KMPUD
Renewable Energy Advisory Committee

In-Valley Energy Feasibility Study
September, 2009

(Draft for Final Review)

Committee Members
Eric Richert, Raejean Fellows, Al Graf,
Peter Dornbrook and Peter Baltay

Contributors
Peter Millar, Cheryl Stern, Brent Larsen,
Wayne Amer, Michael Sharp, David Myers,
Mike Richter, and Mike Hodgson

Thank You
To Tom Henie, General Manager
and to all the participants of the July 5, 2009 and
September 6, 2009 Energy Roundtable Discussions

This study has been undertaken by a group of Kirkwood homeowners interested in Kirkwood's energy future. Committee members are not energy experts; this has been a "citizen" effort. Our report is based on the best information available to us at this time. With the completion of this study, it's time to formally engage others with professional expertise in the areas of renewable energy, energy conservation, and emerging technologies. We hope that we as a community can engage with these professionals on a more informed basis as a result of this work.

Executive Summary

The KMPUD Renewable Energy Advisory Committee's charter is to develop a roadmap that will guide KMPUD decisions for investing in energy conservation and renewable energy resources in Kirkwood. The roadmap is to be based on a comprehensive review of energy alternatives: in-valley firm power, renewables, and energy efficiency.

This feasibility study is the required review. With this study, we are more informed about how a roadmap can be created that will fit either an "out-valley" or an "in-valley" decision for how Kirkwood's electricity services will be provided.

We believe that renewable energy and energy efficiency will need to be a part of Kirkwood's future whichever decision is made, though the scope will depend on which decision it is. The wide range of energy and climate change discussions at the state and national levels, new and pending legislation and regulations, tax policies, the California Energy Commission's interest in distributed power, and interest expressed by Kirkwood homeowners and the Resort all indicate that we should have a better understanding of the role that renewable energy and energy efficiency can play in Kirkwood.

This study's conclusion is that renewable energy is feasible for Kirkwood. From 5% to 20% of Kirkwood's electricity demand can feasibly be satisfied by renewables. Scope and type depend on the larger in-valley/out-valley decision. If an in-valley decision is made, renewables can be combined with newer "firm power" technologies and energy conservation to create a full "hybrid" solution. Importantly, some portion of heating needs can come from renewable resources, independent of the electricity decision.

While the scope and types of renewable and alternative energy will depend on an in-valley or out-valley decision, this study does not evaluate the out-valley effort. In addition, this study has not evaluated the cost of an integrated hybrid in-valley solution. This should be a next step, to provide a solid basis for an in-valley/out-valley comparison and decision.

Feasible Technologies

We believe the following technologies to be technically, politically, and economically feasible for Kirkwood:

- Energy efficiency measures that reduce overall demand.
- Combined Heat and Power (CHP) Microturbines (propane) in larger buildings and complexes.
- Microturbines (diesel) in a central powerhouse.
- Solar installations, 2 KW to 50 KW each.
- Wind installations using 100 KW turbines, up to about 10 total.

The following may be feasible and should be studied further:

- Larger scale wind installations (if an in-valley decision is made; including storage).
- Hydro power from Caples Lake (if an in-valley decision is made).
- Geothermal energy for heating homes and condominium complexes (homeowners should study economic feasibility on a case by case basis).
- Solar for domestic hot water for individual homes or buildings.
- Active solar for space heating, analyze on a case by case basis.

The following are probably not feasible for Kirkwood today:

- Larger scale solar installations.
- Biomass (wood to steam) generating plant.
- Community-wide geothermal.
- Anaerobic digestion to produce methane to use as a fuel.
- Fuel cells.
- Gas turbines.
- Spark Ignition engines.

Energy Goals Needed

To ultimately evaluate how the various feasible technologies can be combined into an integrated hybrid system, we believe a set of community-wide energy goals is needed, expressing reliability, cost, and environmental goals and a long term energy vision for Kirkwood. These goals and vision could also be used to evaluate an out-valley solution. We recommend that a set of goals be established and used as a basis for creating and monitoring a long term energy solution for Kirkwood.

PART 1 BACKGROUND

Some Basic Terms and Abbreviations

- **Electric power** is expressed in watts (W). 1,000W equals 1 Kilowatt (KW). 1,000 KW equals 1 Megawatt (MW).
- **Electric energy** is power supplied over time, expressed in watt-hours (WH). 1,000 WH equals 1 KWH. 1,000 KWH equals 1 MWH.
- **The cost of electricity** is usually expressed in cents/KWH.
- **Use of propane** in Kirkwood is measured and billed in Cubic Feet (CF). It is purchased by the utility in liquid form, the utility converts the liquid propane to gas and distributes the propane gas to homes through a network of gas lines.
- **The British Thermal Unit** (BTU) is a common measure of energy, whether electricity or gas. BTU's used over time are expressed as BTU hours or BTUH. Useful equivalencies are:
    - 1 KW of electricity = 3,412 BTU's
    - 1 CF of propane = 2,500 BTU's
    - 1 Gallon of propane = 91,000 BTU's
    - 1 Gallon of diesel = 139,000 BTU's

Energy Consumption in Kirkwood

Kirkwood's annual consumption of electricity is approximately 8,000 MWH, used as follows (this data is derived from several sources so is only approximate):

- Resort: 4,800 MWH
- Residents: 2,400 MWH
- PUD: 800 MWH

All electricity is generated by diesel generators except for solar shingles on one residential roof. Peak demand for electricity requires approximately 4MW of power.

Kirkwood's annual consumption of propane is 500,000 to 530,000 gallons or approximately 19,000,000 CF.

In 2008, the average cost of electricity for residents was approximately $0.54/KWH. So far in 2009, the average cost has been about $0.36/KWH, but rising above $0.40/KWH through the summer months. The average cost of propane for residents in 2008 was approximately $0.075/CF. So far in 2009, average cost of propane has been about $0.09/CF.

Kirkwood's Specific Plan allows the addition of 600 - 700 new residential units beyond what is already built, and over 100,000 square feet of new commercial space. These developments will create additional energy demands. The Specific Plan predicted these demands would require over 8MW of power capacity and reach 21,000 MWH of consumption at build-out, but actual demand is trailing these projections. The Specific Plan indicates that consumption in 2001-02 would be about 10,000 MWH, while actual 2008 consumption was only about 8,000 MWH, even with growth in the number of buildings between 2001 and 2008. This may be due to the economic slow down, but is likely also due to a longer term trend of conservation by both KMR and homeowners.

Seasonal Electricity Demand in Kirkwood

Kirkwood's demand for electricity varies from a high of 4MW at the height of ski season to a low of about 0.5 to 0.75MW during the summer. According to data in the Specific Plan, over 70% of electricity consumption occurs during the months of November through April. Recent data indicate that 14% of all electric consumption occurs in December, and less than 5% in June. Evaluating the feasibility of in-valley technologies needs to keep this wide variation in demand and consumption in mind.

Five Approaches to Our Energy Solution

We have studied technologies that can contribute to five approaches--not mutually exclusive--to an energy solution:

1. Use energy efficiently. Reducing energy demand may be the most economic way to "generate" electricity and heat.
2. Provide "Firm" power: Electricity that is available on demand, and which can be dialed up or down to closely match demand. Connecting to PG&E or implementing a power house solution with an alternative to diesel generators are examples of firm power.

3. Provide "As-Available" power: Electricity that is generated when the source, such as sun, wind or water is available to generate the electricity. For larger systems, storage (such as with batteries) of the electricity generated is required to create a match to demand.
4. Provide "Hybrid" power: A combination of firm and as-available electricity generation, to take advantage of renewable energy sources while assuring power when it's needed.
5. Provide alternative sources of heat: Develop renewable sources of heat such as geothermal, or capture heat that is normally wasted, such as the heat created when generating electricity.

Needed: Kirkwood Energy Goals

The feasibility of an energy solution should be evaluated against a set of goals that we as a community set for our energy future. From community discussions, we believe that goals are needed for energy reliability, energy cost, and impacts on our environment, particularly those associated with emissions of carbon dioxide and air pollutants such as oxides of nitrogen and particulate matter.

As a community we have not yet set energy goals, other than to express reliability as the most important aspect of an energy solution followed equally by cost and environmental impacts. Energy goals might take the form of:

Reliability Goals

- Electricity will be provided so that power outages will not exceed x events and y hours per year.
- Electricity provided will have stable voltage and frequency, with fluctuations remaining within industry accepted ranges, allowing proper and safe operation of electrical appliances, equipment, and connection of renewable energy sources to our grid.

Environmental Impact Goals

- The rate of energy use, measured in BTUH, shall grow at a maximum of x% of overall floor area growth in the valley. KWH of electricity consumed shall not exceed yy,yyy MWH at Specific Plan build out.
- We will not exceed xxxx metric tons of CO_2 emissions from generating electricity and heating buildings at Specific Plan build out.

Cost Goals

- Our electricity costs will not exceed xx cents/KWH in 2012, and will not increase faster than the state-wide average rate of increase in future years.

This goal format is just a suggestion. What's important is to set measurable goals against which different energy solutions can be evaluated, policies and programs established, and progress measured. In addition, projects aimed at achieving measurable community-wide goals can be a great basis for seeking grant funding from a variety of sources.

Note that setting long range goals is important with either an in-valley or an out-valley solution for electricity. Even with a distribution line built to connect to PG&E, we can strive to measure our overall use of fossil fuels versus renewable non-carbon resources.

Kirkwood's Regulatory Environment

The regulations relevant to this study are those established by:

- **The California Public Utilities Code**, which regulates the operations of special districts such as our KMPUD. For example, the Public Utilities Code contains sections that set forth what municipal utilities that provide electricity services must do to comply with the California Solar Initiative.
- **The California Air Resources Board (CARB)** is responsible for monitoring the regulatory activity of California's local air districts, including the Great Basin Unified Air Pollution Control District. CARB is the state agency responsible for developing state-wide programs that will achieve the 2020 greenhouse gas emissions reductions set out in Assembly Bill 32. CARB also establishes diesel fuel regulations.
- **The Great Basin Unified Air Pollution Control District** sets air quality regulations for Inyo, Mono, and Alpine Counties. It

enforces federal, state, and local air quality regulations, and is responsible for issuing permits for using diesel fuel.

- **The California Energy Commission (CEC)** is the State's primary energy policy and planning agency. It establishes energy efficiency standards, supports renewable energy programs, and is the state agency through which Federal stimulus funds related to energy will flow to cities and counties.
- **The Eldorado National Forest** surrounds Kirkwood. The local staff of the United States Forest Service regulates uses of the Eldorado National Forest. Of particular relevance to this study, any use of Forest land as a location for renewable energy facilities (such as wind turbines) would need to be approved via the Forest Service's application, environmental review, public hearing, and approval processes.
- **The California Public Utilities Commission (CPUC)** regulates investor owned utilities, including Mountain Utilities. It does not regulate municipal utilities such as KMPUD.
- **Alpine, Amador, and El Dorado Counties** regulate land use on all private lands within their county boundaries, except incorporated cities within the counties regulate their own land use (Alpine County has no incorporated cities; Amador County has several). Kirkwood is an unincorporated area that spans all three Counties.
- **The Kirkwood Specific Plan** establishes land use regulations for Kirkwood. It is an Alpine County ordinance but applies to all of Kirkwood.

Renewable Energy and the USFS

The USFS and the Eldorado National Forest staff would like to be supportive of renewable energy through use of USFS land. However, certain policies need to be observed, such as adherence to the Visual Resources Plan, respecting wilderness area requirements, and approval processes that require firm proposals, environmental reviews, and public hearings. There is potential to use USFS lands for larger scale renewable energy installations, but there is no assurance in advance of the normal review process that such installations will be approved.

Diesel and the Environment

A primary environmental concern about diesel generators are the pollutants that they emit into the air: oxides of nitrogen (NOx), carbon monoxide (CO), sulphur dioxide, and particulate matter. A second main concern is carbon dioxide (CO2) associated with global warming. A third concern is ground pollution caused by diesel spills.
In 1994, the EPA and the California Air Research Board collaborated to release a plan aimed at reducing the amount of diesel engine emissions. The program was a reaction to a government study on the effect of diesel emissions on overall air quality. The study identified that diesel emission levels of NOx, carbon monoxide (CO), hydrocarbons, and particulate matter were a substantial contributor to poor air quality in the United States. The program implemented the reductions starting in 1996 and continue over a 20 year period. *(From dieselserviceandsupply.com)*

In Kirkwood, the Great Basin Unified Air Pollution Control District provides permits that allow use of diesel fuel. Their permit process involves analysis of the health risks of installing and operating a particular type of equipment that runs on diesel fuel. To the extent that equipment cannot meet the strict standards established by the District, it's possible to employ the "Best Available Control Technology" (BACT) to control emissions to the greatest extent possible. In evaluating technology using diesel, the District's standards, requirements for "modeled ambient impacts," and BACT will all need to be understood.

PART 2 DESCRIPTIONS OF ENERGY TECHNOLOGIES

Introduction

This section of our report is organized by the several approaches to an energy solution for Kirkwood: Energy efficiency, firm power, as-available power, hybrid power solutions, and heating alternatives.

We have looked into the potential technologies that we think could be applicable to an in-valley solution for Kirkwood. In addition, certain of the technologies may also be feasible and/or required in conjunction with an out-valley (connection to PG&E) solution.

1. Energy Conservation

Experience in a number of communities indicates that a 30% reduction in energy use within buildings is achievable with economic paybacks. Energy reduction is generally recognized as the cheapest form of energy "generation."

A first step in an energy conservation effort is often an energy audit, using tools and analysis that pinpoint sources of heat loss and inefficient use of electricity. Typically, the following aspects of cold climate buildings can be economically retrofitted to improve energy efficiency, according to research done by Peter Millar:

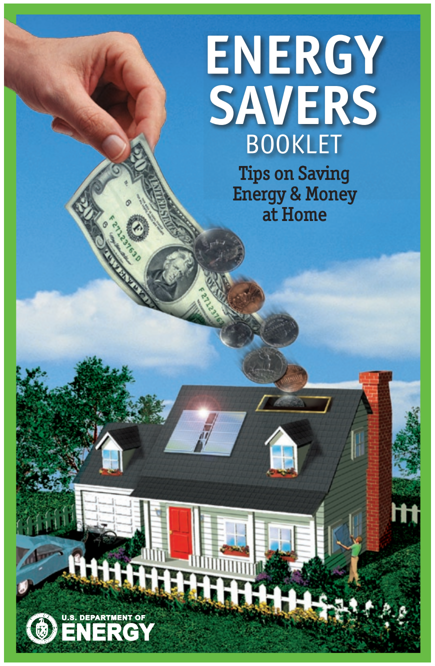
1) Air leak sealing
2) Duct sealing; rework/resizing of ducting
3) Insulation
4) Insulation of hot water tanks and lines
5) Replace incandescent with fluorescent
6) Setback thermostats/controls
7) Window coverings/shades

And if people have a little more to spend:

8) Upgrade of HVAC/hot water equipment
9) Appliances

All new buildings in California need to conform to the energy efficiency standards contained in the State's Title 24. This represents a minimum standard. The Building Performance Institute (BPI) has established a set of building standards and certification programs that have been adopted by a number of communities to improve building energy use. Ron Clark, the "guru" of Building Science in the State of Nevada, recommends adoption of BPI technical standards and implementation by certified professionals.

The CEC has established a Home Energy Rating System (HERS). Using the HERS Index, a certified HERS rater evaluates the projected energy efficiency of a home. An index of 100 is the "reference" home, and a 1% *increase* in projected energy efficiency results in a 1 point *decrease* in the index. Thus, an index of 85 is 15% more energy efficient than an index of 100. Our community may want to establish a HERS index that new homes must meet before connecting to our energy systems; and perhaps an incentive program to encourage owners to improve the HERS index of existing homes.



Energy Pamphlet by US Department of Energy

2. Firm Power

Connection to PG&E

Connecting to PG&E would be via a new KMPUD distribution line built along an underground route parallel to or within Highway 88. Total distance of the new distribution line would be about 25 miles, including upgrading an overhead line that extends from Salt Springs Reservoir to Highway 88. Of the 25 miles, 20 - 22 are “easy” construction (estimated average construction cost $1 million per mile). 3-5 miles are “difficult” with unknown costs, now being analyzed. Additional costs would include environmental review (currently underway), engineering, and project management. Future widening and realignment of Route 88 may require re-routing of portions of the electric line at additional future cost.

An evaluation of this electricity solution is a separate effort by KMPUD. It is the alternative against which the benefits and costs of in-valley solutions will be compared.

One significant difference between the out-valley solution and an in-valley solution that is relevant to this study is that the out-valley solution will depend on relatively high demand for electricity, so that the cost of the project can be amortized over many KWH’s and to generate sufficient revenue to pay for the bonds that will need to be issued to finance the project. An in-valley solution on the other hand will depend in part on reducing both peak demand for and consumption of electricity. Reducing peak demand will allow smaller initial investments. Lower consumption will decrease amounts of fuel purchases required for the firm portion of the energy solution.

People will discuss and debate the relative merits of out and in-valley solutions. We do not evaluate the connection to PG&E here, nor compare it with in-valley possibilities.

Power House Alternative: Microturbines

Various technologies are being used elsewhere as alternatives to diesel generators. These technologies are not necessarily “mature” in the sense of being widely used. However, they have a growing presence in the marketplace, and may have good potential for Kirkwood.

A good example is microturbine technology. Microturbines are small combustion turbines that recover heat from exhaust gas to boost the temperature of combustion and increase efficiency. Different types of microturbines are available, some that burn liquid fuels such as diesel, kerosene and biodiesel, and others that burn gas fuel such as natural gas, propane, and methane biogas (see the later section that discusses anaerobic digestion).

Microturbines are available in a wide variety of generating capacities. This modularity would be very important in Kirkwood, enabling both adding generating capacity as demand grows, and efficient operation by shutting down multiple modules during the summer and running most or all of the modules during the winter.

Units that are installed to only generate electricity run at efficiencies that can be better than or approximately the same as diesel generators. Their benefits in Kirkwood would be the modularity and flexibility in seasonal operations described above, and low emissions compared to diesel reciprocating engines (which we have today).

Microturbines, however, gain a huge efficiency advantage when they are used to both generate electricity and capture heat through exhaust heat recovery to heat water or for other uses. This is referred to as Combined Heat and Power (CHP) or “co-generation” and is a type of technology that is encouraged by the CEC. It appears that the most successful uses of microturbines are in individual buildings that can use both the electricity generated and the heat captured. It may be that microturbines could be used in this way in the cluster of PUD buildings, in the Main Lodge (where the heat could also help with melting snow on the plaza), in Red Cliffs Lodge, or in any larger building or complex of buildings.

As a central source of electricity and without the efficiencies of CHP, the feasibility of microturbines will likely depend on the ability to use diesel, which is less expensive than propane, while still meeting emissions requirements. Microturbines running on diesel do a better job with emissions than do diesel generators, but California continues to increase emissions standards that discourage using diesel fuel.

Photo of Capstone Microturbines

Several other important points about microturbines:

- Microturbines intended for CHP need to be the type that burns gas, such as propane, rather than liquid fuel, such as diesel.
- Microturbines are not inherently great at following changes in power demand. However, companies like Capstone have developed microprocessor based controllers that allow the units to respond to changes in load, and in the case of very large surges (such as when a ski lift turns on), capacitors can be included to allow the microturbines to respond effectively.
- Microturbine power output declines with gains in altitude. At 8,000 feet power output declines from the manufacturer's stated output by 20 to 25%, though this "derating" is less at lower ambient temperatures. For example, a set of modules rated for 1 MW would produce about 800 KW of power in Kirkwood.
- Microturbines are less noisy than other combustion engines.
- An example of a higher elevation installation of microturbines is at the Sierra Nevada University Environmental Sciences building in Incline Village. Their engineer reports that the system operates reliably with low maintenance costs.

Power House Alternative: Combustion Engines

Two other alternatives to diesel generators but that also burn some form of fuel are gas turbines and internal combustion engines that use a spark (rather than diesel's heat of compression) to ignite fuel. These are referred to as "SI" engines for Spark Ignition.

Gas turbines are typically large units (generally rated in megawatts of capacity), and seem to mostly be designed to burn natural gas. Gas turbines are like jet engines, and are similarly noisy. For these reasons: typical size, use of natural gas, and noise, we do not think gas turbines are feasible in Kirkwood.

As with gas turbines, SI engines generally use natural gas, and are generally available in larger capacities than appropriate for Kirkwood with our wide changes in seasonal demand. We therefore think that SI engines are also probably not feasible in Kirkwood.

Our investigation of gas turbines and SI engines has not been exhaustive, so if a response to an in-valley RFP were to include either of these technologies, it would be worth review and consideration.

Power House Alternative: Fuel cells

Fuel cells use an electrochemical process to convert the chemical energy of hydrogen into electricity (and water). Fuel cells use hydrogen that is extracted from natural gas, methane or bio-gas (such as from the "digestion" of wood chips). The Sierra Nevada Brewery near Chico, CA uses fuel cells driven by natural and bio-gas to both generate electricity and create heat for brewing operations.

From what we have learned so far, issues of fuel source, system costs, and concerns about system durability are likely to make fuel cells infeasible for Kirkwood today.

Power House Alternative: Methane from Anaerobic Digestion
Anaerobic digestion is a process of recovering methane from solid wastes. It occurs in three basic stages as the result of the activity of a variety of microorganisms. *(from the U.S. Department of Energy website).* Methane is odorless and colorless; it's the primary component in the natural gas used in many homes. It is an excellent fuel to use to generate electricity.

Capturing methane from solids requires an anaerobic digestion facility:

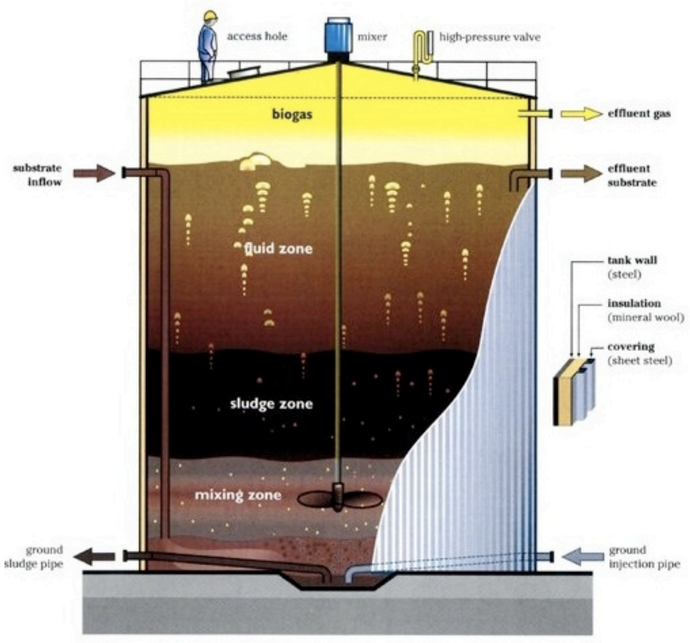


Diagram of an Anaerobic Digester
(from the Encyclopedia of Alternative Energy and Sustainable Living)

Today, KMPUD uses aerobic digestion to treat waste water, and trucks treated solids to a landfill. At this point we do not yet know the feasibility or potential costs of converting to an anaerobic process, nor do we know if the volume of solids is sufficient to capture the quantity of methane that would be needed to operate a generator or microturbine (we suspect that our volumes are too low to merit installation of an anaerobic digester).

Anaerobic digestion requires a relatively constant temperature of either 100 or 130 degrees. A benefit of microturbines would be the ability to capture heat from electricity generation to provide heat to the digestion process. Also, methane generates low levels of CO_2 (similar to natural gas) and can be stored on-site at low pressure.

Biomass
California currently has more than 30 generating plants that burn wood fuel to create steam to drive turbines and generate electricity. It is a proven technology, but lack of a steady, reliable source of wood from mills and forests has prevented any new plants from being built in the past 18 years (in fact a number of plants have closed). The Eldorado National Forest has a substantial amount of fuel to dispose of annually, so it seems that biomass for Kirkwood would be a possibility. However, a variety of environmental concerns and the need for about 20 acres of land probably make a biomass generating plant infeasible. In addition, while biomass generation is included under firm power, this type of generation is not very responsive to wide fluctuations in demand, so may not match Kirkwood's seasonal demand very well.

3. As-Available Power

Solar Energy
Kirkwood provides a very good environment for electricity generated by solar photovoltaic (PV) cells, as long as snow can quickly shed (or melt) from the panels. Kirkwood's many sunny days year around, cool weather, and the reflectivity of snow allow south-oriented panels to generate an estimated 1600 KWH per KW of panels.

Four conditions need to be satisfied to get the most out of solar panels: southerly orientation, slope steep enough to quickly shed snow, no or minimal shading from trees, and for roof mounted panels, metal roofing to avoid the damage that ice dams can cause to shingled roofs. Membrane or “peel and stick” solar materials may allow solar to be installed on roofs with shallower slopes than needed with glass-faced solar panels.

Four solar installations in the Kirkwood area show the viability of solar: Al Graf’s house (solar shingles on a steep roof), Caples Lake Resort (solar panels on metal roof), Schneider CalTrans Station (pole mounted), and on land near Caples Lake (pole mounted).

Solar Panels Near Kirkwood

A technical challenge with solar is how to store the electricity generated if the electricity is not immediately needed. Most commonly, this electricity is fed into the grid. Batteries can also be used. However, if the solar installation is relatively small such that all electricity generated can be used, storage is not an issue (in a sense, delivery to the grid is a kind of “storage”).

Another challenge with solar is visual impact. While California’s Solar Rights Act minimizes the ability to restrict solar installations based on visual impact, it is nevertheless an issue to consider.

Large installations of solar panels are difficult for Kirkwood because of the large area of land needed: approximately 8 - 10 acres of south facing land for 1MW of solar panels. Most likely, a large installation would need to use land within the Eldorado National Forest. We believe that gaining approval to use a large area of land close to but not within Kirkwood would be difficult.

Smaller installations of 10 to 50 KW should be possible adjacent to or within parking areas. In addition, there could be incentives that encourage future home owners and developers to design their buildings to accommodate solar from the beginning. When KMPUD becomes the electricity provider for Kirkwood, it will need to comply with the portion of the Public Utilities Code that incorporates laws associated with the California Solar Initiative. Specifically, KMPUD will need to provide financial incentives for installation of solar generating systems. These incentives could be a vehicle by which solar on new buildings is encouraged.

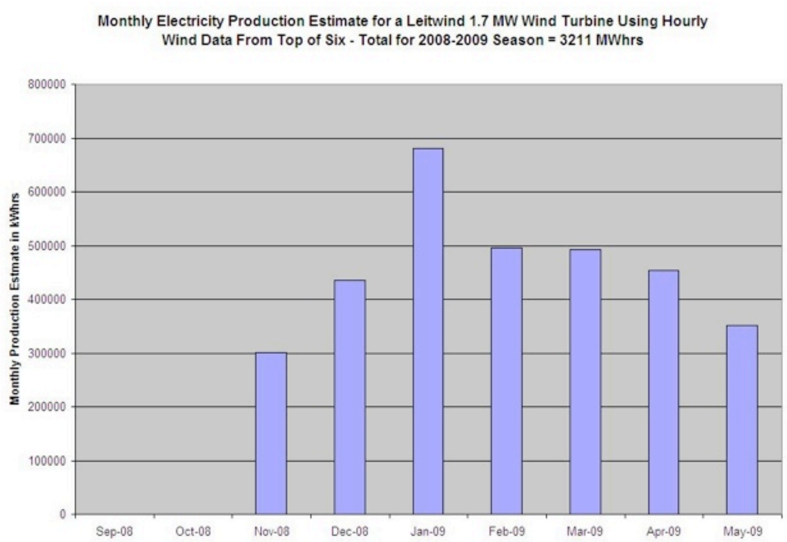
Wind Energy

Kirkwood’s ridges provide very good wind energy potential. Winds are frequent, with a relatively high average speed. Wind is greatest in the winter when demand for electricity is highest.

Winds within the valley may not be constant enough to justify wind turbines. Caples Lake Resort has installed a wind turbine, and we will learn more about the viability of wind turbines placed at “lower” elevations from that installation.

Wind turbines on or near ridges will need to meet the Eldorado National Forest requirements for visual impacts. It is unknown at this time whether placement of turbines and/or mitigations can satisfy visual impact policies. Some study of this has been done by a vendor, Synergy Power, engaged by the Resort in 2008. Their study and discussions with Forest staff indicate that a location near the top of Chair 2 might work, both for wind exposure and to satisfy visual requirements (assuming turbines no taller than about 100 feet).

Wind turbines need to be installed with turbine blades above areas of air turbulence. For our high wind ridges, this probably means blades at least 80 feet above the ground. Wind turbines of this height would probably provide about 100 KW of power each. Turbines in the 200 foot tall range can generate well over 1 MW of power each. Using wind data collected by the Resort at the top of Chair 6, Al Graf has calculated that a single 1.7 MW wind turbine could generate as much as 3,200 MWH from November to May, with the generation profile roughly matching the pattern of demand during ski season (this type of wind turbine is planned for installation in Aspen and will need to be approved by the USFS there. This may give us guidance on the approval process with the Eldorado National Forest).



As with solar, wind energy either needs to be used or stored. And as with solar, if the installation is small enough, storage is simply “within the grid.”

Regarding visual impact, Peter Baltay has produced a photo simulation showing what a 200 foot tall wind turbine would look like on the ridge above Kirkwood (image is included separately). While skiers near such a turbine would sense its full size, the visual impact from the valley is surprisingly muted. Our mountains are large and appear able to absorb the presence of objects like wind turbines.

Wind turbines face other challenges in Kirkwood’s environment. Wind speeds above 140 to 150 mph can be destructive, as can excessive icing. There are wind turbines on the market that claim to resolve these issues. Also, a type of wind turbine called vertical axis wind turbines can withstand higher winds than propeller (horizontal axis) turbines, and may be able to be installed on shorter towers and take up a smaller footprint. An encouraging note is that a 1.5 MW wind turbine has been operating successfully at Jiminy Peak ski area in the Berkshire Mountains, on a high wind ridge top; and the three turbines planned for Aspen will also be exposed to high winds.

Hydroelectric Power

The water district in El Dorado County, in conjunction with the El Dorado Irrigation District, has studied the possibility of generating electricity at the Caples Lake dam. We have not seen the final report, but the report’s author Rick Lind has let us know that while a hydroelectric project at Caples Lake is not one of the “top ten” for EID, it does have the potential to generate up to about 300 KW of power. Up to 200 KW of power would be available to Kirkwood, with a minimum of 100 KW during lowest flows. Overall, according to Rick, Kirkwood could expect about 800 MWH of electricity annually, or approximately the amount of electricity consumed by KMPUD each year and 10% of all current electricity consumption in Kirkwood.

We don’t know what the cost of buying electricity from EID would be, though early indications are a price in the range of $0.40/KWH. In addition to paying EID for electricity, KMPUD would be responsible for installing a transformer and line from the dam to the spillway closer to Kirkwood, a distance of about a mile, where Mountain Utilities has a high voltage line that connects MU power to pumps that pump lake water to the Resort for snow making.

Hydroelectric power can also be provided in conjunction with wind turbines. When wind turbines are generating more power than is needed, the power can be used to pump water (such as treated water from our waste water treatment plant) up to a storage tank (possibly to a new, larger tank at the old water tank site above Danberg). This stored water could be released through a pipe or "pen stock" when needed to drive a turbine that generates electricity. Whether this would be economically feasible needs to be part of a more detailed study in conjunction with wind energy.

4. Hybrid Power Solutions

A combination of firm and renewable energy sources can create economic energy solutions. Initial investment is somewhat redundant, because the firm power portion of the solution needs to be able to meet total demand. For example, if Kirkwood requires 4 MW of power to meet maximum winter demand, this amount of generating capacity would need to be provided by firm sources. Additional investment in wind turbines or solar panels for as-available power would then be redundant.

The economic benefit of this approach stems from the fact that the main cost of the firm power over time is the purchase of fuel rather than the initial investment. This is particularly true in Kirkwood, given high costs of diesel and propane. If the renewable portion of the solution reduces fuel purchases significantly enough, such a hybrid solution is both economic and "green."

A hybrid is the most likely candidate for an in-valley power solution. The very large variation in seasonal demand for electricity can represent a challenge, but also an opportunity to match different kinds of generation to the seasonal situation. For example, in summer when demand is low and sunlight is a near daytime constant, solar might play an important role. When winds are stronger and nearly always present in the winter, wind turbines might be a good complement to firm power, reducing the amount of fuel that needs to be burned. It could be that a combination of centrally located diesel microturbines, distributed propane CHP microturbines, solar panels and wind turbines is a hybrid solution that is responsive to Kirkwood's unique situation.

5. Alternative Heat Sources

Geothermal Energy

With the Geo Exchange system, the Earth's natural heat is collected in winter through a series of bore holes, called a loop or a "wellfield". Geo Exchange systems have very high efficiency and relatively high initial cost. The electric operation of the system's pumps must be kept in mind with these systems. At 40 cent+per KWH in Kirkwood, the system is approximately break-even on an operating basis, compared with traditional boilers using propane (at today's cost). If kWh prices drop or if combined with solar roofs, geothermal can potentially be an attractive choice for heating.

One home in Kirkwood uses a Geo Exchange system, primarily to avoid the hazard potential of propane in the home. Geo Exchange systems run completely on electricity, eliminating propane.

Of the several types of systems, vertical bore ground loop is most likely for Kirkwood. Our area generally appears to have soil and water characteristics appropriate to installation of Geo Exchange. A prime local example of a working vertical bore Geo Exchange system is the new Truckee Middle School. The 100,000 square foot school is fully heated and cooled using a vertical bore system. Other examples of successfully operating vertical bore systems include many private residences in the Western Sierra mountain area.

The vertical bore holes used in Geo Exchange are typically drilled in the range of 4 to 6 inches in diameter and from 150 to 600 ft deep. The holes are fully grouted with a hole-sealing mixture of self-expanding diatomaceous earth from top to bottom, sealing the complete hole. The same approach is used in water well capping to prevent surface water contamination of the drinking water supplies. Factory-joined, engineered plastic tubing, similar to that used for buried gas lines, is run to the bottom and back out the top of each hole prior to grouting. The system of bore holes is interconnected with further lengths of tubing into a system which is then hooked up to the equipment serving the home or buildings. An antifreeze solution is used to provide heat exchange while ensuring that the fluid in the bore holes does not freeze. The antifreeze is food-grade and non-toxic. There is no reason to expect any leakage of fluid from the sealed holes or contamination of the outside soil.

The fluid circulating in the loop carries the earth's heat to the home or building. An indoor Geo Exchange system then uses electrically-driven compressors and heat exchangers using the same principle employed in a refrigerator (but operating in reverse)--to concentrate the Earth's energy and release it inside the home or building at a higher temperature. The system is versatile and can work with radiant (hydronic) heat and forced air delivery systems.

Geo Exchange equipment provides heating and cooling at extraordinary levels of efficiency when properly designed and installed. The load requirements of buildings being heated must be known including all aspects of infiltration loss, ventilation, envelope and use. Heat pumps can operate at over 400% efficiency, compared to carbon-base fuels which have maximum efficiency in the 90+% range. To achieve this extraordinary efficiency Geo Exchange systems MUST be properly designed, matched to the loads, and all efforts made to eliminate unnecessary electrical pumping cost. Geo Exchange can be cost effective because it uses energy so efficiently. For this reason the EPA, US Department of Energy, and the California Energy Commission endorse it.

Combined Heat and Power

As discussed in the section about microturbines, the ability to simultaneously generate electricity and capture heat from the generation process that is otherwise wasted is referred to as combined heat and power (CHP) or co-generation. CHP dramatically increases the efficiency of the fuel being burned to generate electricity, creating strong economic and environmental benefits.

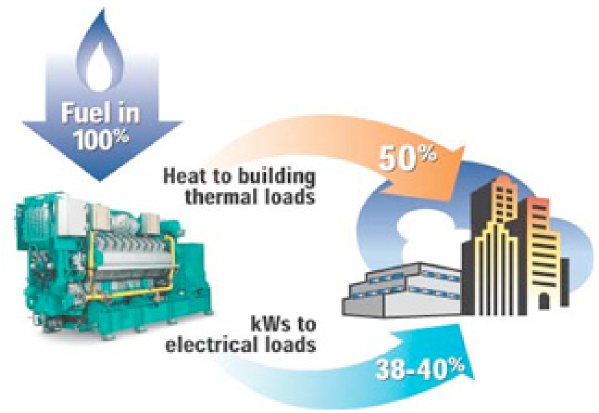


Diagram from Integrated Power Systems International

CHP is possible with a variety of combustion technologies: gas turbines, microturbines, and even diesel generators. One key is to have the source of combustion close to where heat is needed, or a way to move the heat to where it is needed. In Kirkwood, that likely means that the generator would need to be in or adjacent to the buildings where the heat would be used. Microturbines are the most likely technology to use for CHP, since microturbines are available in relatively small physical sizes (to fit within existing or new buildings) and are only moderately noisy compared to other combustion engines. In addition, whereas other generators create very high heat (appropriate for industrial processes, for example), microturbines create a lower level of heat in a range more appropriate for heating water, hydronic heating systems, and snow melting systems.

If microturbines make sense for generating electricity in Kirkwood, some modules should definitely be fitted with CHP capability and placed in or adjacent to our larger buildings and complexes.

Solar Domestic Hot Water

Heating water with the sun's energy is an old, proven technology. Today, two types of systems are used: flat plate collectors, which are glass faced "boxes" with pipes that carry a glycol/water solution to capture heat from the sun (the glycol prevents freezing); and evacuated tube collectors, which are empty tubes with a fin configuration that heats up and transfers the sun's heat to a "header" that is filled with the glycol/water solution. In both cases, the heat collected is transfered to a heat exchanger which in turn heats water in a water tank.

Typically, the flat plate collectors are mounted on roofs, or on racks secured to roofs. Evacuated tube collectors can be hung vertically on exterior walls, which is an attractive possibility for homes in snow country. According to one provider, mounting structures can be designed for high wind loads, as long as they can attach to solid building structure.

For a home occupied by 2 people, 2- 4 ft. x 8 ft. flat plate collectors set at about a 40 degree vertical angle will do a good job of providing much or most of the domestic hot water needed.

The technical issues in Kirkwood that need to be addressed are primarily snow load and how to manage the heat generated in homes that are often unoccupied.

Typical flat plate collectors include large sheets of glass that are not well enough supported to handle heavy snow. We have heard of two solutions: an Austrian company that has designed a product for heavy snow; and an American company that makes smaller units so that the glass panels span smaller distances (4 ft x 6 ft). And of course the evacuated tube systems hang vertically, so they do not have a snow load problem.

Typical water heaters are not designed for very hot water. The heat that is collected each day by the solar systems needs to be used or "dumped" somewhere. If too much is dumped into already hot water, tanks and pipes can be damaged. If a home is continuously occupied, this is not an issue; the hot water is used. If long periods of time go by without the water being used, electronic controls and other means need to be employed to manage the excess heat (such as dumping to cool night time air). This is apparently possible, but adds cost to the system.

A good candidate for solar domestic hot water would be a home with a roof steep enough to allow panels to be at the correct angle and in the right orientation to both collect heat and shed snow; or with adequate south facing wall space; and that is intended to be a mostly occupied residence.

Flat Plate Collectors (from Tahoe Solar Designs Website)

Active Solar for Space Heating

This technology is essentially the same as for heating water, but requires more extensive collectors, controls and storage. Peter Baltay has recently analyzed active solar for space heating for a new home, and concludes that while feasible, such a system may require about 1SF of collector area per 5SF of heated area in Kirkwood; an extremely thermally efficient home (triple glazing, R-50 insulation); some passive heating; and a method to heat the home during extended stormy periods. Active solar for space heating may be feasible for new homes designed with this system in mind, but probably not feasible as a retrofit to existing homes. We believe that feasibility should be based on a case by case analysis.

PART 3 FEASIBILITY SCORING

In the absence of articulated energy goals, we have chosen to evaluate the technologies through assessments of the technical, political, and economic characteristics of each. We have assigned a score of 1 (negative) to 10 (positive) for each characteristic associated with each technology, and then averaged the scores for each technology to express an overall feasibility score. This approach results in a reasonable guide for which of the technologies should be pursued further, and which should be "shelved" at this point. The following Table provides a summary of our conclusions.

Feasibility	Small Scale (Up to 100 KW)	Large Scale (100 - 1,000+ KW)
High (Include in Roadmap)	***For Individual Buildings*** • Energy Efficiency • Solar PV • CHP MIcroturbines (Propane) ***For Community Service*** • Solar PV • Wind	***For Individual Buildings*** • Energy Efficiency • CHP MIcroturbines (Propane, up to 200KW if demand justifies) ***For Community Service*** • Microturbines (Diesel)
Moderate (Research Further)	***For Individual Buildings*** • Geothermal heating • Solar domestic hot water • Solar for space heating	***For Community Service*** • Wind (possibly including storage using water tanks) • Hydro from Caples Lake
Low (Do Not Pursue at this time)	***For Individual Buildings*** • Wind	***For Community Service*** • Solar PV • Geothermal heating • Biomass (Burn wood) • Fuel Cells • Anaerobic generation of methane • Gas Turbines • Spark Ignition Engines

PART 4 CONCLUSIONS

Our conclusion is that a number of renewable and alternative energy resources are feasible for Kirkwood. From 5% to 20% of Kirkwood's electricity demand can feasibly be satisfied by renewables. Scope and type depend on the larger in or out-valley electricity decision. In-valley, renewables can combine with newer firm power technologies and energy conservation to create an integrated hybrid solution.

Some small scale power technologies (see adjacent table) are feasible independent of the electricity decision. Geothermal and solar heating decisions are also independent of the in/out valley decision.

If an in-valley decision is made, the solution should be an integrated hybrid power system comprised of the large scale technologies combined with the smaller scale resources. The high feasibility technologies are great candidates for a hybrid system, and the moderate feasibility technologies could also work well, depending on what further research determines (research will need to focus mostly on costs. For large scale wind, the focus should be on storage and Eldorado National Forest approval). A key to the economics and environmental impacts of a hybrid system will be a well supported energy efficiency program. Also key will be cooperation between KMPUD, KMR, and the Eldorado National Forest.

Our conclusions include the following recommendations:

1. That the KMPUD Board with community participation establish goals, targets, and a long term vision for energy reliability, costs, and environmental impacts in Kirkwood.
2. That a consulting engineer be retained to develop a feasible hybrid solution for Kirkwood, including estimates of initial and on-going costs.
3. That this Committee develop a quicker "ball park" cost estimate, to better understand the detail of a hybrid system roadmap.
4. That we use existing MU and PUD sources to develop baseline energy use data against which new goals or targets can be set.

PART 5 APPENDIX

The following table shows overall scores for each technology. A score of 7.5 and above to mean highly feasible, and a score of 6.0 or below not feasible at this time.

Technical **P**olitical **E**conomic

Technology	T	P	E	Total
Energy Efficiency*	9.5	10	8.0	**9.2**
PV Solar, Small Scale*	8.0	9.5	7.0	**8.2**
Microturbines, CHP	8.2	9.5	6.3	**8.0**
Wind, Small Scale*	7.7	7.5	7.3	**7.5**
Microturbines, Pwr Only	7.7	8.8	6.0	**7.5**
Solar Water Heating*#	6.2	7.3	7.0	**6.8**
Hydro, Caples Lake	7.8	7.3	5.0	**6.7**
Geothermal, Small*^	8.0	8.5	3.5	**6.7**
Active Solar Space Heat*	6.8	5.8	6.5	**6.4**
Wind, Large Scale*	6.3	4.8	7.3	**6.1**
PV Solar, Large Scale*	6.3	3.0	7.0	**5.4**
Anaerobic Digestion	3.5	9.5	3.0	**5.3**
Biomass (burn wood)	4.2	3.5	3.7	**3.8**

* Economics score assumes rebate and/or tax benefits
# Technical score for second homes. Primary homes score higher.
^ Economics score is for retrofit. Economics score for new building would be higher.

Scoring Criteria

Feasibility scores are based on the following criteria. Scores range from 1 (low, poor, or negative) to 10 (high, excellent, or positive). Note that the exact scores are not as important as conclusions about high, moderate, and low feasibility.

<u>Technical Criteria</u>

- Track Record: How proven is the technology?
- Performance: Will the technology perform optimally in Kirkwood?
- On Demand Capability: How responsive to changes in demand?
- Installation Ease: Unusual difficulties in Kirkwood?
- Operating Ease: Unusual difficulties in Kirkwood?
- Future Flexibility: Allow new technologies in future?

<u>Political Criteria</u>

- Land Availability: Is land or space readily available?
- Environmental Impacts: On flora, fauna, air, and visual impacts?
- Community Acceptance: Given impacts, how controversial?
- Approval Likelihood: Will the governing agency likely approve?

<u>Economic Criteria</u>

- Initial Cost: Cost relative to other available technologies
- Operating Cost: Cost relative to other available technologies
- Impact on Rates: Will the technology raise or lower community-wide rates vs. current average?

Appendix, Continued

Estimates of Scopes of Renewable Electricity Generation

The scope of renewable energy in Kirkwood will depend on the decision about whether our electricity will be provided through an “out-valley” connection to PG&E, or through development of a cleaner, more reliable system of “in-valley” generation than we have today. The Table in this part of the Appendix is based on the following:

Solar PV:

With an out-valley decision, we estimate that solar PV will be implemented to satisfy 2 1/2% of peak demand in compliance with the California Solar Initiative. For this purpose, we are using 5 MW as a peak demand and 125 KW as the likely total capacity installed. Although 1600 KWH per KW is our estimate of PV output under optimal conditions, some capacity will likely be installed in less than optimal conditions, so we use 1400 KWH per KW in this calculation.

With an in-valley decision, we estimate that solar PV will be implemented to a greater extent, supported by a more generous level of rebates or matching funds. However, the realities of geography, trees, and limited available land will still limit possibilities. We are using 200 KW as the likely total capacity installed. It’s likely that locations will be more compromised as capacity increases, so we use 1200 KWH per KW in this calculation.

Wind:

Overall we believe that visual impact issues will limit wind possibilities to 100 foot high turbines. Turbines we have seen at this height have about a 100 KW capacity each.

With an out-valley decision, we estimate 3-100 KW turbines installed, supported by tax benefits.

With an in-valley decision, we double this to 6-100 KW turbines installed, supported by rebates, matching funds, or funded directly as part of a hybrid system. We think it’s possible that up to 10 turbines could be installed, but our calculations are based on 6.

Al Graf has estimated the output of a 1.7 MW wind turbine, based on wind data from the Resort. Our calculations pro-rate output based on Al’s estimate. If further study and work with Eldorado National Forest staff enables larger turbines to be installed, then the percentage of power demand provided by renewable resources could increase substantially.

Hydro (Caples Lake)

We use the estimates provided by Rick Lind, author of the Caples Lake hydroelectric study.

Totals and Percentages

Current consumption of electricity totals under 8,000 MWH annually. We use as a total consumption 10,000 MWH, a 25% increase. The pace of renewable energy R&D and energy conservation is likely to quicken, given trends noted at the beginning of this report. Therefore we go out a shorter time horizon with a smaller total than the Specific Plan.

Renewable Resource	Out-Valley Decision		In-Valley Decision	
	Capacity	Output	Capacity	Output
Solar PV	125 KW	175 MWH	200 KW	240 MWH
Wind	300 KW	565 MWH	600 KW	1,130 MWH
Hydro	-	-	100-200 KW	800 MWH
Totals	425 KW	**740 MWH**	**900 KW - 1 MW**	**2,170 MWH**
Percent of 10,000 MHW		**7.4%**		**21.7%**