The Energy Tree

The World We Face (and what to do about it)

For millennia mankind has increased its productivity and quality of life by harnessing energy. In ancient times this was quite literally through the harnessing of draft animals. An ancient proverb references both the consequences and benefits of this practice: "Where no oxen are the manger is clean, but much increase comes through the strength of the ox." Those with wealth and power harnessed other human beings as slaves. Sadly, such was the practice in the USA early in our history.

Some ingenious people were able to harness water power for the grinding of grain. This might be considered the first "kitchen" appliance, in that it replaced an activity commonly performed by women preparing food.

Others – most notably the Dutch – harnessed wind power for the pumping of water.

Water and wind power have their weaknesses. Water power was and is simply not available everywhere. Wind power although more widely available than water power, is intermittent, and varies greatly in its strength. Both of these are limited in their power outputs at any given location. If all the available water power in the rivers of the United States were harnessed, the total would still be a small fraction of our energy needs.

Energy on demand

The industrial revolution in England began with the development of steam power. Now whatever amount of power was needed could be produced wherever it was needed. The only requirement is that combustible fuel be delivered to the site (Let's forever ignore the exception of nuclear power in this discussion).

The need for fuel soon outstripped the ability of natural forests to reproduce trees, and thermal processes (to include the smelting of iron) turned to coal – and eventually oil.

As we fast-forward to our current period, we can see that there are additional issues. Land is devastated by pollution and mining operations, and we have delivery problems. We are forced into bad treaties and wars to insure the resources to meet our voracious energy appatite. Even without the political problems, our current practices are doomed. Oil wells are drying up, and other sources must ultimately follow. The world is increasingly controlled by those who control sources of fuel.

Consider the options

There are often questions with no good answers, and problems with no desirable solutions. In such cases, inaction is a choice, and often one of the worst. A willingness to face reality can steer around the default of inaction, and an intelligent analysis can reveal other options. A willingness to compromise can then make the best option available.

The reality is that the future will be different from the past. We won't have abundant cheap energy, we will use less of it, and we will pay more for it.

The next worst thing to inaction is to make reluctant incremental adjustments as the pressure increases. Legislation and economics are required to drive people into getting more efficient appliances and higher gas-mileage cars. These are good products by the way, and they do significantly contribute to the available energy, but each adjustment required is a reluctant imposition that ultimately fails to solve the real and looming problem.

Change is not an option

Again, the reality check: If/since we cannot close this gap with our current lifestyles, we will either change our lifestyles or suffer shortages. Take your pick: You won't be able to drive your car, electricity will only be on for a few hours a day, you won't be able to heat or cool your house, you won't be able to cook, two or more of the above.

Any of these would constitute a change in our lifestyle – albeit an involuntary one. Although energy costs have already began to increase alarmingly, an availability crisis may still lie in the future – unless a broken treaty, a war, a change in global politics, or a major natural disaster happens. In such cases, major shortages could happen at any time.

It would be far wiser to design a change immune to catastrophic loss and uncontrollable costs, and embrace it voluntarily.

A positive direction

The key word for future energy sources is "**renewable**." When the last drop or chunk of fossil fuel has been consumed, any source of energy we have will be that which is replenished in real time through nature. Such sources are considered "sustainable." For the most part, they consist of wind, water, and solar. Biomass, the burning of wood etc. is technically a category of solar.

With the exception of biomass, such sources cause no pollution directly. Indirectly however, energy usage and pollution are involved in the manufacture of equipment required to harvest wind and water.

Although the burning of wood creates CO_2, growing wood for fuel pulls this CO_2 out of the atmosphere, stores the carbon as energy, and releases the oxygen for us to breathe.

My father planted a one hundred fifty-foot row of eucalyptus trees so he would have wood to heat his home. The fall before the summer he died he harvested the last tree he would ever need; it was about two feet thick at the base. The rest of the trees continue to bind many tons of CO_2 that they have extracted from the atmosphere. The practice of growing wood for fuel is clearly an avenue by which global warming can be reduced.

The potential importance of this technology has justified a section of its own. See "Playing With Fire."

Another key word is "**conservation**." You can have enough of something by either getting more, or by needing less. Renewable energy sources will never provide enough to meet the needs of our current patterns of usage. Therefore we are ultimately going to be making major changes in our lifestyles whether we choose to face this reality or not. Any intelligent individual who is willing to face reality is going embrace conservation and renewable energy, rather than suffer shortages.

A third key concept is "**sustainability**." Sustainability happens when through conservation and the use of renewable energy you continually have enough to meet your needs.

The big challenge for us in America is that there is such a disparity between opportunities for renewable energy and the amount of energy we need. Available opportunities for conservation in our current culture are simply not enough to close this gap. This is why a significant redesign of our living practices is imperative.

A fourth and final key word is "**local**." This concept is essential to the success of the other efforts. To the degree that your place of work and the sources of the fundamental essentials of life (food, shelter, water, and energy) are locally available, you cease to be helpless with regard to your own provision.

Target principles

When designing something, it is a good practice to define the most desired outcome before the actual design begins. Never begin by limiting your thinking with a check list of what can't be done, or that's all you'll succeed in designing.

The local advantage

Over half of all the petroleum used in the USA is consumed in transportation. We reduce this sector of energy dependency directly to the degree that transportation needs can be minimized.

Look around you: Consider the area covered by streets, gas stations, driveways, garages (household and commercial) auto parts stores, etc. This all represents environment that has been obliterated by the transportation infrastructure alone.

How much of your paycheck goes to car payments, taxes, insurance, gasoline, oil, repairs, and maintenance? Such expenses are not voluntary; they are unavoidable if you own a car.

There is a trend in recent years of people moving back from the suburbs into apartments near their work. This is a good thing, and millions of people no longer need cars. It is far cheaper to rent a car for an occasional week or weekend than to own one forever. Another important factor is the amount of time you spend each day just getting to and from work.

A still better direction would be to find or create work where you chose to live. In this case however, the availability of public transportation could become a critical factor.

In the transmission of electrical power, the volume of the wires increases with the square of the distance. This means that if you lived one half the distance from the power plant, only one fourth of the copper would be needed to deliver your power.

Taking this to an extreme, any power developed at the household level from renewable sources would have a tremendous advantage both environmentally and economically (don't write "can't be done" next to this one).

The neighborhood community

A small set of local services would enhance the practicality of living locally. A food store, restaurant/coffee shop, recreational facilities, a community building, a rental agency – anything but a gas station – would provide local employment and bring the essentials of life within walking distance.

Food staples and utility distribution systems should be owned and controlled exclusively by individuals or the local community – with every resident homeowner in it having a voice and a single vote. Prepared foods and all other businesses would remain private. This would prevent individuals and companies from holding the community hostage for their personal gain. A light industrial preserve and a village wood-lot ("forest") adjacent to the neighborhood would provide everything but food, and bring true local sustainability within reach.

Allocate some space for a sustainable energy power plant. We'll need to work on this one, but the objective would be to meet all energy needs as reliably and conveniently as possible.

The size advantage

How much space do you need? At the next recreational vehicle show, view the luxurious appointments in some of the upscale motor homes, and then ask yourself: "How much space do I need? If convenience and efficiency were optimized in bedrooms, bathrooms, and kitchens, the size of a dwelling could be significantly reduced – even though the living/dining area remained a more gracious size. People moving downtown of course, have all this imposed upon them for free.

In the suburbs, smaller indoors means greater outdoors, and significant savings on construction, maintenance, and energy.

Optimizing layout

Transportation and size can be addressed in the context of our current culture, but now we must depart from the traditional American way of doing things. The lot-layout imposed by civic codes in the USA is absurd. Generally there is a requirement for twenty-five feet of setback from the street. This part of your lot is useless for anything but showing off to your neighbors, and you are constrained to maintain it in a beautiful state. Furthermore, you are required to have at least five feet between the sides of your house and the adjoining property lines (Burglars have rights too you know). This totals another ten feet of wasted space.

Mexicans are smarter. Many Latin American dwellings begin with a thick wall right on the sidewalk. The sides of their properties are also thick walls. These are all structural members of the dwellings themselves, shared by adjacent neighbors, at a considerable cost savings in construction materials. All that we waste in setbacks and side clearances is preserved by them and added to their back yards.

On days when everybody is heating or cooling, the only side energy losses are toward the front and back of the dwellings; the shared walls share energy.

One might protest that the beauty of such neighborhoods is greatly reduced, but consider: As you drive past new subdivisions today, all you see around their perimeters is blank walls. Would it be less beautiful if they were fitted with ornate doorways and decorative ironwork protecting the windows? Isn't it about time for building codes to wise up in this regard?

Let's get our perspective

For a brief period I hung out with a small nomadic community of quasi-hippie outcasts. This included older people as well as young families with small children. None however were feeble.

I joined them in simple common meals, and sat at their camp fire for hours into the evenings. Eventually they would depart the fire to sleep in dilapidated vehicles, or on the ground under the southwestern desert sky. Their hospitality was touching, and their peace and contentment quite enviable. I was honored by their invitation to travel with them, but existing commitments prevailed. Most are likely to consider themselves more fortunate than these people, but having experienced both sides of it, I doubt if we really are.

What if you didn't need a car, had much smaller house payments (so you could pay off your mortgage), reduced your utility bills by fifty to seventy five percent, and you no longer wasted one half to two hours each day commuting to and from work? The demands on your household income would have been slashed, so you'd have an opportunity to live life, rather than be driven by it. How much do we really need?

The Power of Heat

Would any of this be possible – let alone practical? Consider what an individual or community could do of if they harnessed the power of thermal energy at the local level. As you consider the list below, note that indented words list features available under the less-indented word above them:

Thermal Energy

- Space heating
- Cooking
- Hot water
  - Convection space heating (old technology radiator)
  - Cooking, bathing, etc.
  - Heat storage in hot tub or tank
- Steam
  - Mechanical energy (steam engine)
    - Shop power
    - Electrical energy
      - Lighting
      - Appliances
      - Shop electrical
- Thermal process chamber
  - Ceramics
    - Basic kitchen implements
    - Special purpose bricks, etc.
    - Stove parts

    - Machine parts
    - Tiles
        - Floors
        - Counters
        - Pools
    - Vacuum chamber construction
        - Aluminize surfaces
            - Mosaic for solar energy collector
            - Lighting reflectors
            - Reflective optics
        - Drying of foods, etc
        - Chemical separation processes
- Glass blowing
    - Recycling broken or discarded glass
    - Artistic creations
    - Kitchen containers
    - Chemical process hardware and storage
- Forge for blacksmithing steel
    - Custom steel parts
    - Custom tools
    - Welding
- Metal casting
    - Lead, Aluminum, pot metal
    - Precious metals
    - Copper, bronze
- Refining of certain ores
- Desiccant drying
    - Heat retrievable through adding water
        - Portable stored heat
        - Transportation fuel
        - Camping comfort
    - Drying vegetables and fruits, and other things
- Pyrolisis of wood (Over 40% of energy in wood is gas)
    - Charcoal production and reactivation
        - Filtering
        - Clean fuel for cooking and heating
    - Petrochemical replacement
        - Cooking gas
        - Internal combustion engine fuels, both liquid and gas
        - Bases for paints, solvents, plastics, varnishes, etc.
- Pyrolisis of bone and calcium based minerals
    - Cement
    - Plasters and related compounds
- Charge thermal storage for remote usage
    - Solid thermal mass
    - Desiccant or other thermal reversible processes
    - Phase change thermal storage (such as eutectic systems)
- Non-steam heat engines
    - Forced air heating

Shop power
Electrical generation

Such a list can never be comprehensive because new technologies arise every day – but still, the potential is awesome. Now picture a sustainable lifestyle with all the benefits listed in the paragraphs before this list, but with access to global travel and the best of global technology.

None of this can happen by doing nothing.

Energy Systems

The most useful and versatile form of energy is mechanical – that is anything that physically moves. Once you have mechanical energy you can perform work directly at almost 100% efficiency. The easiest form of energy to distribute throughout a household or community is electrical, and with generation efficiencies exceeding 90%, there is very little loss in converting from mechanical to electrical. Our basic energy system goal then is to produce adequate mechanical energy, any time of any day of any month.

Since any form of energy may be converted to heat, the most versatile systems will be powered by heat. This would allow us to use the most locally available energy anywhere on the planet – be it wind, solar, or buffalo chips.

For energy to be readily available at will, some form of storage will be needed. If the energy source has been converted to heat, this will be a tank of water or other form of heat storage. In the case of fuel-based heat sources however, the fuel itself would be the storage.

The remaining component – and the most difficult one – will be that which converts the stored thermal energy into mechanical energy.

In a nutshell, the basic universal energy system will consist of:

1. An energy source optimized to the most locally available form/s of energy
2. Energy storage – quite likely water because
    a. It has a high specific heat
    b. It can be conveniently manipulated through pumps and plumbing
    c. It would be an important emergency resource to have on hand in the event of infrastructural problems
    d. It can store both heat and cold, to provide a wide temperature difference
3. An engine that can function off the temperature differences that can be conveniently created and stored locally. Additional engines might be provided to work at higher efficiencies directly from available higher temperature sources

Sources of energy

The most common sources of sustainable energy are biomass (fire wood etc.), wind, solar, and water power. Others to consider would include geothermal, the spontaneous reactions of compost piles, and tidal power. Energy is available in any difference between two temperatures. Theoretically, you could acquire energy by storing heat from the warmest two hours of the day, and storing the “cold” from the coolest two hours of the night.

Solar energy is an incredible resource. On a good day, one square yard of collector surface squarely facing the sun is receiving almost one horse power of heat and light. Typically, 70% to 80% of this can actually be captured in the form of heat.

Constant progress has been made in the efficiency and cost reduction of solar electric cells over the past several decades, and efficiencies of fifteen to twenty percent are now available to the public. They are quite practical in many applications, but they are dependent upon multi-million-dollar high-tech facilities. This could put them out of reach if not already in use by the time they are needed.

The most obvious problem with solar is that is quite rare in the middle of the night, so energy storage would be required.

Fire wood IS stored solar energy, and the process of storing it (growing it) reduces greenhouse gasses, and generally improves the quality of life for all.

A distinction needs to be noted in the case of much-touted fuel cells, and other forms of hydrogen power. These are not actual sources of energy, but merely convert stored chemical energy into electrical energy.

When a small scale electrical system becomes important, ponder the opportunities available in the salvage of a single dead car. If you have some form of mechanical energy adequate to drive an alternator you could have a complete 12V electrical system. If you have the tools and know-how, an automotive alternator may be rewound with finer wire to produce higher voltages at lower RPM's. At a lesser scale, often a small electrical motor such as powers a window etc. can be rigged to generate electricity.

With the 42 volt standard being phased into some of the newer cars, automotive-based electrical systems will become even more practical.

Any form of energy can be converted to heat, and heat is easy to store. A system based upon the collection and storage of heat, coupled with an engine that can convert that heat into mechanical energy could be designed to fit virtually any energy source.

The Perpetual Motion of Fools

It is the nature of free-thinking activists to consider almost anything, and this is good. The danger arises when they get too focused – to invested in – a particular theme that opposing rationality becomes an enemy.

I have heard many clever and enthusiastic things about free energy. Some claim it is waiting in the aether, some use the term "zero point", a few quote snippets and buzz-words from Stephen Hawking or Albert Einstein, and many wind up in hocus pocus.

I have heard testimonies of magnetic things that spun or oscillated for days with no energy input, but I always ask the question: "Was it lighting a lamp, running an electric motor, or heating anything?" Low friction is one thing, but energy output is another.

Law One of thermal dynamics states that energy can be changed, but not created or destroyed. Call me narrow-minded, but I believe this as much as I believe gravity. You simply do not have energy out without energy in – none the less, some of the innovations attempting to violate this law are fun, and some are even thought-provoking. I even came up with one of my own that had me worried for awhile.

The least clever yet most common is to have a car with an electric motor that drives one wheel. One of the other wheels powers a generator that sends electricity back to the motor as it travels. I try not to sound too condescending as I explain it to people – most of these people are not really stupid, but smart still doesn't seem to do them much good.

If your 100 hp motor was 90% efficient, you would actually apply 90 hp to the motion of the car (assuming there were zero losses in gears, tires, and that the wind was traveling at the exact same speed and direction as you were). This would feed 90 hp into a generator that we will assume is also 90% efficient. So now we have 90% times 90%, times 100 hp, which would be about 81 hp of electricity going back into your motor. Last time I checked, 81 hp was less than 100 hp (OK, so I *am* condescending).

Without me offering you the benefit of my calculations, waste your time on this one: Let's say you inflated a 1 cu.ft. volume balloon under 100 feet of water. This balloon will yield significant energy as it floats towards the top. Will it yield more energy than it took to inflate the balloon? I had to work on this one for awhile, but I'll let you guess my answer. Oh, and don't forget that the balloon expands continually as it travels upwards through the water, increasing its buoyancy (and therefore it also cools as the air expands).

The most-clever one I have seen involved a Freon engine and a heat pump. This guy had a team of engineers, videos, literature, and investors that were about to rock the world – if they could just raise another couple-hundred thousand. Any way I could calculate it there were indeed more BTUs out than there were BTUs in (a BTU. is a British Thermal Unit, equal to the energy required to raise one pound of water one degree Fahrenheit). I'm ashamed to admit it, but it took me a couple of days of intermittent pondering and calculating to finally arrive at the big "Duhh".

Enough of this, as long as three facts are understood:

1. It is a waste of time to mess with "energy" you can't explain and calculate.
2. There is enough "non-mysterious" free energy everywhere that there is no need to worry about the mythical stuff.
3. Some of you will waste your time and life pursuing these things anyway.