Renewable Energy Design

Buildings in the United States are responsible for upwards of 30% of our total energy consumption, and 68% of our electricity usage. This energy is used to heat and illuminate our homes, and also to run the appliances and equipment that we use to support our lifestyles. Energy comes in a variety of forms depending upon the location of our buildings: electricity, natural gas and propane are the most frequently encountered forms of energy that we use here in the Westerns States. These various types of energy are frequently extracted from non-renewable resources.

Electricity is produced on a large scale by releasing the energy content from one material and converting it into electrons, which are then delivered to our buildings via electrical transmission wires (the Grid). The materials that are of most commonly used as a source of energy are coal and natural gas. The production of energy from these sources contributes to atmospheric pollutants commonly associated with global warming. The conversion of these materials to electricity involves the combustion of the material in a boiler, using the heat produced to convert water into steam, and using the steam to turn a generator to produce electricity. This process is inherently inefficient for the following reasons:

1. Energy source materials are extracted (mined) frequently at great distances from the site of electricity production (the power plant);
2. A considerable amount of energy is expended in extracting the materials and then transporting them to the power plant (think coal mine / coal train and also natural gas wells and pipelines), resulting in system-wide energy loss;
3. The burning of these materials to convert water into steam and then turn electrical generators results in additional losses of energy in the form of waste heat and friction;
4. Energy loss is also registered in the transmission of energy from it's source to the end use in your building
5. Finally, the appliances that we then depend upon to use this electricity are frequently inefficient, resulting in additional loss of electrical efficiency.

All told, our centralized system of material extraction, shipment, conversion, and transmission is about 30% efficient at best – 70% of the energy is lost in the process! This is hardly a sustainable model. Further, as these materials become more scarce and as our demand for the energy produced by them increases, the price for these materials, and thus the power that their combustion creates, increases as well. Yes, there are other systems of energy production, such as nuclear energy, large dams, and even grid source renewable systems (wind farms, for example). Each is beset with a different set of problems.

What alternatives are available to you? As an architect and energy conservation and efficiency advocate, I would like to assist you in the overall evaluation of your energy use program. The best option for you may be to become your own energy producer, and to that end we can offer you assistance. Please consider the following tasks as a strategy for your own improved energy independence:

What do you have to work with?

1. You need to understand how much energy in the form of electricity and combustible fuels you use. If you're like me, you probably save all of your utility bills in a folder, only to archive them at the end of the year. If so, great! You're on your way to understanding your energy program. If you don't, that's probably okay, because your energy provider (Xcel, United Power, for example) very likely keeps that data for you. So, either locate all of your utility invoices for the past year, or contact your energy provider and get the information necessary. What you're looking for is your use, and the average cost. So, for electricity, you need to know how many kilowatt-hours (kWh) you use, and the cost. You should also determine the quantity and cost of other fuels (natural gas / propane), in the event that it actually would make sense to convert one or more existing energy use systems.

2. Consider how you use or propose to use energy. How is the lighting arranged? Do you have too much general lighting that could easily be converted to task lighting? Do rooms have multiple light sources so that you can tailor the lighting levels to the task at hand? What type of energy do you use for heat? Are there waste sources of heat that can be recovered, and how? Are there natural heat and light sources that can offset your loads. Answering these questions will help to direct you to answers for efficiency.

3. Now, consider opportunities for efficiency. Can your lighting be efficiently changed to LED or compact fluorescent luminaires? Do you use energy star appliances? Would occupancy sensors or automatic light switches work in certain rooms. Do you have missed opportunities to use natural daylight sources for interior illumination? Efficient use of your energy sources will reduce your need to purchase or create additional energy to heat, cool, and illuminate your home.

   Now consider your thermal boundary or envelope. What is the condition of the exterior wall, windows, doors, and weather sealants? An average home in America has enough holes in its exterior envelope to create a 5' by 5' hole in the wall. Holes are representative of energy, and money, lost to the exterior of your building. So, sealing these openings as best you can helps you to keep the warm or cool tempered air that you've created inside where it does the most good!.

   And finally, consider the potential for air stratification in your home or building. We all know that warm air rises, so it would be best in the warming months to have a system in place to provide for mixing of the air. Warm air can collect at the ceiling of grand spaces – a simple ceiling fan will cause enough turbulence to redistribute that warm air back to the occupancy zone.

What are the opportunities and constraints associated with your site and building orientation?

4. Having already considered saving energy and capitalizing on natural sources, you now need to move into the production portion of the equation. If you intend to install a photovoltaic or thermal system to create energy, you need to know how it would be best done. To save money and ease the access to your system, consider ground-mounting them. This usually works only if you have a large site with plenty of open land that is unobstructed by nearby structures or mature trees. In more developed areas, and those

populated by dense vegetation, a roof-mounted location for the system is best. Access is more difficult, but the higher position helps to remove obstructions and create more energy, all the while using no ground space which is better suited for other uses.

For a roof mounted system, consider the best orientation for your array to be mounted. What is the pitch of the roof? Are there obstructions in the form of flues, chimneys, and vent caps that would impact an array field? What is the orientation of this or these faces relative to due South? How much unshaded space do you have left over?

5. Now, consider present and future obstructions. Are there buildings or trees that will ultimately shade your site? Is the topography flat, or is there a steeply pitched hill on the orientation side of your home? If there are obstructions, or will be, can they be changed or integrated into your total design scheme – such as tree pruning or removal?

6. Having mapped the best site and rooftop locations and determined if you have any obstructions, what is left over for the space we call the primary aperture (your exposure and orientation to south)? This space is the best, least shaded portion of the roof that would efficiently support a solar array. By efficiently, we mean contiguous. An array will be easier and less costly to install if it is higher on the roof, unshaded, and reasonably rectilinear.

What configuration and size of system will meet your present, and future, load?

7. Armed with your present load, a sense of how efficiency upgrades may help, and the potential area for a rooftop array, you can begin to size a system to meet your needs. First of all, how much of your needs do you want to offset? If you have a very large load, it may not be possible, or practical, to design a system to meet your total load. Be reasonable – aim as high as you are comfortable – you can always scale back, and, in some situations, you can phase power in over time if you want to.

   Consider panel sizes and other equipment. Solar panels have a DC power rating. Coupled with your aperture roof pitch, panel size and quantity will determine how well you are able to meet your needs. A few things to remember – lower wattage panels are less costly, so if you have a lot of roof space and reasonable aperture, then use lower power panels. Less space and less than ideal aperture will necessitate that you reduce your expectations for power generation, or simple install a higher performance and more costly panel.

   A word of caution – rebates from your provider are a contract with that provider to generate electricity for them. They are frequently tied to your ability in your location to convert a certain percentage of incoming solar radiation into usable energy. Less than optimal situations that produce lower than optimal power may not qualify for an incentive program. We'll calculate that for you as we design your system.

8. Consider alternative types of systems, such as AC panels, thin film systems, and others that are currently being developed. For example, if you intend to increase the size of your system over time due to a future load (a plug-in hybrid in the future, perhaps), then you'll have to make some decisions about the panel configuration and support equipment. A standard DC system with matched inverter size is not typically expandable, where an AC system may be. If incremental expansion is important, then an AC system may be the best choice for you.

How much money will the system cost, and how much energy cost will you save?

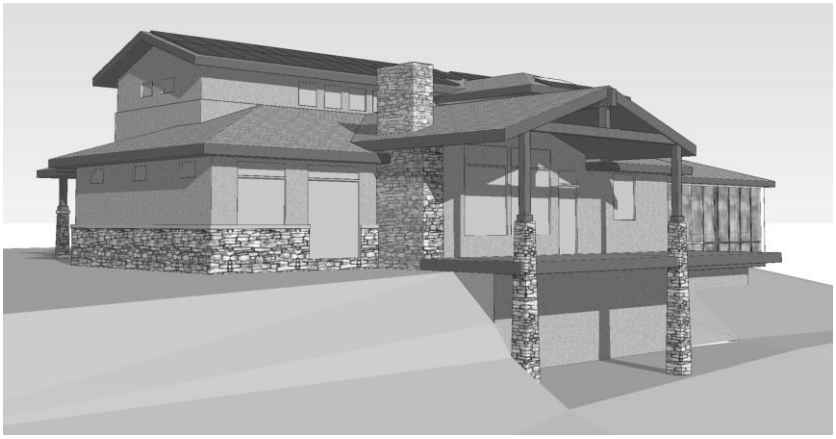
9. To get a total energy and cost picture, you need to do some financial analysis. Start with the total system installed cost – it can be staggering. Add to that the cost of financing – compounded interest can be substantial. Don't get discouraged yet!

   Then, factor in the incentive programs – utility providers are frequently offering rebates. Federal, State and Local governments are offering various tax credits (check it out – credits are not rebates).

   Then, be realistic about energy cost. Energy is delivered to your home at a certain rate per unit of measure – a cost in cents per kilowatt-hour. Energy costs are increasing now with inflation, and, due to extraction, transportation, and regulation, energy cost is anticipated to rise significantly in the near future.

   Look at a reasonable time horizon – we use 15 years, since that is the typical life of a power inverter. Consider the opportunity to "lock in" your energy rate – to flatten it out over time. Consider the increased value that the system will contribute to your home. Consider the reduced load you will be placing on your environment, and on the quality of life for future generations – what is the cost / benefit of that?

There's so much to consider – location, power consumption, orientation, obstructions, power cost, incentive programs. The best way to handle this is, as they say, one bite at a time.



We're here to help you. By our taking a comprehensive look at your energy use picture and identifying the best sources of energy (the energy not used) and system design, we'll determine the best, all-inclusive program of energy upgrades to meet your needs. With our extensive background in architectural and engineering design, we are trained in the tasks necessary to optimize your situation. With our plethora of contacts in the field of renovation, construction, and solar array installation, we'll get you the best cost and the right connections to the service providers that you need. We'll even manage the project for you by coordinating subcontractors, installers, and you, so as to get the necessary improvements and systems installed in a timely and efficient manner. And we'll help with the paperwork by securing rebates, the incentives, and by managing your budget.