norway reports remaining reserves of 11.3 billion barrels (Gb) in known fields with about 2 left to find, or 13.5 Gb left to produce. In 2004, Norway extracted 1.07 Gb, representing a Depletion Rate of 7.4 percent (1.07/13.5). This is a comparatively high rate, typical of an offshore environment. To adhere to the protocol, Norway would have to reduce production from the 1.07 Gb in 2004 to 0.99 Gb in 2005 and an additional 7.4% every year.

The protocol requires importing countries to reduce their imports by the world depletion rate with the intention to bring demand in balance with the diminishing supply. In 2004, the U.S. imported 3.68 Gb of oil.[25] If it were to adopt the protocol, the U.S. would reduce its imports by 95 million barrels (2.5% of 3.68 Gb) and an additional 2.5% each year. Implementing the protocol would require importing countries to rapidly institute conservation and efficiency programs to reduce consumption. As years passed and such programs yielded diminishing returns, adopting countries would likely need to shift the balance of their programs towards reconfiguring their economies and cities.

The protocol is intended for adoption by national governments, and frankly would be most effective if all countries were to sign on; this nonetheless seems quite unlikely in the near-to-medium-term. Yet any country that ratifies the protocol now will likely benefit tremendously, as adoption of the protocol will act as a buffer between that country and inevitable energy shortages and price spikes. If regions and cities in laggard nations like the United States adopt the protocol and act accordingly, those regions and cities will also benefit to the extent that they lessen their dependence on oil and gas. Already many cities, states, and regions in the United States are acting along the lines of the Kyoto Protocol to reduce carbon emissions. For example, the state of California and a number of states in the New England region of the US all have passed laws that essentially support the Kyoto Protocol and require reductions in greenhouse gas emissions far beyond those mandated by the federal government. A similar strategy on the municipal and state level could jump-start adoption of the Oil Depletion Protocol. As the ASPO-Ireland website states, "A positive development [in the adoption of the Oil Depletion Protocol] comes when communities, cities and provinces take steps to cut energy consumption paving the way for national responses."

Many oil exporting countries have already hit a plateau or have begun to decline in their extraction capacity, so reducing exports by their depletion rate would not be as drastic a move as it may sound. Oil exporting countries could enjoy such benefits as a more predictable oil market and a longer time period in which to find other sources of revenue than oil. Oil importing countries would benefit equally, also enjoying more stable oil prices and a longer time period to implement lifestyle change and invest in alternatives to oil. Cities, states, and regions, whether they are oil importers or exporters, could gain the same benefits, independent of their federal governments. Oil importers will, however, have to work hard at redesigning their societies, technologies and economies to achieve even a small percentage reduction of oil imports. Fortunately, ideas and plans for reducing demand exist that can help provide some direction.

Recognizing that 2004 oil prices reached levels unprecedented in recent years, the International Energy Agency (IEA) released a book titled "Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport". A core mission of the IEA is energy supply security. As such, the IEA has the power to mandate that member countries apply voluntary and mandatory measures for reducing oil consumption on very short notice during an oil supply disruption. The book explores measures to help cope with fuel shortages and oil price shocks. As the transport sector is the prime consumer of oil in most OECD countries, the book focuses on options to rapidly reduce oil demand in the passenger transport sector, over short periods of time.

As shown in Table 1, the cost effectiveness of demand restraint policies in the transport sector ranges greatly and depends on the policy context in which they are pursued. Such policies could be applied to meet the obligatory oil consumption reductions for countries, regions, and municipalities that adopt the oil depletion protocol, and are likely to be imposed by IEA on member countries during upcoming oil supply shortages.

Parallel policies with respect to rationing and energy efficiency are also likely to be pursued in the early stages of implementation of the oil depletion protocol. While such policies may be sufficient initially, they will soon yield diminishing returns. Significant oil and energy consumption is built into the economic system and locked in by the built environment. Additional reductions in oil consumption will require us to reconfigure our economies and cities.

Table 1: Summary of direct cost-effectiveness of various policies

Direct Cost Effectiveness Range	**Measure**	**Other Potential Impacts**	**Oil Savings**
VERY INEXPENSIVE Less than $1 per barrel saved	**Carpooling:** large programme to designate emergency carpool lanes along all motorways, designate park-and-ride lots, inform public and match riders		Very Large
	Driving ban: odd/even licence plate scheme. Provide police enforcement, appropriate information and signage	Possibly high societal costs from restricted travel	Very Large
	Telecommuting: large programme, including active participation of businesses, public information on benefits of telecommuting, minor investments in needed infrastructure to facilitate		Large
	Compressed work week: programme with		Large

	employer participation and public information campaign		
	Tyre pressure: large public information programme	Likely safety benefits	Moderate
	Carpooling: small programme to inform public, match riders		Moderate
INEXPENSIVE Less than $10 per barrel saved	**Speed limits:** reduce highway speed limits to 90km/hr. Provide police enforcement or speed cameras, appropriate information and signage	Safety benefits but time costs	Very Large
	Driving ban: 1 in 10 days based on license plate, with police enforcement and signage	Possibly high societal costs from restricted travel	Large
MODERATE COST Less than $50 per barrel saved	**Bus priority:** convert all existing carpool and bus lanes to 24-hour bus priority usage and convert other lanes to bus-only lanes		Small
EXPENSIVE More than $100 per bbl saved	**Telecommuting:** Large programme with purchase of computers for 50% of participants		Large
	Transit: free public transit (set fares to zero); 50% fare reduction similar cost		Moderate
	Transit: increase weekend and off-peak transit service and increase peak service frequency by 10%		Moderate
Source: International Energy Agency (IEA), "Saving Oil in a Hurry: Measures for Rapid Demand Restraint in Transport", 2005.			

Reconfiguring Local Economies

Relocalization is the process of bringing production closer to consumption obviating the need to rely on long supply chains and distant markets so that communities can largely provision themselves. Post Carbon Institute suggests that communities start with local food, local energy, essential goods, and community currencies with the aim to integrate these efforts into a parallel public infrastructure that can serve as a safety net for when times get hard and a launch pad to scale up operations. The process will require experimentation since each community has different circumstances including natural systems, built infrastructure, community resources, and culture. Communities should start the process in earnest now so as to learn as much as they can about what works and what does not before we find ourselves in a full scale energy crisis.

Local government can provide a much needed boost to relocalization efforts by removing obstacles such as zoning ordinances, subsidies to corporations, home owner association restrictions, and local laws that prohibit activities such as gray water recycling. Local government can also provide incentives and make rules favoring purchasing of local goods and funding of relocalization projects. Local government can also provide financial, promotional, moral, and other types of support for relocalization efforts.

In August 2005, the City of Willits and WELL signed a joint statement toward a healthy sustainable community that recognizes, in light of both climate change and oil and gas depletion, the need to "localize" their economy. The City of Willits and WELL will focus initially on food and energy production and on shifting economic development to small, local community enterprises. Implementation of these changes will create businesses and avenues for local youth to express their creativity, improve the landscape, and will provide a "quieter, less expensive, and more dependable set of services, while providing an array of interesting employment." The statement commits the city to a series of community events, news articles, reports and forums in subsequent months that will provide opportunities for citizens to learn more.[26]

Reconfiguring the Built Environment

A vital part of reducing overall energy demand is to redesign our settlements so that they demand less energy from those who live in them. Cities are the largest things that we create and their structure drives material and energy consumption and transportation. According to Richard Register, President of Ecocity Builders in Oakland, California, the most effective way to reduce energy consumption, and the only way to produce ecologically sustainable cities, is to reconfigure our cities to be ecologically healthy. Healthy climax ecosystems have low energy and material throughput (meaning that energy and matter tends to cycle within the system, rather than flow through and out), tend to have large amounts of biomass per unit of land, and high diversity. Ecologically healthy cities incorporate those characteristics, and tend to work with the surrounding environment in mutually beneficial ways. Currently there are no truly ecological cities in existence, but existing cities can be redesigned to incorporate more ecological design principles.

Ecological cities rely on renewable energy sources that are, as much as possible, integrated with the city itself, and are therefore energy independent, using, for example, solar and wind generators on the tops of buildings. They are also compact, built for pedestrians and bicyclists rather than motorists, and zoned for a diverse number of uses in a small area so that residents can walk or take public transit to workplaces, schools, and commercial centers. At the same time as being densely developed, ecological cities also leave space for gardens and parks where residents can grow some of the food consumed in the city, reducing the food shipments from outside and maintaining a healthy and pleasant environment even in the city's core. Compact, diverse cities that provide for their own energy needs are the only way to preserve urban populations while letting go of our car culture and all of its energy demands.

If we cut down on the energy demands from our normal ways of being, we will then have more energy resources available for making other, vital transitions, such as weaning our agricultural system from its dependence on oil and natural gas, and redesigning (and in some senses reverting) our transportation systems to run on electricity rather than liquid fuels. Since an energy-constrained future is inevitable, ecological city design is the best prospect for an urban lifestyle that we can sustain for generations to come.

Cities, suburbs and towns, as we construct and live in them today, stand to lose nearly all of their services and comforts as life-supporting environments in our energy-constrained future. But if those in power act now to change our constructed environments to better reflect the coming reality of expensive energy, cities could preserve far more services for their citizens than could higher levels of government or national organizations. With informed and timely action on the part of both local governments and individuals, cities could adjust to an expensive-energy environment. Given the energy expense associated with engaging in global-scale transport, production, and politics, and energy savings associated with staying local, cities have a better chance of retaining their effectiveness while national-level transport, production and government goes into decline.

Conclusion

While local government may not be ready to jump directly into adoption of the oil depletion protocol, relocalization, or ecological city design, all municipalities would do well to follow the lead of Hervey Bay, Sebastopol, Willits, and Denver. Government has a duty to determine its vulnerability to energy shortage and to develop viable energy and material alternatives in order to maintain a working support structure for its citizens.[27] It also has the duty to hold the space for open conversations about preparing for an energy-constrained world in their locale. Similarly, constituents must hold local government responsible for the performance of its duties. Failure to do so by either government or its constituents will likely be seen as dereliction of duty by future generations.

If municipal leaders and planners take action now, cities could become the most relevant political and economic arenas for their citizens. If we, as citizens, follow the action taking place in Hervey Bay, Sebastopol, Willits, and Denver, and spur our leaders to similar action, we may be able to transition to a more ecologically sustainable, socially just, and spiritually fulfilling future, rather than suffer through systemic breakdown for lack of cheap energy. While the leaders described above are openly facing the problem of Peak Oil, inviting dialogue on the subject, and even implementing solutions, the vast majority is still conspicuously silent and manifestly inert. Shall we continue to reward this majority for shirking its duties? Or shall we leverage on the courage of the few leaders who have broken the silence and inertia, and demand that all of our leaders - politicians and otherwise - step up to the plate and earnestly begin preparations for the post-petroleum future?

10. 2 Appendix Two

Past the Peak

How the small town of Willits plans to beat the coming energy crisis

By R. V. Scheide

A few miles north of Ukiah, Highway 101 shoots upward into Northern California's coastal mountain range, climbing and weaving up the Ridgewood Grade, leaving the vineyards of Mendocino County behind on the valley floor. The four-lane section of superslab peaks at Ridgewood Summit, the highest point on a road that stretches from Mexico to Canada. It then gently slides down into Little Lake Valley, where, at the first stop light on the highway north of the Golden Gate Bridge, it reaches the city center of Willits.

An enormous iron arch spans main street downtown; it once welcomed visitors to "the biggest little city in the world," Reno, Nev. It has since been repainted the green and red colors of Christmas and beckons visitors back to a simpler time.

Willits is a timber town. Weathered men in flannel shirts rumble by in four-wheel-drive pickups and logging trucks. The town boasts the longest continually operating rodeo in the United States. One of the local museums proudly displays steam-powered logging equipment. The Ridgewood Summit serves as a cultural as well as a geographic divide. This is where rural truly begins in Northern California.

But not all is as it seems in this rustic little town. Since at least the 1970s, the promise of a simpler life has lured a large number of Bay Area hippies, alternative types and other societal dropouts to the woods of Mendocino and Humboldt counties in what came to be known as the "back to the land" movement. These so-called ecotopians, many of whom are still around today, sought to escape what they saw as the pollution, corruption and dehumanization of modern urban life. Here in Willits, they battened down the hatches and waited for the end of the world.

It took a little while, but it appears that the end of the world has finally caught up to them.

Suburbia's End

A boyish 37-year-old with a Ph.D. in biology, Dr. Jason Bradford only relocated to Willits from Davis with his wife, Kristin, a medical doctor, and their two children last August. Initially interested in energy issues while studying climate change in the Andes several years ago, Bradford didn't really know what he was getting into when he decided to sponsor several screenings of The End of Suburbia: Oil Depletion and the Collapse of the American Dream just two months after arriving in town. Hosting a film that proclaims human civilization is going to run out of oil and is therefore doomed doesn't usually guarantee a visit from the welcome wagon. But then again, Willits isn't most towns. Bradford's initial invitation to view the film has blossomed into a popular movement that aims to, in the words of one member, "reinvent the town."

"Thirty people showed up the first time," he says. A number of people stayed to chat after the movie, and sensing local interest in the topic, he hosted another showing. Sixty people turned up that time. Ninety came to a third presentation. Bradford, who'd never really led anything larger than a small research team, could feel the momentum building. "Oh, shit!" he thought. "What do I do now?"

As it turned out, Bradford didn't have to do too much to keep the ball rolling, other than volunteering all of his spare time. That's because there's a current running through Willits that harmonizes exactly with what needs to be done to prepare for what petroleum experts call "peak oil." That current is supplied in part by the very same ecotopians who flocked to the region in the '70s. Under Bradford's leadership, they've teamed up with concerned professionals, local government officials and ordinary citizens to form the Willits Economics Localization (WELL) project. It appears to be one of the first civic groups in the United States dedicated to preparing for the coming energy crisis. But if other communities are to have any hope of retaining some semblance to the lifestyles they've grown accustomed to during the age of cheap oil, it definitely won't be the last.

Peakocalypse Now

Put simply, peak oil theory states that we've already burned through half the oil that ever existed. Competition for what remains will turn increasingly vicious as the supply dwindles, as we are already witnessing with higher prices at the gas pump and the increasing number of casualties in the Middle East, where the world's largest remaining oil reserves are located. At the current rate of consumption, some experts estimate that the remaining supply will be exhausted by 2042. When that happens, the world as we know it will certainly change and perhaps perish. Many experts are convinced that if we don't start conserving now, the end of oil may come even sooner.

That's where the back-to-the-landers come in. They may have dropped out, but they still needed to turn on. Problem was, PG&E didn't go out to the woods, and portable gas generators weren't quite as light and powerful in the '70s as they are today. So they turned to such alternative energy sources as wind and solar power. That legacy can be found in Willits today in such successful renewable energy businesses as the Applied Power Corporation and nonprofit research firms like the Renewable Energy Development Institute (REDI), which counts the city of Sacramento among its clients.

On a sizzling July afternoon, Bradford and the core members of WELL met at the REDI Haus--a 1950s home in downtown Willits refurbished with natural-fiber rugs and hemp window shades, and powered entirely by photovoltaic cells--where they prepared for that evening's community meeting. Most of WELL's core members are older than Bradford and have lived in Willits much longer. Brothers Richard and Phil Jergenson, inventors who've dreamed up products that include a life-sized erector set for adults, moved here in 1978. Phil is president of REDI; Richard has gained local fame with inventions such as the Sol Train, a solar-powered rail vehicle.

"We were fortunate to grow up when this was the book to have on your coffee table," says Richard, 54, slapping a dog-eared copy of the Whole Earth Catalog. He serves as one of the group's archivists, and his collection of Willits memorabilia includes a copy of the second issue of the locally published Mendocino Grapevine, featuring original tree-hugger cover art by R. Crumb, as well as fliers from the first Solar Expo and Rally in 1978, an event that eventually morphed into the Solar Living Center and Real Goods, the popular environmentally correct merchandise store in Hopland. He refers to WELL as "the usual gang of disgruntled individuals trying to change the world."

Lanny Cotler, 64, who describes himself as an "entrepreneur, revolutionary and successful Hollywood scriptwriter," fits right in with the gang and serves as its video archivist. You may have seen some of Cotler's work: The Earthling (1980), Backtrack (1990) and Heartwood (1998), the latter starring the late Jason Robards and set in a small town strangely similar to Willits. Ten years ago, Cotler began shopping around an idea for a sitcom, Off the Grid, based on "the kookiness of a town as it goes off the grid." He's still shopping it around today, but with the advent of peak oil, Cotler feels that "it would be more of a reality-based show now." At this evening's meeting, he's giving a presentation on the necessity for media outreach.

Thin, hawk-faced Brian Weller, 59, is the group's self-described "resident alien," a British native who's served as an organizational consultant for such major corporations as British Petroleum. Weller is extremely proficient at managing small- and large-group dynamics, a skill that has proven invaluable during WELL's first months of existence. When it comes to a topic as large and frightening as peak oil, he explains, "there are different scales of what people are able to think about. I'm helping WELL understand the process as an emerging social organization. This process will be achieved through people, and people have different perceptual filters and different agendas, both open and hidden."

Put another way, Weller means that the stakes are incredibly high. The consensus among peak oil experts is that the reduction in oil will translate into an enormous fall in global population, perhaps as much as an 80 percent decrease. (Keep in mind that cheap petroleum permeates the global economy, from transportation to manufacturing to agriculture to medicine.) Just prior to the 1992 Earth Summit in Brazil, President George H. W. Bush famously said, "The American way of life is not negotiable." Peak oil says everyone must give up something, a fact that can be difficult for individuals and groups to accept.

Ad-Hocracy

Weller helps facilitate communication when such hidden agendas block progress, ruffling as few feathers as possible. He's fond of noting that the Chinese ideogram for "crisis," weiji, is made up of two characters, one signifying danger and the other opportunity. He finds both elements present in the crisis presented by peak oil. "This is a trend that plays against the overall trend of globalization," he notes. "We feel there's been an erosion of well-integrated communities. We want to reinvent what it means to be a community."

With an abundance of such enlightened individuals in the Willits area, which has a total population of 15,000, why hasn't the community already prepared for the coming storm? The answer can be partially seen along the so-called miracle mile strip of highway south of town with its ubiquitous fast-food restaurants and strip malls defining the suburban American landscape. The same economic forces that have shaped the rest of post-WW II America have been hard at work in Willits.

"Only 5,287 people live in the city proper," Bradford elaborates. "Almost two-thirds of the population live sprawled out in the suburbs. We're a rural community with agricultural land, but none of that ag land feeds us. The average person commutes to work 28 miles per day."

As the core members of WELL discovered, such basic elements of modern suburban life are merely the tip of an enormous iceberg that shadows not just Willits, but the entire American way of life. The sheer size of the problem is intimidating, leaving only one logical solution: Chip the iceberg down to size.

From the first three showings of The End of Suburbia, Bradford attracted roughly 60 volunteers who were willing to turn up at meetings even when there wasn't a film being shown, even when it was pouring down rain. In many ways, they're a homogenous lot--mostly white, middle-class baby boomers--but they also represent a wide diversity of skills and viewpoints.

Bradford and the core members, working as a steering committee they jokingly refer to as an "ad-hocracy," originally identified 14 key areas of interest pertaining to peak oil and the community's survival that seemed to match up well with the interests of the overall membership. Eventually, these 14 areas were consolidated into six working groups: food, energy, shelter, water, health and wellness, and social organization.

"We need to figure out what we can do now, and what we can do in the future, when we don't have the resources coming in," says Brian Corzilius, 47, a core WELL member whose training as an electrical engineer landed him in the energy group. Working with energy-group members Richard and Phil Jergenson, as well as Willits City Council member Ron Orenstein and others, Corzilius helped conduct an "energy inventory" of Willits that provided the first snapshot of where the town is now--and how far it has to go.

Compiling existing data from companies and government agencies ranging from PG&E, the California Energy Commission, the Mendocino Air Quality Management District and the U.S. Department of Transportation, the group was able to determine that Willits uses more than 1,000 megawatt hours (MWh) of imported energy per day. Energy sources from outside the Willits area include propane, firewood, natural gas, electricity and--by far the largest slice of the imported energy pie--diesel and gasoline used for transportation. It appears that the 28 miles per day that the average Willits resident commutes costs the community a bundle in terms of money not spent in the immediate area.

"Annually, we have $30 million that leaves the area; 56 percent of that is for transportation," clarifies Corzilius. "Bring that money back, and you've got money to grow new local businesses." In turn, creating new local businesses reduces the number of commuting miles.

The 1,000 MWh per day figure serves as an important baseline for conservation, since every megawatt saved, according to the energy group's report, results in an annual savings of $1 million--money that doesn't have to be spent on developing new power-generation facilities. The report also estimates that there's enough unutilized space on the rooftops of city, residential and commercial structures to easily produce 25 MWh per day with solar panels, further reducing energy imports.

The long-term conservation goal, the report contends, should be a 50 percent reduction in current usage, which could be facilitated by appointing a local "energy czar." The short-term goal is much bolder: complete energy independence by 2010. That's just five years from now.

Feud Chain

The preliminary report by WELL's food group, an inventory of the food stocked by Willits' two major supermarkets and several smaller grocery outlets, reveals the fairly startling fact that none of the stores uses local vendors in their food-supply chains. "What this essentially tells us is that we have a few days supply of food at any one time," says food group member Cindy Logan. "Safeway is dependent on daily deliveries for some items." Or, as another Willits resident puts it, "What if there's a meltdown on 101 and the truck can't get into Safeway?" Or: What if there's no diesel to fuel the trucks in the first place?

To address topics as complex as localizing food supplies, WELL invites guest speakers to talk to the group. Some, such as world-renowned bio-intensive gardening innovator John Jeavons, author of the perennial bestseller How to Grow More Vegetables, didn't have to travel far: Jeavons lives in Willits. Others, such as Stephen and Gloria Decater, had to come over the hill from Yolo County, where they operate the Live Power Community Farm near Covelo.

The Decaters practice community-supported agriculture. Their 40-acre farm provides food for 160 member families, totaling some 300 people, over a 30-week growing season. The families pay a subscription that provides operating fees for the farm and a modest income for those who work it. And when the Decaters christened their farm "Live Power," they meant it. Five full-time farmhands and an array of draft horses do all the work on the farm with the exception of hay baling, which is done by tractor because the farm has been unable to acquire a horse-driven baler. Apparently, they don't make them anymore.

During their presentation to WELL in April, the Decaters used simple math to solve Willits' potential future food shortage, at least on paper. Divide the town's 13,300 immediate residents by the 300 people Live Power Community Farm can feed, and it's easy to see that all that's required to feed the town is 44 similarly-sized farms. These plots would only take up a modest 1,733 acres in total--roughly the same area as the 2.8 square miles within Willits' city limits. Because the Decaters' numbers are based on a partial diet--an unintentional vegan slate that doesn't factor in dairy or meat--the actual acreage might have to be doubled or even tripled. Still, it's doable, and in fact, it's the way things were done not too long ago, before the automobile came along. Since then, Gloria Decater told the audience, "We have not thought of farms as permanent places. As the next generation left farming and development encroached, the farms have been cashed out. . . . With peak oil, we now have a new perspective. This may not only be sad, but it's also a matter of future survival."

Green Health

In WELL, caring for the survivors of a coming calamity falls upon the health and wellness group, which includes members drawn from both the traditional and alternative medical fields.

"I've been in this community for three decades, and I've always been interested in doing alternative therapy," says Marilyn Boosinger, whose expertise includes herbology and acupuncture. She hopes the group can develop an apothecary for locally grown natural medicines. "We would grow herbs, harvest them, make them into tinctures. We see natural medicine as something that is sustainable. The prescription medications and a lot of the supplies used in modern medicines may not be as available."

That's particularly important to Dr. Kristin Bradford--Jason Bradford's wife--a medical doctor who understands that many of today's pharmaceutical products depend upon petroleum for their manufacture. She's eager to learn as much as possible about alternative therapies.

"It's something that I'm not trained in, so I'm very excited to be collaborating with people who are, so I can have something to benefit my patients when the other isn't available," she says.

The health and wellness group got an added boost when Margie Handley, president of the Frank R. Howard Foundation (established by the son of Charles Howard, owner of the famed Willits racehorse Seabiscuit), which funds the local hospital of the same name, began attending WELL meetings. Handley has been the driving force behind converting the Frank R. Howard Memorial Hospital into California's first green hospital--a goal near completion--and she's sought community input in part through the members of WELL. The shelter group, for example, has drawn up architectural plans for a hospital greenhouse that employs straw bale construction and solar power for energy.

Willits city officials are also becoming increasingly involved with WELL. When $10,000 was recently freed up in the city budget, the funds were directed toward bringing in speakers to complement those who have spoken to the community so far at WELL meetings, such as the dark prince of peak oil, Santa Rosa author and New College professor Richard Heinberg, and Ann Hancock, coordinator of the Sonoma County Climate Control Campaign and past coordinator of the Ecological Footprint Project.

"We're trying to bring the city into a leadership role in this effort," says city planner Andy Falleri. Earlier this year, Falleri attended an E. F. Schumacher Society conference in Massachusetts, where establishing land trusts for small local farms like Live Power was discussed. He was surprised to discover that more than a quarter of the people attending the conference were aware of WELL, even though the group had only been up and running for six months. "A number of people had heard about the stuff Jason Bradford was doing with peak oil," he says. "I thought maybe Seabiscuit would be more widely known, but [he] wasn't."

Falleri admitted that there's still not a sense of urgency among city officials and the population at large about peak oil.

"We've got some real nice policies in Willits to reduce energy consumption, but people haven't really understood what they've meant," he says. "We've got to get to the next level and get some of these ideas implemented."

Going to the WELL

"I still think we should have called it SWELL," Richard Jergenson grumbles over organic Mexican food at Burrito Exquisito in downtown Willits. The S in his proposed acronym stood for "sustainable," but he was overruled by the ad-hocracy, which felt the term has gained too much of a lefty connotation. Even though many of the methods employed by the sustainability movement apply to the coming energy crisis, Bradford continually emphasizes that the seriousness of peak oil requires reaching out to as wide an audience as possible.

It's a hot, stuffy Monday night in July, but at the entrance to the Willits Community Center, where people are already streaming in for the meeting, Bradford's message appears to be getting across. Everybody's talking about peak oil in Willits these days, including members of American Legion Post 164, such as Keith Rosen.

"The post commander has instructed me to come to the meeting and see what the Legion can do to help with the issue," Rosen says, adding that his commander was following orders from the military veteran organization's national command. "The idea is to use the good name of the Legion to get different factions together." For Rosen, who describes himself as a "potter, welder and maker of things" who dropped out of mainstream society to come to Willits in 1970, there's no question that we must prepare for peak oil. Apparently, the Legion is in agreement.

"We [the Legion] came to the conclusion that if half the community is fed and the other half isn't, the half that isn't will feed off the other, and that's unacceptable," he says.

Bradford opens the meeting, held in the large hall beneath the Community Center's domed ceiling. About 40 people have turned out for the event, a far cry from the 200 or so that turn up for speakers such as Heinberg. Still, getting 40 volunteers to show up on a muggy Monday night is no mean feat for any organization. Bradford catches the group up with the latest news and sets them up for Lanny Cotler, who's pitching WELL's proposed media-relations campaign to the audience tonight.

Perhaps it's the heat, but the pitch doesn't go over well, even though Cotler volunteers to do all the work. The work--editing megabytes of digital footage, putting together press kits, is necessary--he urges, because, "we have a big responsibility for people who are coming behind us." The campaign will serve as a blueprint of sorts, and a record is required in order to secure government grants and other funding sources. Yet after Cotler finishes, several people in the audience express their displeasure, mainly because they crave action and perceive the media campaign as just more talk.

"It's going to bring more people into town," complains one man. "The energy of the group is going to be diverted to making a commercial about how cool we are." Several more people sound off before former BP facilitator Brian Weller steps in to smooth the situation over. Acknowledging the group's desire for action, he gently points out that the chance to act may never come if WELL doesn't eventually secure major funding, which in turn is dependent upon a public-relations campaign, and thank goodness we've got a Hollywood screenwriter who's willing to do all the work for us. Everyone appears satisfied, and the members break off into their assigned groups.

Just two members of the water group, Larry Desmond and Ree Slocum, are in attendance tonight. They're scheduled to give a presentation at the next WELL meeting in August, but both find it hard to get spare time to conduct the research into local water supplies.

"Most of the water resources we have require energy," says Desmond, noting the seriousness of the matter. "Being without power is one thing; being without water is another"--meaning, without water, you die.

Perhaps the chance to belong to an organization in which such crucial matters are at stake is what has made WELL such an easy sell.

"For me, it was the right thing to do," explains Slocum. "All along, I wanted to be working in a community that was sustainable. Willits is still livable and functional, but we've all gotten busy. We're small enough that we could

eventually do something." However, the question of whether that something will be enough remains. Peak oil experts such as Heinberg and James Howard Kunstler, author of The Long Emergency, the latest doom-and-gloom tome on the topic, seem convinced that the time for large-scale meaningful action has come and gone. Perhaps Willits could become what Heinberg terms a "lifeboat," carrying a few survivors to some unknown solution in the future. Or perhaps Willits will become self-sustaining, only to be overrun by starving, rampaging hordes from the cities. Shouldn't WELL establish a militia to defend against such possibilities?

"The questions of militias came up early on," says Brian Weller. "What do we do under a Mad Max scenario?" referring to the postapocalyptic science-fiction movies where rampaging hordes murder, rape and kill in a desperate battle for the last drops of gasoline. In the end, the steering committee delegates the issue to the social organization group, which in turn delegates defense issues, at least for now, to the local police and sheriff's departments.

"Most of [law enforcement's] plans deal with acute problems, like fire and disease," Bradford says doubtfully. "They haven't thought about things like long-term food security, for example."

There is, of course, another solution if the hordes come from the city.

"We'll just blow up the bridge in Hopland," Cotler says, only half-jokingly.

From the August 10-16, 2005 issue of the North Bay Bohemian.

10.3 Appendix Three

Conducting a Local Energy Inventory

Draft rev. 10/05/05, bsc

Any energy inventory of a community, town or city is at best an approximation. Hopefully, with proper attention to the data sources and the use of statistical sampling, the resulting inventory will be a good representation of the actual energy used for your area of consideration. This means examining all data critically to see if it makes sense – don't accept data blindly!

So how do you start? First and most importantly, you need to define the area of interest. It can be by size, by township, etc., but most data is available by zip code and that is a convenient method that comes with specific definitions of size and population. Once you define this area, go to the internet and request demographics (I used Google and asked for demographics by zip code). This will give you the size, population, income, etc. which will be useful when you start looking at per-capita consumption.

Next you need to determine the types and sources of the energy used in your area (e.g. distributors, wholesalers and retailers). *Note that this energy inventory does not take into account the embodied energy of products we buy, just the direct purchase and use of energy products themselves.*

In our case, the main types of energy used in our area were defined as: natural gas, electricity, gasoline, other transportation fuels (e.g. diesel), propane and firewood.

Sources of these products were then defined as follows:

? Natural Gas – gas pipeline distribution (and billing) by Pacific Gas & Electric (PG&E)

? Electricity – high voltage distribution lines (and billing) by PG&E. *Note that off-grid installations were not considered in our work* (they've already been 'liberated' <grin>).

? Gasoline – Wholesale distributors transporting fuel by trucks for distribution by local retailers (gas stations) on a scheduled basis

? Other Transportation Fuels (diesel, kerosene) – as above

? Propane – as above

? Firewood – Generally individuals cut either from private or open public lands or purchase from others who do.

The next step is to determine how these fuels are employed. Is it for private consumption (home heating, transportation, etc.), commercial businesses, or public entities? This step helps us to determine how stable the use is and what alternative (locally-produced) fuels can be used to replace those currently imported.

Up to this point, everything we have discussed in the local energy inventory process could take place sitting around a table. Now the real work begins.

One of the more complex pieces of data to obtain is that of natural gas and electricity usage for your defined area. While there are ways of obtaining this yourself, to obtain accurate statistics from an electric company (like Pacific Gas & Electric) you will need to enlist the assistance of someone in city, state or Federal office. They will need to make the call and request the information, most likely receiving it by email. For the Willits area audit, we had the benefit of a City council member as a member of our group who took the time to place the call to PG&E. He was able to get zip code specific data. As an alternative (if you have no one to represent you), contacting the Public Utilities Commission will get you electricity usage for your area but perhaps not specific to the area you have defined (they generally have it by county). For California, here is a starting contact I used: Andrea Gough, California Energy Commission, 1516 9th Street, MS-22, Sacramento, CA 95814, ph 916.654.4928 fax 916.654.4901, email agough@energy.state.ca.us. She ended up sending county-wide data which was a good benchmark for checking the final data set we received directly from PG&E (e.g. total consumption->average per household x #households in your defined area).

Transportation fuels (gasoline, diesel, etc) brings with it their own problems. Specifically, the local stations sell fuel not just to residents and local businesses but also to those traveling through. What needs to happen here is to locate department of transportation (e.g. CalTrans) statistics on the vehicles on the road in your area and what the percent of local traffic versus pass-through traffic is. In addition, the US Department of Transportation has statistics on the mix of vehicles (compact cars, SUVs, trucks and freight) that inhabit the road as well as their average fuel economy. An alternative is to employ stats from the state Energy Commission and the US Department of Transportation as to the transportation fuel use per capita as well as the ratio of cars to trucks for the state in general. Using your demographical data, the total # of local vehicles and the fuel economy for each vehicle class can be derived and the local defined area stats can be calculated.

Propane consumption is a bit easier. For our inventory, we contacted the local retailers (wholesalers, if present in your area, may also work) and queried them as to the total sales for the past year.

That leaves us with firewood consumption. In larger areas (mid to large towns and cities), firewood consumption is more of an aesthetic than a need and you might want to discount it altogether. However, if your area includes rural or parts of a community not served by natural gas, then the consumption of firewood is relevant in that it s used (at least to some degree) for heating of residences. Statistical approximation from firewood dealers and forestry service permits is one approach. For our inventory, the County Air Quality Management Board was able to provide stats on wood burning equipment and use (including whether it was used for primary or auxiliary heating), that allowed us to derive a reasonable figure for firewood consumption.

Now you are down to compiling the figures and adding through the total consumption for your area. When you do so, we recommend selecting a standard unit of energy (e.g. Therms, megawatts, or BTUs. This will help compare different fuels as well as to assess potential (local) replacements. Also, don't forget the current value of the fuels (by unit consumed) since this will be important in assessing total funds expended per-capita as well as total revenues leaving the community to pay for such (non-local) energy. Most importantly, examine your data sets critically – if one seems too large (or small), recheck your calculations. If that still returns the same result, try finding another way to assess that fuel's use and see if the figures agree within a reasonable margin of error.

Regarding the potential energy of fuels as well as emissions from specific fuel usage (should you wish to include such in your local inventory), there are many sources available out there. However, you may just want to use the data we have already collected in our (Willits) inventory. That work was done in Microsoft Excel and the formulas for potential energy and emissions are already plugged in. A copy may be viewed at http://www.greentransitions.org/WEL/WillitsEconLoc.htm. Contact us if you would like a copy of the actual spreadsheet for your own use.

Some relevant links that might be of interest:

California Energy Sources: http://www.energy.ca.gov/html/energysources.html
US Census Quick Facts: http://quickfacts.census.gov/qfd/states/
Energy Information Administration: http://www.eia.doe.gov

Thoughts on other Inventories that may play a role in your Group's Work

Health & Medicine Inventories
How many people are treated from our local population, at what level (in or out patient and if in-patient, avg. length of stay), and what are the common supplies used (aspirin, morphine, penicillin, sutures, etc.). From this, the number of treating physicians, nurses and other medical professionals, and given the population figure for the area of concern, the needs can be established (inventory). The vision phase can then determine local supplies, alternatives (e.g., acupuncture, etc.) or means of local creation (e.g., willow, opium, penicillin, suitable suture fibers, etc).

Water Inventories
A standard of 160 gallons/day/person is the industry-wide accepted figure used by water companies. Add to that an irrigation figure (or keep that separately under the food heading) of roughly 500 gallons/day/quarter acre/household. Combined, the water inventory could be completed, at least at a rudimentary level. This can be balanced against usage figures out of the area's reservoir and storage tank system, as well as the State Water Resources Control Board (SWRCB) and county well records. The end goal should be the amount of water consumed and the potential amount available.

Food Inventories
A simplistic approach to the inventory needs could be based on a standard caloric intake/person/day, with the vision phase being what crops can be raised here and their associated caloric value. True, knowing how many pounds of meat, grains, fruit, vegetables, eggs, milk (not to mention coffee, chocolate, etc. <grin>) are consumed by the target population would be nice but I suspect this could take us into such extremes as how much fast food is consumed, etc.). So back to the caloric intake – from this one can calculate how many pounds of grain are needed per person and the amount of land (water and fertilizer) required to raise that quantity. Parallel to this

is how much arable land is available -- this information, at least initially -- could be taken from the county in terms of land zoned agricultural.

Social Organization Inventory
What are the social services available in the area (food banks, soup kitchens, clothing sources, etc.)? How many people use them annually? What are the emergency services available (police, sheriff, etc.)? Are food and water stockpiles available and of sufficient quantity to last how long?

Shelter Inventory
What is the average household size and what does the typical house consist of (appliances, bedrooms, bathrooms, etc.)? How many houses are substandard (multiple families, insufficient facilities, etc.)? Is there low-income housing, and if so, what quantity? Are there shelters for those without homes (including transients)? Is there an emergency shelter, and if so, what is its capacity?

Work Recorded Brock Nedland

Date	Hours	Task
1-Feb	1 hour	brainstorming
6-Feb	1 hour	online research with Jen
6-Feb	30 min	emailed energy committee
8-Feb	1.25 hour	brainstorming - problem
8-Feb	2.5 hours	research
9-Feb	1 hour	email to Jim Zoellick and response to David Boyd
13-Feb	45 min	group email - Maureen Hart, Morgan king, jim Zoellick, Davic King
20-Feb	1.5 hour	in class - draft problem statement
22-Feb	30 min	met with Jen and Sarah
22-Feb	3 hours	research
26-Feb	3 hours	edited background statement
1-Mar	30 min	refined problem statement
6-Mar	1.5 hours	brainstorming - solutions & refined goals and aobjectives
8-Mar	30 min	completed goals and objectives
20-Mar	45 min	met with Jen and Dick
22-Mar	2 hours	group discussion and GIS work
27-Mar	1 hour	met with Jen and Scott to create preferred alternative
28-Mar	2 hours	individual work on alternatives
4-Apr	1.5 hours	research
5-Apr	1 hour	brainstorming - implementation strategies
5-Apr	20 min	wrote e-mail to Sarah
10-Apr	2 hours	generated random sample of 100 houses
12-Apr	15 min	group met
15-Apr	2 hours	research - used footprint data for HSU buildings to get area
17-Apr	4 hours	field work - random sample
19-Apr	2 hours	excel work
24-Apr	2 hours	met with jen and scott - started ppt
26-Apr	20 min	wrote e-mail to group
26-Apr	2 hours	analyzed data
28-Apr	1 hour	met with entire group - ppt work
30-Apr	3 hours	ppt work
1-May	2.5 hours	individual ppt work, & goup preperation for presentation
1-May	30 min	gave presentation to class
5-May	2 hours	worked on paper
5-May	1 hour	wrote email to Morgan King, Jim Zoellick, Maureen Hart & David Boyd
6-May	15 min	wrote email to group

Scott Harris-Werner
Environmental Science 410
Brief Time Synopsis of ENVS 410 Project

February:

1 – One hour: brainstorming with group
5 – One hour: online research (solo)
8 – One hour: brainstorming problem with group
10 – 1.5 hours: online research
13 - 2.5 hours: Energy data research
20 - 2 hours: Met with Jen – draft background statement
21 – 1.75 hours: Edited document and passed on to Jen, Brock, and Sarah
23 - .75 hours: Research photovoltaic efficiencies/output data
26 – 1 hour: work on problem statement

March:

1 - .5 hours: refine problem/background statement with group
6 – 1.5 hours: brainstorm solutions, refine goals and objectives
8 - .5 hours: refine goals and objectives - class
22 – 2 hours: Discussed alternatives with group – group GIS work
27 – 1 hour: created preferred alternative with group
28 – 1.5 hours: created estimation alternative

April:

5 – 1 hour: brainstormed implementation strategies with group
10 – 2 hours: random sample created – evaluation doc created
12 - .5 hours: met with group – methods discussion
17 – 3.5 hours: performed field study
19 – 2 hours: incorporate field study into single data sheet
24 - 2 hours: met with Jen and Brock – power point
26 – 2 hours: data analysis
28 – 1 hour: met with Jen, Brock, Sarah – pp discussion
30 – 3 hours: format pp presentation with group

May:

1 – 2.5 hours: edit, practice pp presentation with group – give presentation to class
4 – 1 hour: worked on data analysis section of paper
9 – 2.5 hours worked on results, formatting, data analysis, table of contents, editing, etc. of paper
10 – 1 hour: formatting of paper