Challenge Document

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Written to the University of Wyoming Engineering Students

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Introduction

Here is my challenge to the University of Wyoming students generally, engineering student directly and specifically to the student engineering organizations. Get together as groups and look at Wyoming's strengths and weaknesses and come up with a set of answers that will get the most from our state's strengths and minimizes the weaknesses solving future problems and growing the economy of the state. Start with the professional engineering student organizations. Discuss strengths and weaknesses and brainstorm ideas and solutions and build a list of problems to be solved. Some of these will be within the realm of senior design projects and can be worked on that way while on the higher end some might be thesis topics for graduate degrees. Many others of them might be farmed out as ideas for high school science fairs. Yet others might be used as real world exercises for college or high school classes. Get students in other areas involved in planning for the changes. For example will it require new laws? Possibly it will have environmental effects that will need to be mitigated? There will be problems to study in nearly every field from finance, law, engineering, life and physical sciences, and agriculture. Since many of the students are from Wyoming they will understand this state as no other group will and can bring their knowledge of the state to the problems and solutions.

Look at what we have to offer such as energy sources and come up with a list of our best options and the problems with those options and hopefully how to solve those problems. Look at our main strengths like energy, agriculture, tourism, mining and figure out how to protect our way of life and how to improve on those strengths. Another possibility is to find new niche items or markets that can be produced right here in WY.

The rest of this document will be my best ideas of what you might want to look at. You can choose to use it as a base to work from or you can throw the whole thing out and build your own base. This challenge is put together more as a tool to hopefully get you thinking rather than as possible road map to the answer. It is possible there is not a single worthwhile idea here. Go and look, learn and think, get together and share ideas, and find the better answer.

Lets look at energy since it is the backbone of our economy. We have carbon fuels, mining for nuclear, wind, hydro and biofuels all as possibilities. Each has room for growth and each has major problems. With carbon fuels we have global warning problems meaning a need for carbon sequestration in some form if we are going to be able to continue to sell them. Wind brings with it, the need for major transmission lines, the need for storage or replacement source of power and the eyesore of covering all our wide open spaces with towers. For hydro we have the problem of where to find more sources and how to develop them in an environmentally sound manner. Biofuels introduce a whole host of problems from how to produce with a net energy gain to how to produce without reducing the food supply. Look for solutions that solve more than one problem at a time. Look for synergies that could make a process economically viable. In many cases the technologies you need are already in existence if you just apply them in new ways.

The rest of this document will examine some ideas about:

I. Wind energy
II. Hydro energy
III. Biofuel ideas

There are then two appendices with various other ideas to consider for food for thought. The first appendix is a list of other ideas that might be used to directly benefit the state. Ideas like these are the primary goal of this challenge. The second appendix features a few ideas that don't benefit the state that I thought should be included simply as food for thought. While the primary goal is benefits for the state that doesn't mean that projects that benefit society shouldn't receive some thought.

I. Wind energy

Wind energy is one of the fastest growing new areas of energy development and WY has many locations with fairly steady wind that might lend themselves to that development. But wind energy has many problems. Lets just list a few.

1. Wind is not totally reliable. It does stop blowing and this tends to destabilize the electric grid meaning that alternate generation sources are needed.
2. High end wind speed isn't economical to build the generators and power lines heavy enough for winds that happen intermittently so we get poor use of the wind speeds that could be the best source of power.
3. The sites are often remote leaving the need to run long power lines to them to recover the electricity. This leads to both visual pollution and to the environmental damage of having the lines there. Windmills also are often the tallest things in an area meaning that they show on the skyline for miles or possibly even hundreds of miles. Both factors result in visual pollution of the wide open spaces.
4. Damage to the environment from roads and damage to wildlife from roads, windmills and other hazards.

Now lets see if we can figure out how to answer some of those in a form that would make better use of this resource.

Looking at problem 1. the obvious answers are to add storage or to add an alternate power source. For storage without major expense or major advances in technology directly storing electricity is not really viable at the current time. How else might we store it? The common answers that are scalable to the large scales needed are as lifted water, as compressed gas or to convert the electricity to some energy media such as hydrogen gas.

Storing the energy as lifted water is one that we have a large number of possibly viable sites to use. Most of the major reservoirs in the state have some sort of large set of hills to small mountain ranges next to them. If small reservoirs were built up in those hills and a wind farm was built to pump water instead of generate electricity the power could be stored. The advantage is the ability to provide steady power flow, existing power lines to those dams wouldn't require new rights of way for power lines(though they might need upgrades), and the fact that pumps can more economically be scaled to utilize the full power output of the windmill during peak winds. This is also a fast turn on power source. The big disadvantages are added complexity to the systems plus the additional costs that go with it and more importantly the loss of efficiency due to changing the form of the power from wind to water to electricity. This is a solution though that might be made viable though and we have many locations that have possibilities. Things to look at here include geology to be sure the upper reservoir could be successfully built, environmental damages from the water storage and pipelines, water rights issues from moving part of the stored water to a different location. “If land is a problem for this, would mounting the windmills over the water work?”[1] Are there any synergies that could be added to this to make it more economical? Is there some way to raise the efficiency? Can you find wind sites with good storage options?

Now that brings the possibility of storing compressed air up next. We have large number of

geological structures in this state that would make this a viable possibility. There again the disadvantages of this are added complexity and the losses of efficiency from the energy storage. Here real gains might possibly be made through changing how we look at a wind farm. Instead of looking at the wind farm purely as a power producer with storage lets look instead look at wind farms as remote cooling towers that also happen to produce power. Wind towers in a sense are the ideal air cooling tower locations. The are widely spaced sites with lots of height and surface area in each tower and the more heat they produce the more wind there is to scrub that heat away.

The basic idea of how to changing wind farms is for each tower to produce some electricity directly but for most of its output to go into producing compressed air. The act of compressing the air is going to produce large quantities of heat. A heat engine/generator combo will be added to the tower and then the whole tower used as the cool side of the system. This is also a point in the process to add heat consuming businesses and synergies as there will be large quantities of low grade heat to dispose of. The piping will then carry the the compressed air from the whole wind farm to a central area. Some of the compressed air should be pumped down hole into a geologic structure to act as an air tank for when the wind isn't blowing. The rest will be compounded to increase the pressure of some greatly while the rest is vented back to the atmosphere or if possible vented down hole as part of the storage. The vented air is another good synergy add in location for cooling need uses. Remember that it is also extremely low humidity at this point so if it is rewarmed then you have the idea air for a drying operation. The extreme pressure gas will there again produce large quantities of heat while the expanded gas will be cool. Use the heat differential to run some sort of heat engine/generator combo.

The whole goal up to this point has been to produce air in as close to an ideal situation as possible for conversion to a cryogenic liquid. A center group wind towers will be used to power the final conversion of some of the air to liquid. In particular the goal is to separate out cryogenic oxygen although if the process can produce liquid nitrogen and liquid CO2 it would be nice as they are salable products. Likely the center towers will be standard electrical generating towers directly powering commercial refrigeration units. It would be more efficient to directly power the units but likely the needed new designs and equipment would make this a non-affordable option. Up to this point there has been greatly added expense and complexity with efficiency losses the whole way along the route. Now here is where I think the system can be made to pay for itself. Pipe the cryogenic oxygen a short distance to some industrial process burning large quantities of fuel steadily. Running a burner on pure oxygen increases its efficiency because you are not heating all the nitrogen that comes with air. The fire is also hotter leading to greater efficiency. So here are some gains. The real gains come in the form of having all the cold of the cryogenic oxygen there to cool the output gases from the burner to condense the CO2 out of the exhaust stream for sequestration. Scrubbing also should be greatly simplified by doing this. Remember that if the burner is running on pure oxygen the output should be mostly CO2 and water vapor. If you condense both of those then the little that is left in gas form should be easy to scrub of pollutants. Probably you will not have enough cooling to leave the CO2 in the liquid form so before it is piped off site it will be vaporized in the process providing more cooling and converted to high pressure gas for piping to the storage well. That is the basic overview of the proposed solution. Now lets chop it in pieces and look at the steps in more detail.

The first thing to look at is the individual towers for the main portion of the wind farm. At best guess the generator part of the unit will be sized for slightly less than the maximum reliable wind output in an area. Meaning the speed that comes as close as possible to happening 100% of the time

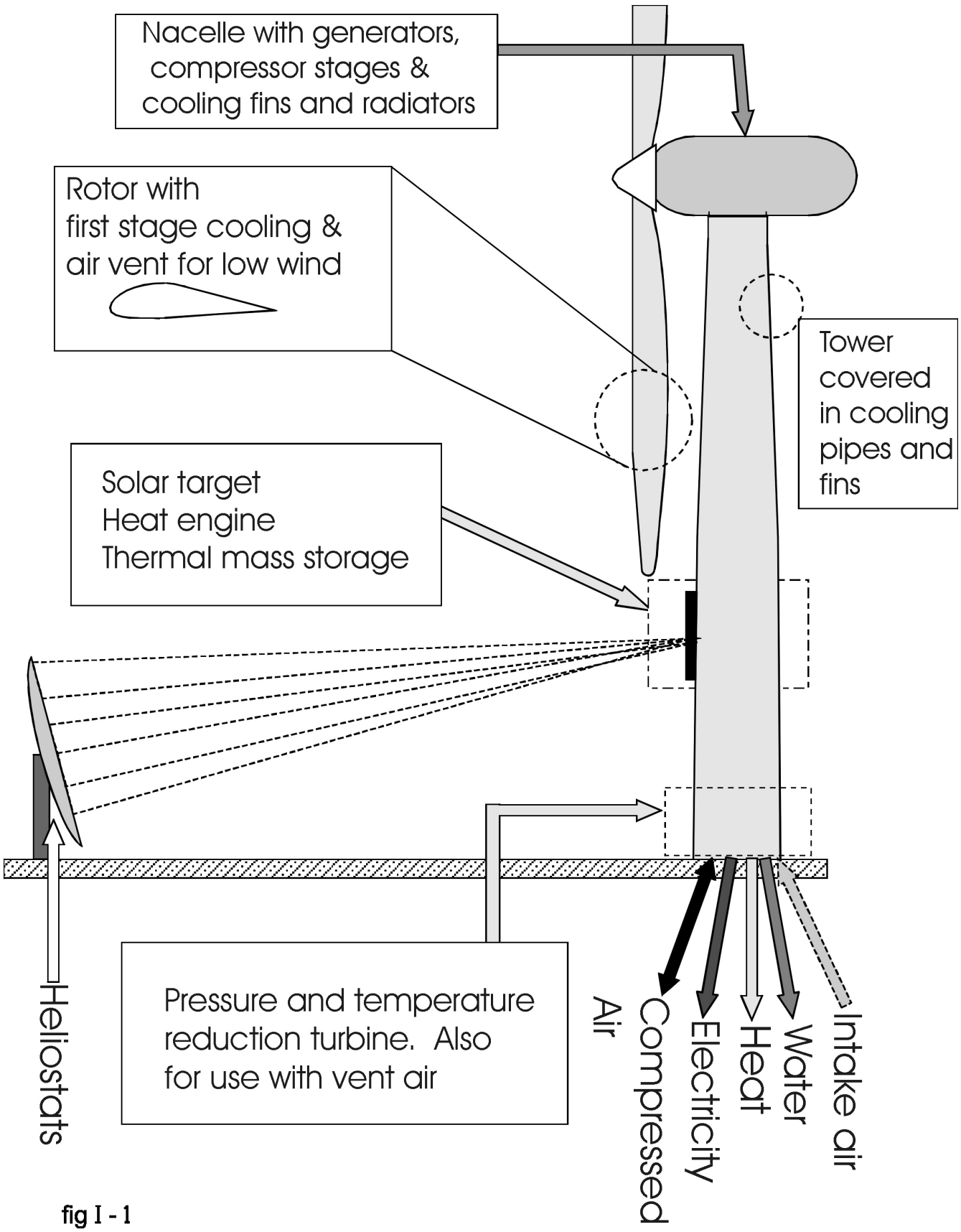

Nacelle with generators, compressor stages & cooling fins and radiators
Rotor with first stage cooling & air vent for low wind
Tower covered in cooling pipes and fins
Solar target
Heat engine
Thermal mass storage
Heliostats
Pressure and temperature reduction turbine. Also for use with vent air
Compressed Air
Electricity
Heat
Water
Intake air

fig I - 1

as reasonable. This would produce very stable power output from the tower because as wind speeds increased anything over this minimum, the rest of the power output will go into air compressors. The ability of the tower to dissipate the heat will also help dictate the balance of the power use between generation and compressors. Compressors are a good choices because they are easily scalable to virtually any power output level meaning that the full range of wind speeds should be usable instead of having to shut down power production when wind speeds reach a certain level. The real limiting factor on their scalability to this operation will be the ability to dissipate heat. Likely there will be multiple stages in compressing and multiple cooling stages. Ideally every square foot of surface area possible of the tower will be used for heat dissipation,. plus any synergy businesses that can be added to use the heat economically.

If the rotor is used to dissipate the heat from the first stage of compression this gives a large surface area that is constantly scrubbing new air so there is good cooling potential. The rotor will have to be the first stage because if high pressure pipping were were need it probably would be a problem in rotor. The big problem is how to build the heat engine to utilize this power effectively? Maybe thermionic modules in the skin of the rotor? Maybe a heat engine built into the rotor? Remember if this is a first stage system the pressure and temperature will both be fairly low. Another advantage here is there is a problem with rotors keeping them deiced in colder months. If the rotor is always heated when it is running this problem goes away. As the pressure is increased through consecutive stages of compressors more heat becomes available. The best economically possible heat engine should be used to consume as much of this heat for power as possible while the rest is disposed of by the surface of the tower. If a heat storage bank can be added then power delivery times for when the wind isn't blowing can be stretched for utilizing the generation capability. This also brings up the possibility of other uses for the heat. A year round green house for vegetable production, a fish farm, a fish hatchery, an agricultural drying station, a body shop paint dryer, a trash drying station for an incinerator, a distillation unit for ethanol production, a dryer for sugar beet pulp, a dryer for some mined mineral, heat for buildings, a man made hot springs are just a few of the things that come to mind. There are thousands of uses for low grade heat if economical uses for it can be found. So is there something that can be added to financially make all this work? What provides the best value in a given area? Different wind farm locations may have very different economic synergies.

Another thing produced by compressing air and cooling it, is water. There will be a small amount of water from this operation. For comparison a little 5 hp single stage shop compressor running 8 hours a day produces about ½ cup of water in the tank on a typical dry warm day. On a cold wet day it may produce nearly ½ a gallon in the tank. The water separator on out on the line will produce about another ¼ of a cup during that 8 hour run time on a dry day. If we assume equivalent results scaled up and ½ megawatt average output an average of 8 hours a day that would mean roughly 6.3 gallons per day per tower. If there were 100 towers in the field and 365 days of operation that means roughly 2/3 of an acre foot of water based on the dry assumption. Since pressure would be higher and the cooling better a bigger percentage of water would be removed from the air in these towers. If the wet day assumption is scaled up and used for a full year the total comes out to about 7.5 acre feet of water a year for the same field. Any field would produce a significant volume of water during the year too yielding another possible economic synergy. As we go ahead to the future this water will become more valuable. Remember that if the inlet air is filtered the water should be of very high purity if draw from the open air. More water might be produced if the suction for some of the compressors comes out of a commercial drying operation or out of the exhaust stream from some

combustion process but the water then will be lower purity. But this can also be used to collect contaminates before they become airborne. Now one other note this might allow lands for siting to be gathered through federal government through desert lands entries. A new source of water used in greenhouses to stretch its use over more acres would likely allow entries to be covered.

After all the power that is possible, is produced from this hot air and it is cooled the most it can be, it is time to ship it to the central location on the wind farm. Since the pipping carrying the air to the central wind farm will likely need be plastic and since the air is still too warm to use in plastic pipping a small turbine to reduce the pressure and there by the cool the air that also generates power will likely need to be added thus cooling the air enough to use the plastic pipping. While metal piping and high pressures would be preferable likely, will both the initial cost and the cost of maintenance be prohibitive? Remember to connect every tower you are probably talking on the order of 100 miles of pipe and since it is carrying high pressure air steel pipe will be very likely to corrode. For best central cooling the pressure needs to be kept as high as possible so steel would be a better choice if possible. Another possible addition to the thinking on the single tower level. The heat engine and power grid will already have to exist so can heliostat mirrors be added around the tower to maintain generation when the sun is shining but the wind is blowing less than maximum? Lack of wind for heat dissipation will be the problem. Peak winds and peak sun rarely occur at the same time this should provide greater gains for minimal added cost. A spot just below the rotor sweep on each tower could be target. The rest of the system would already exist bringing cost for this addition down probably making it economical to add to the system. On the rare occasions the solar heat can not be utilized, the mirrors could just be aimed away from the tower.

The next piece of the puzzle is the central location which will have a group of wind turbines for powering cryogenic refrigeration equipment with cooling built into these towers too and a building built to dissipate even more heat in the middle of them. Some or most of the incoming compressed air is then pushed down into a geologic structure to act as an air storage tank for low wind and no wind days. The rest of incoming compressed air will then be run through a compounder that uses most of the air to really compress a small portion of the air to high pressure. This will produce a large stream of cool to cold air at low pressure and a small stream of very hot air at high pressure. The hot side will then be used to run another heat engine/generator thus cooling it. Because of its extreme heat it will also be idea for any other large scale heat consuming operation. The cool stream may have cooling synergies such as cooling a refrigerated warehouse. The building or the central towers will be used to cool the air as much as possible creating as close to idea conditions as possible for liquefaction of the air.

The next step is the make or break of this idea. The easiest answer is simply to liquefy all the air and separate the components as each reaches its dew point. It would also produce the most salable products. The problem with this will be the large amount of energy needed to do this. Making this a goal that possibly can not be reached economically. So here are some alternate possibles.

A. Concentrate the oxygen using either a gas absorption technology such as used in small scale shop gas seperator/purifiers(nitrogen or oxygen generators) or using molecular sieve type separator such as is used in many other large scale separation processes. The problem with both is that neither produces a totally pure product. Both should produce a pure enough product to make cryogenic cooling more economically possible and separation of contaminate gases should be now possible. Both of these

would likely be applied before the gas was compounded changing the makeup of the output streams.

B & C both start by splitting water into hydrogen and oxygen. The oxygen can then be cooled to liquefaction. The hydrogen is then either run through B. a fuel cell with the compressed air to produce electricity or burned in the air to produce heat to run a C. heat engine/generator combo. The water produced by either can then be condensed out and recycled The fuel cell answer might be the better answer because certain types of air/hydrogen fuel cells are endothermic when run at low power densities meaning more cooling. This would let the fuel cell run at an idle for faster startup. There again this could be part of the backup power source with the hydrogen stored till needed. The problem with both answers is will you produce ammonia or nitrous oxides at the same time? If either is produced can it economically be separated to use for fertilizer? One other thought here is if you have nitrogen and hydrogen and heat can you economically make ammonia for fertilizer? The major advantage is the really pure oxygen stream is easily achievable. The windmill compressors themselves could be used to compress and condense the steam back to water to go around the loop again. This would also allow for recovery of part of the waste heat energy in this process. It might be the hydrogen will have enough resale value that it will be worth shipping water in for this process.

Maybe there is a better answer to separate oxygen on a large scale from air? The ability to separate and liquefy large quantities of oxygen is critical to attempting to make up for the efficiency losses else where in this scheme. It also requires the wind farm be fairly close to some large scale user of carbon fuels because running a cryogenic line any real distance would be cost prohibitive. Maybe build the burner on the wind farm site? So will the economics work or can they be made to work? Locations? Maybe plan to build the carbon burning on site then all that would needed is oxygen storage? Burn biofuels so this actually becomes a carbon capture plan?

Now on to the oxygen user end of the cycle. Any large scale carbon fuel burning industry would work. Probably a large cryogenic oxygen tank will need to be added on that site to deal with lack of wind days and possible line failures. Because a burner running on air needs to heat 4 units of nitrogen for every unit of oxygen burned, running on pure oxygen will provide the first major efficiency gain. Also notice that other than the bit of nitrogen mixed with the fuel that nitrous oxide formation will nearly eliminated because no nitrogen is introduced from the oxygen side of the system. The burner can also run hotter increasing heat transfer efficiency in the process. By using reverse flow and mixed air cooling and oxygen cooling it should be possible to condense all or most of the water and CO2 coming off the burner. Having done this will virtually eliminate the exhaust gas stream making scrubbing far easier. In the process more power may be generated with large turbines like used for OTEC power generation. The other gain in this process would be allowing easier CO2 separation for sequestration.

Finally on this topic lets take a quick look at synergy businesses. This is the ideal location for a fish farm or hatchery. Pure water produced from the air having no disease vector connection to the outside world. Constant source of vent air to aerate the water and waste heat to warm the water are also built in advantages. Now you still have to contend with evaporation loss and water filtration. Lets put a greenhouse over this and make this an aquaponics system. To recover the water vapor tie the air intakes of several windmills to the greenhouse to condense the water back. During the winter months the water will serve as thermal mass keeping the greenhouse from freezing when you have clusters of windless days. If you need more help double layer the greenhouse and don't use the outer greenhouse during the coldest couple of months. In the spring use the outer to grow garden stuff and through the summer use

it as a solar dryer and in the fall maybe grow flowers. In the inner you grow consumer goods like vegetables year round. The greenhouse also solves predator problems for the hatchery. And remember you have cool vent air to cool the system during the summer months. Best sun use for this system comes if we have it on a gentle south facing slope. So maybe put it at the edge of wind farm where there is such a slope or maybe combine synergies again. Put a refrigerated warehouse in. As part of its insulation lets earth berm it and put the aquaponics system on its south facing slope. Above the warehouse lets put the main refrigeration building for the cryogenic oxygen. Lets also make it a large air cooling tower building. Put the cold stuff close to the roof of the warehouse and the hot stuff isolate up for heat dissipation. These two building will help isolate the warehouse from solar gain. Remember if we are separating gases from the air we also have the gases do to low oxygen refrigerated storage. And maybe with the vent air from the warehouse we might be able to cool a computer server farm.

On a different synergy set lets say you were running a trash incinerator. Put it at the bottom of a south facing hill. Take the trash up and grind it at the top of the hill. Run it down a slide and run hot dry vent air from wind farm in the whole way down the slide from holes in the slide. This will both dry the garbage and preheat it for a cleaner burn. Roof the slide in clear panels so you can solar heat the garbage to aid in the drying. At the top of slide pull the air and all of the pollutants it has gathered back to some of the windmill compressors to recover the both the water and to capture the pollutants so they are not released into the air. Using some combination of reverse osmosis, fractional distillation and cold filtering clean the water up and separate the pollutants. Then burn the gargabe in the oxygen incinerator and recover the CO2 condensing that output stream using both air cooling and the cold of the oxygen so there is virtually nothing left to scrub. The purpose of these last two paragraphs is to encourage the thought of combing synergies for even greater economic benefit.

When the wind isn't blowing the vent air from underground still contains power so can the low pressure stream of air be shipped back to the sites windmills via existing piping and can it be vented out the tips of the blades on the central towers turning those generators even when the wind is to low to directly run them? It might be as jets of air that simply propel the blades or maybe it is possible to vent the air such that you amplify the effective size of the blades in much the same way as a bumble bee manages to fly? Either answer might allow lower wind speeds to be tapped to generate power. At this point the goal is to produce the most value while producing energy and cooling.

A final thought on whole wind field level; would a whole field of hot towers create an updraft just like a large forest fire and would this cause its own wind enough for the field to run for a while after the wind quits? It would not run it steadily but would it help the whole field sort of coast to a stop running on heat energy longer than the wind itself would allow?

Going back lets look at the problems and see how we did. 1. Added multiple possible storage modes all renewably driven in the form of compressed gas, hydrogen and stored heat. 2. Provided a local use load in the form of the air compressors that is economically scalable to use the higher wind speeds effectively getting more use from high winds. 3. The added cooling fins etc on the outside of the towers should provide shadows and serve to slightly break up the outlines of the towers from a distance and if we are running a cryogenic liquid line out of the wind field maybe with additional cooling a buried superconducting power line is economically feasible eliminating some of the visual harm from the power line. 4. As for environmental and wildlife damage we have done very little but we have tried to make better use of the resource so maybe we need fewer windmills to generate the same amount of

power. So can you do better yet?

Other general thoughts on wind generation. For lower and smaller scale turbines can properly planted wind breaks be used to concentrate stronger winds around smaller turbines? This would help to hide the towers cutting visual pollution and increase the productivity of the towers. Over the next few decades we will likely see many house hold and slightly larger wind towers go in all over the state for which this might be useful knowledge.

Farms and ranches often have need of compressed air at remote locations. Storage tanks are fairly cheap and are low loss storage. Can you build an affordable reliable small scale windmill that produces air instead of electricity? It might be trailer mounted or built for installation at remote locations. Other reasons to build it include being used to promote winter fish survival in shallower reservoirs and to keep watering holes open for livestock and wildlife as other potential markets.

The next thought on wind generation is can houses be built such that they use positive and negative pressure to generate power in fairly conventional looking houses. I know for example the ventilation fan on the shop runs at nearly full speed when off under certain wind conditions. By adding some one way flaps and channels to roof construction can the end vent fans be used for power generation if the rest of the house is built properly for prevailing winds? Simply by trapping the high and low pressure zones can power be generated in a semi normal looking roof using vent fan motors?

II. Hydro power

There are several forms of hydro power that are being ignored in the state. While it would be good to continue to look for locations for more large scale dams given current environmental standards and water law conflicts building more of them is unlikely. We need look for other sources. I see two major sources that are being totally ignored. They are: A. Irrigation dams and Canals and B. River bottoms and the cut bank area below the flood plain.

A. Irrigation Dams and Canals

The problem with these is that the power production is seasonal. We have many thousands of acre feet of water stored in irrigation reservoirs in the state that don't generate power. The dams discharge water typically for only a month or two during the year meaning that paying for the generating equipment and power lines is more difficult. A possible answer is to avoid building the lines by directly generating hydrogen locally and hauling it out to central local generators instead. Generate steady state power for the grid at some location using standard fuel cells or generator sets. Only the turbine generator, electrolysis unit and storage would need to be added at the dam sites. Most likely it would need to be installed from the head gate end because the pipping in the dams was not designed to handle the flow under pressure. This will mean the generator and turbine will need to be a water immersible assembly that can be set in front of the head gate in the reservoir.

The irrigation canals in the state have hundreds possibly thousands of small drop structures. Usually these are a concrete dam with slots in the sides for boards to adjust the amount of water held back. Just in the town of Powell for example there are 6 or 7 of drop structures just in the distance it takes the canal to pass through town. Some of the structures are close to power lines like the ones in Powell but most are remote. Most of them lower the water fairly short distance ranging from about 2 feet to 10 feet per drop. What would be needed is a generation unit to take advantage of varying flow rates and drops, store the energy in a usable form, deal with what sometimes amounts to large amounts trash in the water without plugging up and be inexpensive to install. One other thing to remember, while this is seasonal power in that most canals in the state turn on some time in April and off some time in November, there is a seasonal load to go with it from irrigation pumping and power needed to run sprinklers. This is somewhat more valuable demand load power if used correctly.

The simple answer of a water wheel probably is not functional in that it would be prone to jamming and plugging plus each would have to be custom built. Turbines would be the next most likely answer but the large quantity of debris going down the typical canal also likely rules these out. Either the assembly needs to be self cleaning to allow these answers or another type of answer needs to be found. Since canals can have nearly every size and shape of debris filtration is difficult. Trees, fence posts, barrels and dead cows on the large end down to weed seed size particles on the small are some of the things I have seen float down the canal through the years.

The best answer I have come up with as a possible answer is a Tesla type water wheel. This is a water wheel using a series of stacked disks with gaps between them. There is nothing to catch debris most of it should just flow over the top of the wheel. If each disk was made of a fairly rigid but still somewhat flexible plastic then most of the debris should either float over the top or wedge between blades while it is carried over and then fall out. The other main advantage of this scheme is the ability

to scale for both drop and width fairly easily. If done properly no major modification should be needed to most of the drop structures themselves. None of the structures are identical so the frame work would have custom for each one but if designed correctly it should be just a matter of cutting a few lengths correctly and drilling some bolt holes for assembly. The wheel will probably need to drive a right angle gear box that will be needed to get the generating assembly completely away from the water. It will also need to be a speed multiplier since most affordable small generating units are design for far higher speed operation. Most likely it will be a permanent magnet alternator but maybe there is a better answer? A direct drive from the wheel would be a better choice but affordable options that are water proof and low speed are likely not available. From there into an electrolysis unit to make hydrogen. The amount of water used from the canal would be small but likely would take special rules changes in water law to be allowed as that would be an industrial use with no return flow. A small compressor will be used to move the hydrogen to FeTi hydride tank for storage. Then the local Coop or the local power company once or twice a year sends someone to deliver empty tanks and haul the full tanks in from each of the drop sites to a central location and generates power with the hydrogen either through fuel cells or through a standard generator set.

While there are numerous problems to solve with this answer it could be done mostly with off the shelf components. The combs for the water wheel and the disks themselves would require custom manufacturing capability. The wheels likely could be vacuum formed by a sign manufacturer out of standard sheet materials. Thousands would be needed if these were put in across the state most of the set up costs could be amortized over a fairly large production run. Much of the rest should be able to be built with off the shelf components. Numerous problems from keeping the electrolyte clean, to mechanical design problems, to water law problems with industrial use of agricultural water and more would still have to be solved.

An alternate answer for canal generation that likely would only be valid in some instances would be to scale a standard ditch trash cleaner up. They go by various names including bubblers and fountains. In canals a standard trash rack would be needed ahead of each one to deal with really big debris that comes down the canals at times. The trash racks would need a powered self cleaning mechanism to prevent their needing added personnel for cleaning. The bubbler screen is mostly self cleaning but would need some debris removal too if added labor wasn't to be needed. Once the water is cleaned then it could be dropped through a standard water wheel or maybe even a turbine generator. There again piles of organic debris once dry might constitute a biofuels source. Usually the trash in canals is silt covered so if a way of having it self washing could be added the chances of using it for fuel improve.

Any way you go on this issue there are options and lots of problems to solve. Do you have better options? More things can be added that are desirable. Filtration to the size of weed seeds would be one example that would be a nice addition that I am sure farmers and weed and pest offices around the state would love to see. Aeration of the water for increased nitrogen content when it hit the fields would be another. Moss removal might be another desirable benefit that could be achieved. So can any of these dream ideas be added to the base system?

B. River Bottoms

The second major suggestion for unused hydro power in the state is many of the river bottoms

themselves. In many places when the water is below high water there is a fairly steep tall cut bank down to the water from the flood plain. In some places this cut bank area is 20 ft or more and there are lots of places in various rivers with 10 ft banks. If the water could be backed up to just below the flood plain level there would then be a high flow volume low drop for hydro generation. (Fig 2-B1) Locations would be limited by places with those cut banks and without existing housing in the flood plain which could be a problem from things like raising the water table. The dam would have to be built such that it could be lowered or removed to allow peak flow and it would also have to be built so that debris didn't get hung up on it. It would need to be able to handle running widely variable flows A generating unit capable of dealing with the debris that comes down river would be the biggest problem. This would also be seasonal power in that at high water you wouldn't have anyplace to back the water up. So for a month or 2 each year this power source would go by the way side. Most of the rivers are used for boating and other recreational activities the fact that the hydro passage would also need to be safely passable in the size boat that typically runs that water way adds to the complexity of the issue or possibly the need of just bypassing it by adding a separate boat channel or lock.

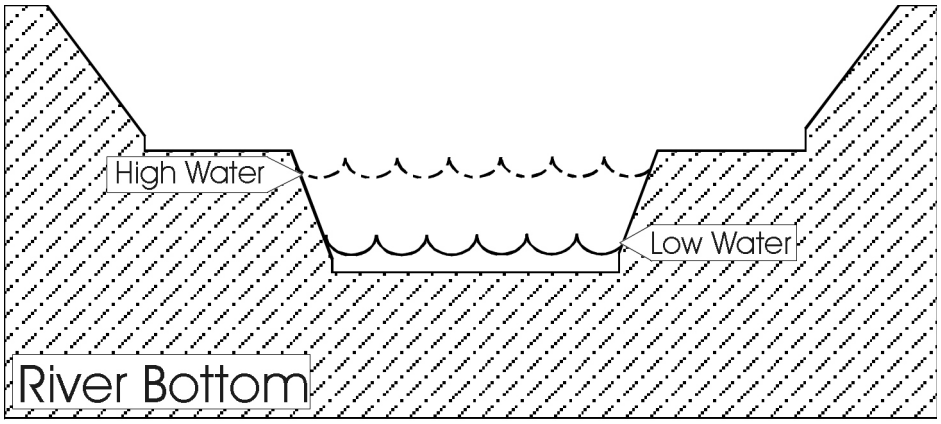


fig. 2-B1

In this one lets first look at a possible dam. There was a magazine article on a tide control dam in the Netherlands from about 25 years ago. It consisted of 2 slabs of concrete with a triangular rubber bladder between the slabs and a slight channel type cylinder and socket hinge at one edge. The bladder was simply inflated with air to raise the top slab to form a dam and deflated to lower the dam. (fig 2-B2) If these were built in a standard length and a whole row of them was placed in the river as many as are needed to divert the flow into the generator channel could be raised. A whole series of these dam segments placed in a row would comprise the dam. If they were placed in an arc shape instead of a straight line as the slabs lowered they would move away from each other making the chances of their being jammed in the up position low. Installation would be simply the matter of digging a trench across the river to drop the dam block assemblies into. Erosion control around the blocks means it might be a preferential answer to pour the lower half of the concrete in place so there are no cracks between assemblies. Individual segments can be raised or lowered to adjust for changing river flows simply by adding or removing air.

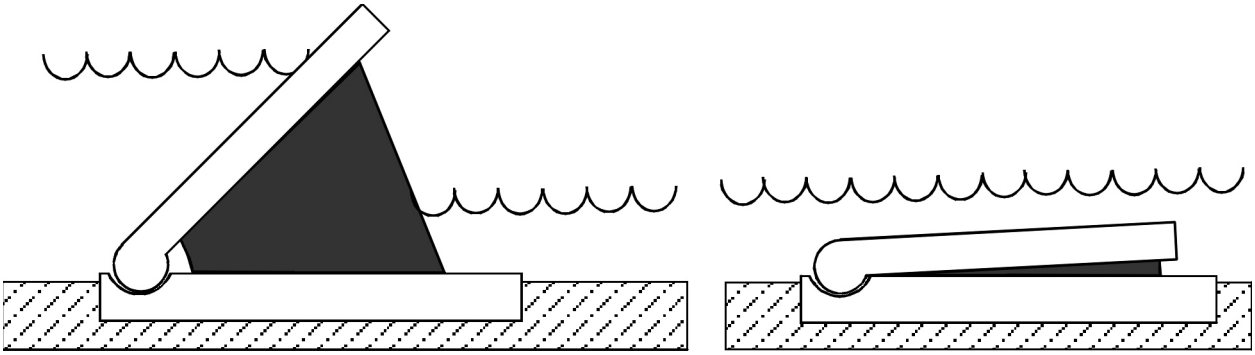


Fig 2-B2

The next major problem is debris control. The easy answer for this and the nice thing about this power generation is that it would be ideal for peak demand during the day because it could be turned on and off quickly. If it was cycled daily it would also allow the sediments and collected debris to be flushed down the river. It would also help produce a daily surge in flow that was more natural that would likely improve fisheries. If you had areas of the flood plain you could occasionally flood backing the water up also then other natural habitats could be helped. Helping establish new tree growth and wetlands. Without the flood stage and the higher water tables that go with it many trees have trouble establishing new stands. In many areas the flood plains are full of a single age of tree because that is when the dam was built upstream that stopped new trees in many native species from being able to get a foot hold in those areas. Surging these small dams would raise the local water table some plus if it could be occasionally pushed even higher to flood stage natural flood cycles could be emulated to help native trees to establish. Small wetlands would also happen.

If it was to run semi continuously at max flow instead of on a daily cycle other debris control measures would have to instituted. Most of the stuff that floats down once dry can be a biofuel so a slow drag line and piling operation might turn it into a biofuels collection point. The debris would need to be washed to minimize dirt in the fuel and then piled to dry. Sediments would be the other problem. A possible way to make beneficial use of these is at the inlets to reservoirs. If such a dam was put in and a slow dredging operation was run upstream of it that dropped the gravel and sand into a river powered washing sorting/crushing machinery it should be possible to build a gravel pit that continuously refilled itself while at the same time keeping those sediments from slowly filling the reservoir for a dual benefit. It wouldn't be fast but should still generate large quantities of gravel and sand over time if it can run continuously most of the year that the water isn't frozen. The inlet for Boysen just above the causeway might be an ideal location for example. Close to the highway with lots of sediments flowing down stream make it a good possible location. There would likely be more fine silts than desirable for road base. If these were strained out and piped as a slurry to a field it should be possible to build some extremely rich farm ground by creating a banked wetland for a few years and simply letting the sediments settle out and then moving it to the next location and repeating.

In surge or continuous flow trash forks would probably have to be added to keep the biggest debris from going down the generator channel. A simple pipe fork set so that the tines opened slightly going downstream could be used to divert the large debris away from the generator channel. The important thing here is to have nothing for the debris to catch so it can flow on by and downstream.

The next major problem is how to gather the power. Since keeping the river passable to boating

is needed and since the flow at the dam would likely be too violent for upstream passage the generator channel needs to be passable. To allow that and to allow the passage of smaller debris I would suggest a series of Tesla turbine water wheels arranged in a series of long shallow stair steps be the answer. At low water they would all be in use and at high water most of them would simply be submerged and doing nothing. If the steps are kept fairly small they would not be any worse than small rapids in the water. In bigger rivers with bigger boats operating likely a separate boating channel would need to be maintained too. If the channel for the generators is placed on the inside of a curve in the river you would have the ideal location to block the larger trash from the channel to divert it down stream. The area between the dam and the inlet to the channel could then serve as a trash trap and holding area for the big debris. Proper location of trash forks at the top end of the channel would divert most of the big debris on downstream to the dam. If the forks were properly placed a boat could go up or down the channel and around them. It might be better to include a boat channel and either continuously run water down it or possible add either lock gates or simply and on/off dam that was button operated by a button at both ends. (fig 2-B3)

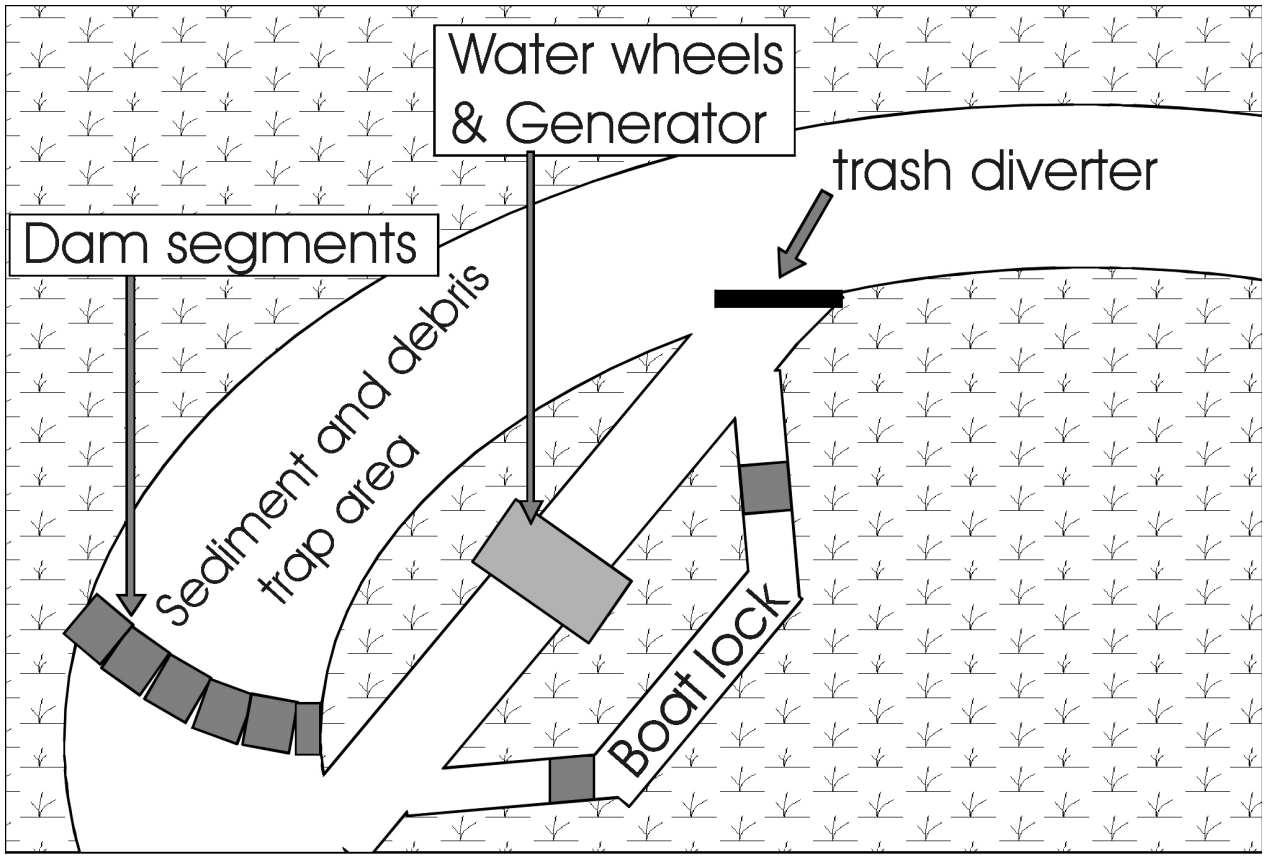


fig 2-B3

Such a system might be used for pumping water too. Some of the canals in the state are pumped up out of the river. If this lifting could be accomplished by hydro power then the electricity used to run those could be used else where. This still could be peak demand power in that the electricity is freed up for other uses during peak hours and use the electric pumps during the off hours to let the collected sediments and trash flow downstream. Remember even without doing anything for pumping if the pumps are in the area where the water is backed up by the dam electricity use will be reduced a little

because of needing less lift. It might also be used to pump water to a higher storage reservoir for back up generation for a wind system or a peak/surge demand generating station, since the water from the upper storage reservoir could then quickly be turned on and off to meet demand needs. If used like this then a large reservoir or site for such with fairly high lift close to the river would also be added to the list of desirable qualities for such a system.

If you build a list of desirable qualities for such a dam set up such as; tall cut banks, low flow much of the year, no housing close up stream on the river, power line close or high lift storage reservoirs and give it to the students, you have the ideal search squad in the students for desirable locations as they between them know the state like no other professional group you could put together. Other problems come up with things like how you deal with ice during the winter? Would it cause ice jams? So can you solve the mechanical problems and figure out where such a thing might work?

III. Bio fuels

There are many bio fuels in the state that go to waste currently and this is one of the best locations for opportunities if you can solve the problems. Downed or beetle killed timber, Russian olives and tamarisk(salt cedar), straw, hay stems, cattails, sileage and manure are just a few of the many possible fuel sources already in the state that are as yet mostly untapped.

Currently one of the best comes from the fact that the state has declared Russian olive and salt cedar to be noxious weeds. This means serious and expensive efforts are being made to control these. In Shell valley watershed those contracts have been in the neighborhood of $200 an acre just for the removal of Russian olives. Surely if you are being payed $200 an acre for removal of a “crop” there should be some way to make it pay for power production. There are a number of pieces of specialized equipment that will be needed to make this work as well as specialized processes to solve. While the payments for removal would be short term it would help amortize the start up of this as a permanent biofuel operation.

Lets look at a few of the issues. Harvesting the trees is the first one. There probably needs to be three types of harvester for example. Something like a lawnmower capable of clearing large areas quickly, an outfit that can selectively harvest around and among other trees and other obstacles like fences and buildings, and finally a harvester capable of working from the river for areas where the trees can't be reached any other way. The majority of the trees to be removed are mixed with other trees, in fence rows or other areas requiring selective removal so think about that one. The machine itself needs to be such that it can maneuver between existing trees so it will likely need to be a fairly narrow chassis. It needs to be able to grab and pull, cut or shear off each individual tree. It then needs to be able to convert those trees into some compact transportable form. This all needs to be done quickly and with energy efficiently if this is going to work. My best guess is that this task will actually end up with three machines to allow it to happen in tight places. An in the field transport, a tree grinder/ baler and a shearing grapple on a track hoe. The track hoe needs to be a fairly narrow track for maneuverability in tight quarters with the ability to safely handle the largest trees in its area. From there the tree is passed to a machine to package it for shipment. There will be a major balance in the design because the amount of fuel needed to shred the tree down to easily handled small bits will be excessive while if it is left in large pieces then there will be a lot of waste in space likely meaning far more loads to the generation facility for the same volume. Best guess is that it will either be cut to length sticks with small stuff ground as filler around it or it will be all converted to fairly large chips. How do you handle the trees economically? Finally there is the need for transport from the harvest site to the location where it is loaded on the truck. To keep man power requirements down ideally this will be accomplished either by automated equipment or by a land train that moves lots of loads at once. This might be as simple as a GPS tracker and computer control system that the track hoe operator has built the track for such that the load can go back to the truck by itself. Or it might be a mechanical self tracking train like they use for the tour train in Boise that the track hoe operator pulls along with him. Or it might be something completely different. What answers are available?

The next major step is the generating plant. This might be a standard wood fired steam plant, a diesel engine running on smoke, a gas turbine or other answers. Finding something reliable and cost effective for the location will be vital to making this pay. Remember that waste heat can likely be used to dry the incoming wood so some waste heat doesn't matter. Other uses for the waste such as building

heat or agricultural product drying may help pay a small portion. One way that might help pay for this is by choosing proper locations. Many of the REA branch lines are growing in load such that they will need expensive upgrades in the future. If the generator can be located out in the middle of one of those lines it may be possible that part of the funding for building the station can come from the REA. If they can get reliable power out in the middle of the long line they can postpone for decades the need to upgrade that line. There again wood fired plants are ideal for this in that you do not want to be hauling the wood great distances. A number of smaller plants scattered around is probably more cost effective on several fronts. The problem of course is then cost effective smaller scale pollution control. If the ashes are hauled back and scattered as the trees are harvested there should be little or no net soil nutrient loss from the harvesting so that shouldn't be a problem.

The next question is what do you do with this when all the Russian olives are gone? We have huge quantities of federal forest land that could use clean up and thinning on a continuous basis. Once the basic startup cost is amortized out then hopefully these power plants can be self supporting by simply permitting down timber removal. Right now for example the whole western US has major beetle kill problems that will take years or decades to clean up. For all of this to happen changes in various laws will be needed too, changing how the forest service looks at timber sales. Allowing thinning and downed tree removal would be necessary for long term viability.

One other added suggestion for use of woods would be as saw dust or actually just a little coarser than that. It makes a good floor dry for cleaning up messes in the shop. The other advantage if we go to trash incineration or if we can just mix the cleanup sawdust with the power plant wood would be that then we wouldn't have the clay residues from normal floor dry in the ash. Instead of having a contaminated product sitting in the land fill both the collection agent and the product could be burnt in many cases.

The next major fuel source wasted in the state is straw, stalk and hay residue. Hay residue is common in this area from raising alfalfa seed. The herbicide they use to cause the seed to ripen is not approved for use in animal feed for alfalfa so the hay is wasted after it is combined. Some farmers burn it in the windrows then. Others bale it to cut burn damage in the field and then burn it. One of the farmers in this area burned 170 4'x4'x8' bales in a previous year. At basically a ton a piece that starts to amount to a decent fuel source. A there are dozens of farmers this size or larger in the area raising hay seed this starts to look like a real fuel source. What do you do with these for fuel? The ideal would be an on farm set up that let the farmer efficiently burn the bales and generate power. If he could utilize them on the farm then transport cost and handling could be kept down. If not then maybe a small plant that that a half dozen farmers in a given area could then haul to. The next best would be small regional plants. There are huge quantities of straw and cornstalks also available for fuel in the state each year. Power plants running on these fuels already exist so most of the design problems should have been solved at some level. Another possible fuel source here is yard waste from towns and cities. Yet another possible fuel here to suggest is cattails. Anyone who has watched a cattail patch burn knows there has to be a huge fuel value here. While you would not want to harvest all the cattails in a given area because they provide habitat and shelter for wild life and a bio-filtration for many pollutants it should be possible to harvest patches in strips on a rotational basis so every second or third year you have done the whole patch but half to 2/3 of it is still there every year. If done after everything is frozen in the winter the damage to the wetlands would be minimal and the swathers and balers needed to do the harvest are all sitting idle that time of year.

Another possible fuel being ignored is silage piles. They generate alcohol and even though it is a small amount per ton there are many hundreds of piles around the state with some of them going into the thousands of tons range. Currently most of that alcohol ends up evaporating, soaking into the ground and ingested with livestock feed. Can you build an affordable collection system for fluids off the pile with some sort of separator to remove the alcohol for use as fuel while returning the sugars and nutrients back to the feed. If it also reduced feed spoilage, improved packing and made feeding easier or less wasteful so much the better. Maybe a large rigid thick plastic sheet on the ground sloping gently to the middle where drains are located. Around the edge some sort of latching system so a soft plastic sheet could be pulled over the top of the pile and latched down air tight to the bottom sheet. Pull some vacuum on the drains to help pack the pile and then collect all outflow juices as generated. Distill off the alcohol and return the rest of the liquid to the top of the pile. Ideally a solar powered still would be used so it remains a totally renewable process. Better ideas? Can it be made to pay off? You are stopping pollution and possibly gathering millions of gallons of alcohol for biofuel each year if done state wide Plus this is alcohol done with no food loss.

The final major bio-fuel I am going to suggest is manure. Really large operations can put in a methane digester but it is not currently cost economical for the smaller farm and ranches that make up the bulk of agribusiness in WY. So can you design a digester that smaller operations can use economically? The ideal unit would be one that the farmer could economically build himself. A more expensive and complicated unit might need a to be provided by something like the Coop and towed to various farms so mobility might matter. Ideally it should generate a dry sterile low bulk product for return to the fields and it should allow separation of things like ammonia so that it can be applied later and separation of things like salts that you do not want to return to the field. So can you build a digester that will meet all or most of this? How do you economically store and use the methane once generated?

Biofuels that are also used locally also make the ideal for carbon collection system for sequestration in that if we continue to export carbon fuels the carbon can be recollected here with the plants as collection media. The oil, gas or coal can be shipped out of state but if we harvest a biofuel and burn it here it can be used to regather some of that carbon for in ground sequestration for example. Growing timber that is used in long term projects would be one of the best uses for getting economic gain out of sequestration. Fuels is a poorer choice in that you have to pay to sequester it. Likely the future will be a mix of all of those. Suggestions for systems to add? Maybe grow plastics for example?

Addendums

These are random thoughts that might have value. Most of them come from a problem that there should be an answer or a solution for. These are all problems and thoughts on solutions from life over the last 30 plus years. As I have watched and thought it has been interesting to see how similar ideas have come into existence. The stun gun shell in here for example there appeared in a national magazine a year so after that section of this was written. Or glass highways with solar cells under them is another. Clear back in college I thought it was a good idea but ran into so many people who said I was crazy I let it fall by the wayside. Well it has only been a couple of years ago I read an article on someone working on doing it. These are here for food for thought. There may not be a viable idea in the bunch. The first appendix is problems and solutions that might benefit the state. The second is a few that don't benefit the state but are included as food for thought on things that might benefit society.

Appendix #1

A. Problem: Long term carbon sequestration to allow continued carbon fuel sales into the future.

There are a number of answers through growing plant materials or through in ground storage.

In ground storage needs to collect the carbon somehow and burning the vegetation provides a collection system. The problem of course is providing cooling and concentration for well injection for sequestration. Plants also provide other answers. When you build a house with timber that carbon goes out of the cycle for the life of the house. We have other ways; for example a farmer in the area built a shop using big square straw bales as walls. That means walls 4 ft thick using waste material. Done on a small scale it doesn't mater but what if you could make it common place? If certain problems could be solved. Fire resistance, insect and rodent proofing and rot are some of the ones that are possible problems. Is there a cheap way to fix these? Partially petrifying wood is being used for making lumber more durable. Could the same thing be done to bales? Maybe in some sort of outfit the farmer could rent to turn his own bales into building materials?

Another small step that could be taken is breeding an algae that thrives in high CO2 water. The reason for doing this is there are many people trying to breed algae to produce oil or plastics. To get the best conversion and growth rates having higher concentrations of CO2 dissolved in the water would likely be desirable. An added benefit would be if the algae needed this acidic environment to survive then you would have a built in safety factor to keep it from escaping into the environment. Finding a way to grow plastic or oil of course could be highly beneficial too. While algae looks like the best bet any crop we could grow here would work for the last two.

“Another carbon storage step might be as carbon fiber. Can a good source for carbon fiber be grown from plants? Carbon tied up plus strong and light weight vehicle part for improved fuel efficiency and safety”[1]

Finally put some thought into to other ways the life expectancy of sequestered carbon could be improved. Can you make lumber more durable? Can you change the kinds of lumber grown in some areas of the state to do this? For example furniture grade oak would likely produce products used for a longer time than homes if built into quality furniture. Can you find some new product that produces sequestration through being durable goods? Maybe you can just protect products we already produce? Maybe grow plastic from algae? Anything that ties naturally produced carbon up as a durable good is sequestration. Or maybe you can find a way to go straight from CO2 to a durable carbon good in an energy efficient manner? Another ways is to make wood more durable through some treatment process.

B. Problem: Improperly stocked fish in various lakes and reservoirs.

In numerous areas around the state fish have been illegally stocked creating problems for that fishery area. Currently the only really solid answer is to poison the entire area and then restock it. Since that is not really an acceptable answer the current best answer has been to make certain species no limit fishing in some locations in the hopes that the fishing pressure will keep the numbers in check.

A better answer would be to increase the fishing pressure to levels just anglers can't reach. If laws allowing the state to contract out a body of water for commercial fishing were put in and if the equipment was created to make it practical far greater population pressure could be put on the target species. Different species would require different fishing techniques. It would all need to be live fishing techniques so that target species could be harvested while minimizing the kills on the desirable species. In shallow water some sort of electrofishing might be used while in deeper waters some sort of net fishing might be used. Because of the need for shallow draft, highway transportable and large horsepower the boats would likely need to be inflatable hulls and likely 3 needed. 2 net lead boats and a fish collection boat for sorting and possibly processing although that part might be handled on shore. They would likely need limited hover craft capabilities because of not always having boat ramps capable of handling them. Diesel electric drive would be useful so that generator power would be also available for large scale electro fishing when the horsepower wasn't needed for net handling. A flash freeze capable system where ever the fish are processed would also be needed.

If such a system existed there are also many private irrigation reservoirs around the state that could be stocked also. Most farmers would love to have another income stream. So once the equipment existed other economic gains could be made. Currently about the only functional way to get economic gain from those reservoirs is through charging to fish. But if a commercial grade fishing could be made practical another profit stream might be generated for agriculture. Plus as most of these reservoirs are used for irrigation it could serve as a fertilizer source.

Now the next problem is that without something more added it likely still would not be profitable longer term because the number of undesirable fish taken should drop with use. This brings up the next piece of the puzzle. Could stocking rates of desired fish be increased to make up the difference to make it profitable? The average angler would probably love the increased rates in between harvests. Is the carrying capacity of those bodies of water high enough to allow it? Can it be done without hurting water quality? If the carrying capacity isn't high enough are there cheap and simple things that can be done to increase it? Not pushing it to commercial fish farming levels because that would hurt water quality but simply raising the stocking levels would likely be best. Are there other problems like maybe nets damaging habitat?

Marketing would probably allow increased value to the fish harvested. If the fish sold in branded form as to the reservoir they came out of maybe? Or maybe sell it just as a WY branded fish?

C. Problem: Massive water loss from canals through evaporation.

There are huge water losses from most of the canals especially during the late summer when things are the hottest. Just when water is the shortest, the need the greatest: the shrink losses in the canal are the greatest.

The obvious answer is of course to put the canal in a pipe line. The problem of course is the expense is too great for it to be economically done. So is another answer possible? Could the canal be made to make the pipe itself? The dream machine would take the energy of the falling water in the canal and use that combined with carbon from the air and hydrogen from the water to make plastic and slowly make the pipe that way. Ideally it would steadily bed the pipe and bury it as it went. Since there is probably no reasonable way that could be made to work is there another answer?

What if instead of expecting it to make the plastic we provided it to extrude. In many places in the state plastic isn't recycled or recycling is expensive. What if the polyethylene was used locally in canals to extrude the pipe. There would be no shipping it to another location for processing if the plastic could be sorted and cleaned locally. Either each area having this equipment or possibly a traveling unit that visited plastic piles around the state a couple of times a year to convert it to some sort of fragments or ribbons usable for extruding. All that would be needed in the canal is the ability to heat and pressure extrude it forming the pipe in place which might be doable with the energy the canal delivers. If the head extruding the plastic slowly screwed itself off the pipe as the extrusion pushed it a single continuous pipe could be extruded by heating a relatively small area and a small amount of plastic and thus putting the power requirements possibly with reach. Likely two extruders would be needed across the head from each other with each producing half the thread to keep the pressure even forcing the head to slowly unscrew while making pipe.(fig C-1)

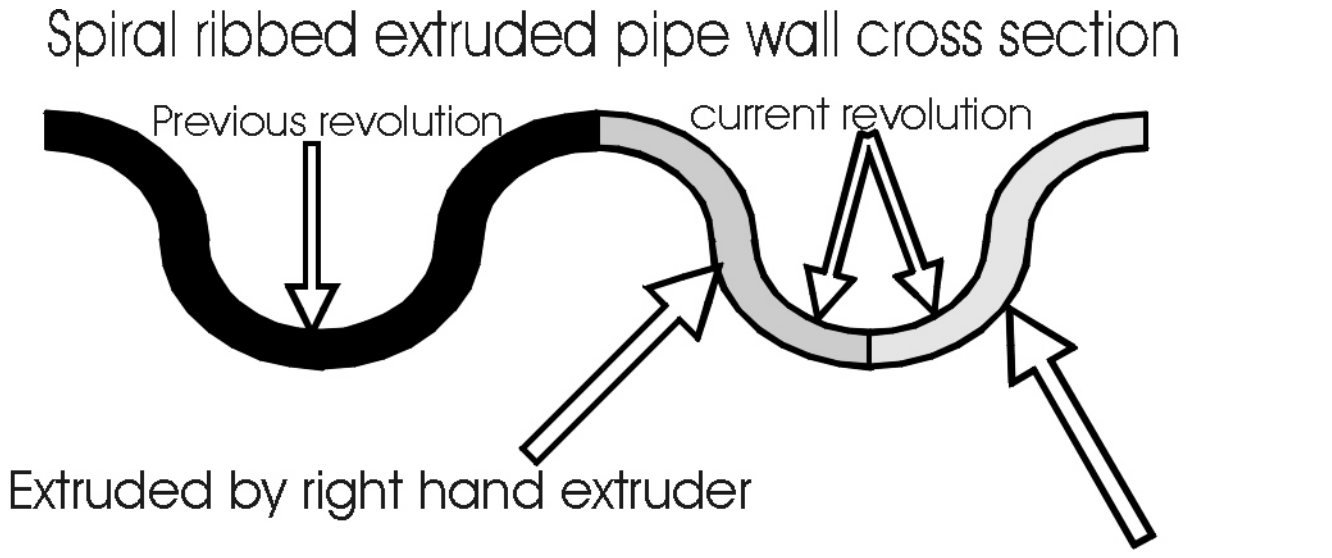


fig C-1

Most canals have problem areas where the losses are the worst so if these were targeted first gains could be made in only a few decades likely. The extruding head would need to be durable, low maintenance and semi reasonably priced for this to work. There would also have to be reasonably price equipment to sort the plastic and wash it and probably at least grind it to pellets on the local level for this to work. Most of the canal bottoms in the state are sand and silt so getting the head to dig enough to bed the pipe shouldn't be a problem. Then if a small amount of the water taken from where the silt flow in the pipe was the strongest was pumped a few hundred yards back up the pipe to allow the silt to settle out the pipe could bury itself over time. Just create a slowly traveling wet land that slowly buried the pipe. Some sort of inflatable skirts to conform to changing ground shapes would be needed up by the head to act as a dam so the water would stay on top of the pipe for the silt to settle out.

In the future if one of the many technologies for growing plastics ever comes to fruition this could suddenly become a major means of carbon sequestration. A plastic line of this size buried in the ground would utilize large quantities of carbon and would be there for the long term making it a very good sequestration tool. Plus once enough pipe is in place this could become another hydro power source. It also has a good chance of reducing electricity usage because if the canal is already pressurized then pumping for irrigation sprinklers could possibly be eliminated.

D. Problem: Flammable housing being put up in dangerous areas.

Log homes are being built in many areas where they are not suitable because of fire danger. The risks could be reduced by building out of fire resistant materials. The problem with this is making the home fit the surroundings. For many people this means log homes.

The best answer I see is to build a log home out of concrete. While looking at a foam block form wall at a building show more than a decade ago my thought was that the part with the foam stripped off the concrete was a log wall when seen from a distance. That lead to the thought that if a block form was built such that there were 3 layers of foam instead of 2 the log shape could be molded into the foam in the outer layer. After pouring the dual concrete walls the outer layer of foam would then be stripped off leaving a log shape to the walls. Color could then be added by staining the concrete. From all but up close it should look like a log wall. On the interior use real log slabs and possibly real logs in entry ways and other areas where people are up close to view the logs surface. The resulting walls should be durable, low maintenance and more fire resistant than a log wall. See fig D-1.

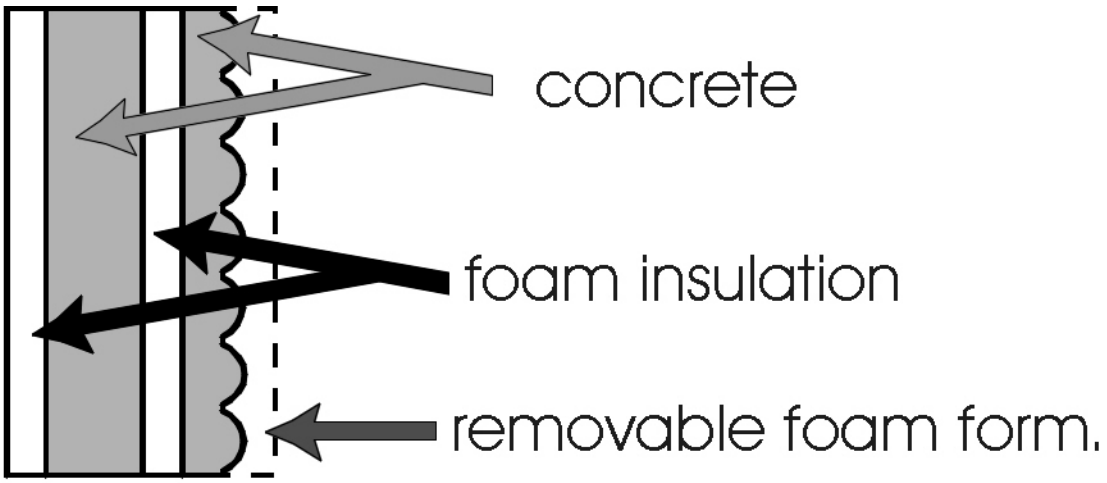


fig D-1

Logs are not the only surface shape that could be emulated, virtually any repeating pattern could be emulated. Bricks, lap siding, logs and even stone could be emulated with this type of form. Logs because of the staggered nature would be the more difficult to emulate. Forms for east/west walls might be colored differently than for north south walls so it is readily visible when the forms are on the wrong wall. By changing just the corner forms several different log building styles could be emulated. Knot patterns, cracks and grain pattern can be molded into the forms. With proper form design it should even be possible to have walls the transition from looking like stone to looking like rock and are seamless concrete the whole way up.

Some form of staining of the concrete to the desired color would be nice. If a concrete dye could be painted on the inside of the form to be absorbed by the curing concrete multiple colors could easily be formed into the concrete thereby reducing the labor. The stripped foam form should be fairly easily recycled to use again. The biggest problem would be it's large volume to be shipped back. Could

it be dissolved in an organic solvent to reduce shipping volume? Or maybe make it an enzyme soluble foam so it could just be dissolved off the wall and just washed harmlessly into the dirt and skip recycling. The cornstarch packing peanuts just melt in water for example. While they wouldn't work could some similar agricultural product based foam be made that would work for the outer layer if it took some enzyme instead of water to start the foam melting?

E. Problem: Big game in towns.

Around the state big game in towns is becoming more and more of a problem. Since hunting isn't allowed in towns they have little incentive to leave once they come in.

A solution of course is to find a way to make hunting possible in towns and to increase the pressure for the big game to move out of town. For reasons of safety it can't be firearms so another answer needs to be found. Any such system would require changes in the state's hunting regulations.

- One would be a bait station trap. My original thinking was a guillotine bait station to do the harvests. A quick positive kill that could be watched and tripped remotely. But on consideration that is probably still far to dangerous. So instead what if a stun gun bait station was made. Simply stun the animal and then the hunter makes the kill at close range. The risks would be reduced to nearly zero to anyone around and the added plus would be that people would stop wanting to feed the animals if that very same thing made them better targets for hunting.

- Another would provide a little more range. Go to using a taser as the next level. Still extremely short range but the risk to property in the area and to bystanders would be small. There again the actual kill could then be made a close range.

- Finally would be to create a stun gun dart. It might be fired from a standard gun or it might have its own projectile propulsion system. Likely any real projectile such as this might be to risky to allow the general public to hunt with but it would still provide a safer way for animal control officers or game wardens to maybe do the hunting. Parks, ball fields and cemeteries would be likely areas where this option might be wanted. Some deer will get to smart for the other hunting systems so another harvest system such as this would likely be needed. Since key ring fob sized stun guns are available surely this would be viable. The dart would need to stun on impact and likely have a remote control to stun again to allow increased time getting to the animal. It would need to attach itself to the animal close enough to work and stay put. The attachment would need to have an automatic release in case something went wrong. The dart would also need a built in radio locater so it wasn't lost either when it missed or when it fell off the animal without working. The easiest attachment system would be a set of needles that crossed in the flesh. This is the worst possible in that it limits other uses somewhat.

Other uses for the last suggestion would include any game handling task for which game wardens now use tranquillizer darts. There is a danger to the animal because animal weight has to be figured in the chemical dart dosage this would likely be safer for the animals. If needed a tranquillizer shot could be administered while the animal was stunned. That would allow weight to be checked at close range before administering the shot. If the dart could be made to pinch or stick to the animals fur like a cockle burr it might also find applications in ranching dealing with combative or sick animals needing treatment. Any sort of injection type mark in the meat is unacceptable, so this market would only be open if the dart didn't depend on sticking in the flesh to attach itself to the animal.

F. Problem: Homes built with modern engineered lumber products burn faster making them a greater risk in a fire for both occupants and for firefighters.

As one possible answer we have several drywall plants in the state for whom another market might be valuable. Could the engineered lumber be coated in mixture of fiber and gypsum at least on the non-load bearing sides to reduce burn rate? Maybe one of the ceramic fire resistant paints applied to the surfaces? Or possibly a combination of the two with the fire resistant paint on load bearing surfaces and gypsum on the non-load surfaces. An example with the I beam engineered trusses coat the top and bottom surfaces with a fire resistant paint and coat the sides with a mixture of fiber glass and gypsum. On roof trusses coat the whole truss with gypsum except where sheeting would normally attach.

Another drywall product that might be worth producing would be a fire barrier to use in super insulated wall construction. Since those walls have a possible fire path between the studs if a dry wall strip was produced to be attached to some of the studs firebreaks might be fairly cheaply added inside the wall.

Providing for carbon sequestration possibilities could lead to something like a small CO2 cartridge used in air guns be made that would be attached in each wall and ceiling cavity designed to pop off when a certain temperature is reached. When the wall or ceiling cavity got hot enough it would be filled with CO2 and cooled by a minor amount. This should slow the spread of the fire by simple oxygen removal. One or two homes wouldn't be worth much if you could sell them in bulk for new construction it would add a small amount to the sequestered carbon and better still it would be an answer the customer payed for. If there are a hundred cavities in a typical stud frame home and if each one got a one ounce of carbon worth CO2 cartridge and you could get it in a million homes over the next decade you are talking that would be roughly 6 million lbs of carbon sequestered that the customer payed for. Plus if you can keep the house from being destroyed that is sequestration maintained.

Two other thoughts on this subject are: One if anchor points were placed around the perimeter of the home on the ground just outside the drip line of the eves and an anchor strip was added out on the edge of the eves could a light weight heat reflecting panel be built that could be used to enclose the perimeter of the house limiting the walls heat exposure during a fire? Just like battening down for a storm these panels would be gotten out of storage and attached when there was a fire danger known to be coming. If they were mounted sloped then the heat not only would be reflected away from the house but also possibly reflected away from the fire. They would need to be wind resistant

The second thought is if a tubing system were installed in the house when it was built could the whole inside of the house including attic and walls be flooded with CO2 from a central tank reducing the risk of it catching fire when the fire gets close. Basically it would be a drip irrigation system for CO2 distribution around the home. Either as the home owner leaves or with a remote trigger the home owner starts the house slowly filling with CO2 when a fire was close. The biggest cost would be for the bottles. the tubing and emitters could likely be fairly inexpensive and if it was run with the wiring most corners of the house would be reached with very little added labor during construction. Then when fire was known to be headed that way hook several tanks to the system flood the walls and rooms of the house with CO2 so there is no free oxygen inside the home to support combustion. This would also serve to cool the house a little also reducing the risk very mildly.

G. Problem: Fire fighting needs better tools for fire control. Water does damage to the structures, smoke control measures can actually make the fire burn faster while they provide safety and the fact that there are areas where fires can't be controlled because access is limited. A fire burning between multiple ceiling for example is on the list of the fire fighters problems.

The answer here I originally came at backwards. Originally the question I was asking was looking for commercial uses for CO2. If we have reasons to stock pile it steadily that is sequestration even if it is only a limited amount; Maybe the sold CO2 can help pay for the sequestered. While one tanker truck of liquid CO2 isn't a drop in the bucket if you can come up with a reason to have a thousands of them then it starts to add up was the original thought. What if every fire department in the nation had a tanker truck of liquid CO2 as part of it arsenal of fire fighting tools.

Imagine that the firefighters pull up to the fire with a tanker load of liquid CO2. They string out a garden hose size line feeding a bunch of sprinklers to vaporize the liquid CO2. Ideally the sprinklers would be near the ceiling. The firefighters' bunker gear should serve to protect them while handling it. If not only slight upgrades in the gear should be needed. The sprinklers inside the burning building would serve multiple purposes. They would drive out the oxygen helping to control the fire. At the same time they would cool the smoke making flash ignition less likely. Finally they would be acting as a ventilation fan that would be as if there is large quantities of gas appearing in the middle of the building the smoke would have to flow out providing both the better view to fight the fire and also getting rid of the smoke as a flash fire possibility. Not much would be needed to set the sprinklers it might even be easily possible to build a robot to do this task improving safety so human lives were not at risk.

The next step would be to add a piercing probe hooked to a similar CO2 hose to the tool kit. A sharp hardened piercing point with nozzles just behind the point would allow the CO2 to be sprayed into many closed cavities for the same gains of oxygen removal, cooling and driving the oxygen and smoke out. It would also allow fighting fires between some layers like in ceilings and through at least some of the walls before a door is even opened to the fire. Modern infrared helmets let the fire fighters see fire through walls and in closed cavities like walls and ceilings so the use of the probe could be targeted. Before opening the door punch a small hole through the wall next to it and spray the inside of the room with it. The smoke would be cooled before the door was opened reducing the chance for a back draft condition. Now the question of how the loss of CO2 that could be sequestered comes up. If the building is saved when it wouldn't have been then that carbon that is already sequestered in the form of flammable materials isn't released so in many cases things should come out not looking quite as bad. The problem then of course is economically producing the liquid CO2. Any better answers here?

If some way could be found to effectively use CO2 on forest fires then you would have a better sequestration tool because far larger volumes would need to be stored. Yes it would be released but while it is held it isn't part of the cycle. Added to that might be another path for paying for some sequestration. Plus by saving mature trees you would be increasing the sequestration rates per acre, especially if those trees are eventually harvested and put to a long term beneficial use. An example would be as long as that wood is being used in a house or a piece of furniture that carbon is tied up.

H. Problem: Portable air compressors are noisy and can be toxic from exhaust fumes when used in closed spaces where electric power is unavailable and if they produce any volume of air they are fairly heavy.

A possible answer would be to build a CO2 powered air compressor. Growing up on the farm my father used a 30 pound propane tank for blowing out radiators on equipment. It was dangerous and a fire and explosion hazard but one 30 lb. tank would run the summer because of the huge expansion ratio going from gas to liquid. In college I learned from an uncle who did commercial refrigeration repair that he did the same thing with a small CO2 bottle while cleaning out the coils on commercial roof refrigeration units. While it was safer it still had dangers. There again the main reason was the huge volume gains going from a liquid tank to gas vapor and the light weight portable form. So how might such a system be made safer and better?

If the CO2 was fed into a compressor that used the high pressure CO2 to compress air and then dumped the vent CO2 and the air into an air tank together some of the problems could be solved. To prevent the CO2 tank from chilling and reducing the pressure the system would need to run as a liquid run system doing the expansion outside the tank.. The best explanations of the reasons why can be found in websites on liquid running paint ball guns in cold weather. This means a heat exchanger would be needed following the tank to flash the CO2 from liquid to gas. Luckily there is source of heat readily available in the form of the air that has just been compressed to be the heat source for the exchanger. The larger paint ball gun CO2 tanks would likely be an idea fuel tank for this. The tank would have to be mounted in the down position or a dip tube type tank used so the system was always starting with liquid.

The compressor itself uses a small piston at high pressure to drive a large piston compressing the air. If this was made double acting both strokes could be doing the work. Two such set ups are placed side by side and run such that the pistons are moving opposite directions so most of the vibration could be damped. A possible suggestion for prototyping here would be to use an air powered wiper motor off an older semi for the valving to make it work..

This could likely be built in a brief case size compressor supplying fairly large volumes of air. The heat exchanger should mostly eliminate pressure drop problems because of low temperatures and problems spraying liquid. If the compressor could compress 4 units of air for every unit of gaseous CO2 used the consumption rate of the tank would be greatly reduced. There would be no explosion or fire dangers from fuel or fumes and no ignition source in dusty environments and the risk from toxic fumes would greatly be reduce in tight quarters. There would also be improved safety because compressor could go right to the work site meaning less hose around to trip over and tangle.

The market for such a machine if it could be kept light weight, portable and affordable would include construction for running air tools such as nailers, repairmen doing anything that requires portable air ranging from construction to mechanics to appliance and refrigeration repair, farmers, any area where the normal compressor could posse and explosion hazard and even hobbyists. And many thousands of CO2 tanks even though small is sequestration. And recharge could be fast and easy from larger tanks.

I. Problem: Ice on highways, streets and sidewalks causing accidents. There are control measures that currently work they each have their own problems. Ice melters can be corrosive, environmentally damaging or in some cases expensive. Sand tracks into buildings and needs to be reapplied so there is always a film on top of the ice

What if instead the ice could be totally removed? A possible answer here comes from the fact that hover craft are used as ice breakers on thinner ice. You will find 2 different published theories on why it works. One has it that the simple weight of the craft traveling over the ice flexes it and does the breaking, if that is the case this won't work. The other theory says that the ice has a series of microscopic pores and cracks and that the pressure gets into these and shatters the ice from the inside as the skirt and the pressure move off that section of ice. The ice is shattered internally by being put under tension by that pressure momentarily trapped in those locations If that is the case some form of hovercraft type device could likely be used to shatter the ice loose from the pavement. Likely it would have to run at somewhat higher pressures to work than a normal hovercraft for reasons of speed. So why do hover craft work as ice breakers? Does highway ice and parking lot ice have the same pores and cracks or are they polished shut by tire action? Can such a device be built? Possibly built as a pressure skirt section to shatter the ice and a rotary brush to sweep the residue off the area.

An example would be the parking lot of the local grocery store where it was solidly icy for a couple of weeks during the winter. I am sure the owner would have loved to have a way to economically have gotten rid of that liability.

Another thought on a similar vein has to do with city snow removal. The trucks that haul the snow off typically have a greater carrying capacity than the loads of snow. Every trip saved is reduced wear and tear and reduced man hours. Can you build a snow baler that would take in snow and produce giant ice cubes for greatest density reducing transport costs and times. Probably it would use some sort of pressure wave passing through packed snow to cause it to melt momentarily in a localized area. It would need to be fast and have some sort of accumulator holding the blocks till the outfit got to a safe location to drop them. If you could build the ice cubes to match big square bales then possibly you could have another collection system for them that could be self loading with only minimal design changes. During peak load times on this maybe towns could rent a couple of these extra trucks either from farmers or from local coops. The bale handing trucks would have to be built heavier because blocks of ice would be roughly 4 tons verses a heavy hay bale at likely at most 1 ½ tons. But the farm equipment has to be over built any way because of the rough environment of the hay field verses street use handling ice blocks. This would be gentler use so likely the over build wouldn't be a serious change. Concentrating these blocks into piles could maybe provide some summer time cooling and possibly water storage for watering lawns into the summer possibly? Is there some use for a modern ice house?

During my time at the University of Wyoming the stretch of sidewalk from the Commerce building to the Union was nearly always the first stretch to melt clean. Part of this was the gentle slope meaning a better sun absorption angle during the morning but the other part was the reddish brown of that piece of concrete that just seemed to be a better sun absorber. Even when the sun didn't come out till the late afternoon that concrete melted off faster than even the fresh black pavement in the parking lot where everyone walked from the dorms. With the same cleaning and the same foot traffic as

numerous other areas it was nearly always the first area on campus to melt off.

Can an affordable concrete colorant be made that would do the same thing and maximize heat absorption in a satisfactory color? Ideally during warm weather it would turn a highly reflective white to help keep the concrete cool, maybe put this transition temperature near 40 degrees. Of course in colder temperatures it should be dark and as heat absorbing as possible to melt the area clean as fast as possible. The other small gain from this would be reflecting a tiny portion of the sunlight back out of the atmosphere part of the time when the concrete was in reflecting mode. Think how many square miles of concrete there are in northern climates that could be turned reflecting. Fight global warming simply by reflecting some of that light energy back to space At night it should also ideally turn white so street lights around it have the best affect for the least power needed. It might be a dye added to the surface of the concrete or some sort of semi conductor grains sprinkled on the concrete as it cures or maybe some sort of fungus maintained on the concrete, or maybe there is some other answer? The big thing is it would need to be cheap and durable. If it also made the concrete so ice wouldn't stick while maintaining traction then you would really have something.

If the same sort of thing could be made in a paint for buildings then both heating and cooling costs could be reduced. The biggest problem with this is the fact that the house would take on a mottled color while going through the transition temperature. Insulation leaks, hot and cold spots in the walls would show on the paints surface and might be unacceptable to the home owners.

J. Problem: Wiring harnesses for older equipment.

As wiring becomes more and more critical in farm and construction machinery there becomes a greater need to be able to replace it over the long haul. Tractors that are only 20 years old they are saying the wiring harness is obsolete and for lack of an easily replaced part they want to junk the tractor. Even when they are available some of the wiring harnesses can cost thousands of dollars Can you design a robot that will build replacement wiring harness. It should be able to deal with all the common connectors, running wires with proper color codes, shaping the wires in 3 dimensions and wrapping the looms once the wiring is done. It might also want to be able to heat shrink reinforce known weak or rub prone areas in the wires or the harness. The materials for this are fairly inexpensive so most of the cost is labor and setup. Can you eliminate those robotically? Build a robot that once programed with a given wiring harness could turn out 1 harness or 100s if needed? If you could keep the robot fairly low cost it wouldn't even need to be hugely fast at this. If you could call in the morning and it had the harness ready for shipping that afternoon would probably be fast enough. This would be another possible niche business that would work almost anywhere in the state if done properly.

K. Problem: When power goes out many homes have serious problems with heating. Modern well insulated homes have far less of a problem but there is still a risk

What if homes could be made self heating needing no power to heat for weeks at a time or possibly the whole season. With no power to use, a heat storage battery is needed. From living in a well insulated passive solar house I know that even when there is no sun because of storms or really gray days, the heat being off and it being very cold out that the temperature in the house stabilizes at about 50 to 55 degrees. This happens because the basement floor begins to radiate just enough geothermal energy to make up for the other losses.

What if we could amplify that effect. Heat pipe systems are being used for everything from big industrial processes down to cooling microprocessors in computers. They are purely convection based and no power is needed for them to run. Bore a series of wells under the hose before it is built and install a heat pipe systems to extract the heat from below the home and carry it up to be radiant heat in the home. If the bores were put in properly they might even act as pilings improving the foundation strength. The problems are two fold with using just a heat pipe system. First the ground at reasonable depths still is not warm enough to keep the house fully comfortable and secondly if the heat is only removed eventually you will drain the battery. Mix in a few additions to get rid of those problems; heat pumps can use the same sorts of bore holes for heat gathering put them in too and dump your summer cooling heat down hole. By raising the ground temperature under the home heating could be achieved at 3 levels. In really bad weather the heat pump might need to extract heat but most likely such a system could be built with virtually zero need to run the heat pump in heating mode. During moderate weather the heat pipe system would heat the home and during mild weather the heat radiating through the basement floor would heat the home.

Another possible addition would be to use the bore holes to waste heat from an active solar collector during the summer months heating the ground under the home even more. During summer time operation one of the problems is getting rid of the excess heat those systems generate it could be stored under the home for winter time use.

Heat pipe systems need to be perfectly sealed to prevent air entry from blocking the fluid convection special valves with no stems would be needed to turn the system on and off. Ideally they also should be able to run without power if needed. If the valve was built as a pipe within a pipe a neck for the smaller pipe could be left. If a magnetic material non corroding ball were allowed to fall over the smaller pipe it would block the smaller pipe. Maybe something like a mouse track ball with a stainless steel ball core for the valve ball. a.) To open the valve apply a magnetic field and pull the ball up till it almost balanced on the rim of the small pipe, this could be done with a small permanent magnet and a solenoid coil around it. Use the coil to pull the ball up and let the small magnet latch the ball up. b.) To close the valve simply reverse the coil so the 2 magnetic fields were fighting each other and let the ball fall back. c.) For a purely manual mode if a larger permenant magnet was added outside such that it could be pulled up on a slide to hold the ball all modes could be covered. (fig k-1)

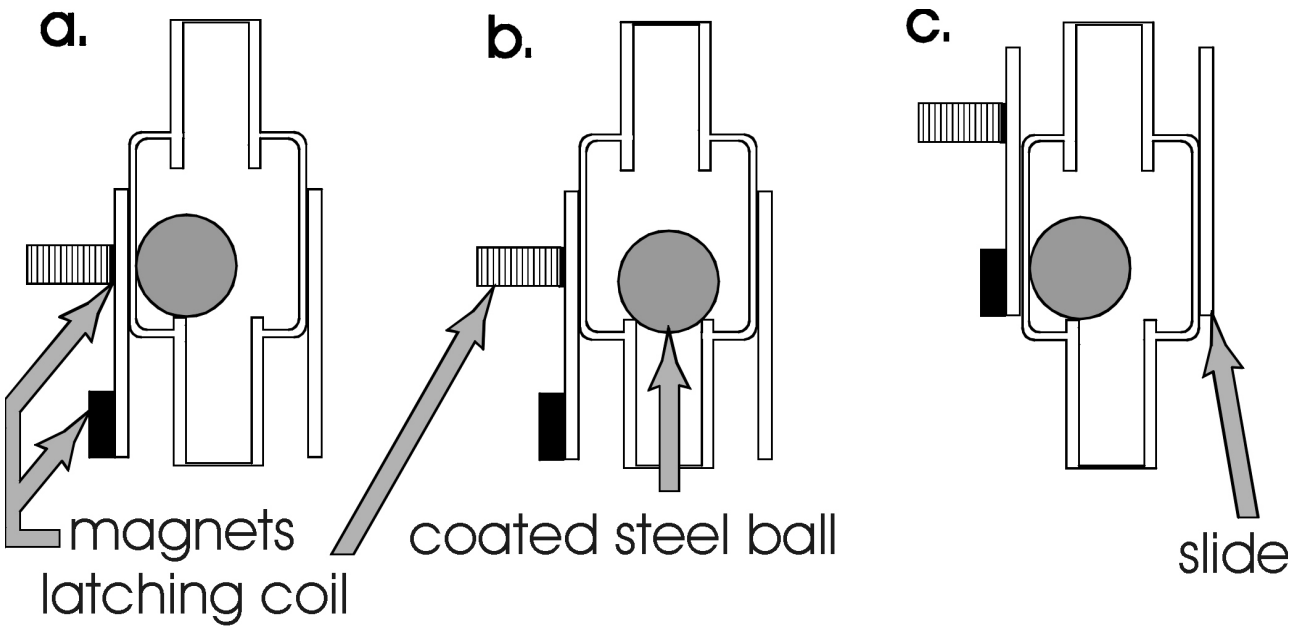


fig k-1

If the valves were mounted a ways down the hole an buffer layer of unheated earth could be created and could act as a time delay so the heat pumped down the hole didn't get to the basement floor for a few months.

L. Problem: niche businesses

What the state would best benefit from is niche businesses that draws outside money in. I have one suggestion here; what if you built a wood stove that did more than heat the house? Your niche market would be would the people building off grid houses, people concerned about EMP, people who for religious reasons don't use electricity but who allow certain mechanical systems and finally people interested in the cool factor of having a renewable heating that is multipurpose.

Start it out by building a Stirling motor into the side of a wood stove(probably a cook stove because it fits with versatility) Put the hot side so that it protruded directly into the fire box and for the cool side run the cold side of a radiant heat water system through it as well as air cooling. Build the Stirling motor as a sealed unit. It should be modular in it internal piece design so different horsepowers are selectable depending on application. Shaft seals are one of the major problems in such a motor for durability if you are going to use the most efficient gases in it at more efficient pressures. Do away with them by making the output magnetic drive. You are not transmitting large horsepower and then it could be a permanently sealed system just like an air conditioning system allowing you to run the most efficient gases in it. Remember that in the winter you have a hot side in the stove and a cold side in the house and you want to move the heat into the house so basically this is free energy. Worst case you are tapping a few thousand watts worth of power to do other things. Most of those still heat the home in winter although more indirectly. Efficiency of the Stirling motor would be of minor concern simply because it is going to heat the home anyway. Weight being a stationary design would also only be of minor concern but durability and cost would be very important..

On the output side you would add fans and pumps. They are mostly fractional horsepower needs at the size a typical house needs you wouldn't need to big power output. The first fan you would want to power would be a draft fan to support combustion. In modern well sealed homes these are necessary both for the home and for the least pollution from the burning wood. This part would also need something to run it while the stove began making heat to get it running under stove power. Maybe a weight and winch set up or a big crank friction motor or flywheel or maybe a wind up spring? Run a hydronic heating system as another part of the system. A very small magnetic drive pump will do a lot here. Horse power requirements for this are very small yet would produce big heat distribution gains. This system or another just like it might also heat domestic hot water or at least provide preheat for it. Finally if the system powered ventilation fans for the house you have home heating with no electricity. What other power users are there in the home? Can you tack refrigeration, or pumping domestic water, or even driving small appliances onto this. Maybe the wood stove would come with an attachment site to couple up a mixer, blender, food processor, grain and coffee grinders or other kitchen appliances. Or maybe the wood stove could drive a heat pump making better use of the fuel? Remember if it is a magnetic drive you are doing away with the shaft seals so your heat pump system could still be a sealed unit if built correctly.

Finally could you put a series of insulating panels into the design of the stove for summer use and simply install them and use the stove to dump the waste heat outside or dump it into the ground to store for next winter via a heat pump while preventing most of the heat from escaping into the house. In the summer you would have great heat for domestic hot water as a waste product and the stove could still be used for cooking while minimizing the heat lost into the house. If the summer heat was stored in groun for winter your long term loses would be fairly small.

M. Problem:Sugar beets and curly top.

This comes out of discussions with 2 different beet farmers located about 80 miles apart. Both of them commented that in areas where they had milk weed problems in the field they had almost no curly top problem in a year when nearly everyone was having trouble with it. This may be nothing or it might be worthwhile. Is there something to this? Does milk weed repel the hoppers that spread the curly top? Possibly they put something in the ground that helps beets fight the disease?

N. Problem: Computer Operating systems.

Knowledge of this problem comes out of 2 areas.

First is discussions at various trade shows etc. where the reason that more systems in cars, trucks and tractors don't just come with diagnostics disk or program that you can hook to any lap top to use is the companies say they can't afford to support all of the ever changing operating systems and computers over the long haul.

The second comes from spending a bunch of time in hospitals and other medical practices with my mother. I watched 100s of times while medical professionals had to waste time rebooting crashed systems to do simple tasks. Most of it was simple database entry stuff or picture display. The computer wasn't being used for any high end task and the needs were fairly small.

Now add in that in a typical operating system that we know the last releases of any operating system are nearly always the most stable. For example for each version of Windows release 2 service pack 2 or later is usually fairly stable.

Lets say you created an operating system that didn't have most of the modern bells and whistles in it. Limit networking to just a few really solid reliable options. Design database and security stuff in from the core. Design a limited operating system with stability and speed the goals for the long haul and get ride of the constant change. That way a car, truck or tractor company writing software for doing diagnostics on it outfit now would know that it would run on a commonly available computer operating system in 20 years. You might even want to fix a set of standards for the hardware too. And by going for a stable system we could stop wasting huge amounts of professionals time in areas where what the computer is doing is fairly simple work and nearly all the bells and whistles just add complexity and risk while adding nothing to the job at hand. It would also reduce the cost of constantly replacing computer infrastructure in fields where it isn't needed.

How would it pay for itself? Think of it this way, say it is a set of doctors using the system and it saves them just 5 hours a month(2 reboots per day at 5 minutes each for 30 days) and their time is worth $100 an hour to keep the math easy. You might be saving roughly $6000 a year. And even if it is less expensive professionals that time is expensive and it would likely be easy to save a couple of thousand over the course of a year in time that wasn't wasted waiting on the computer to reboot. The other gain is in software retraining time each time a new up date comes out should mostly be eliminated with a long term stable operating system. Virus control should be better also if you limit the list of features there are to attack. Protect the operating system with a hardware lock so its storage was read only without the physical key installed to help prevent viruses within the operating systems. By limiting size, the whole operating system easily could be stored in a solid state memory instead of a hard drive speeding up boot times for when it did crash. The idea would be a system that sit there stable for months on end without needing a reboot while being used either steadily or intermittently. If power conservation with fast start up was designed in from the core them money could be saved there too.

O. Problem: elderly walking help.

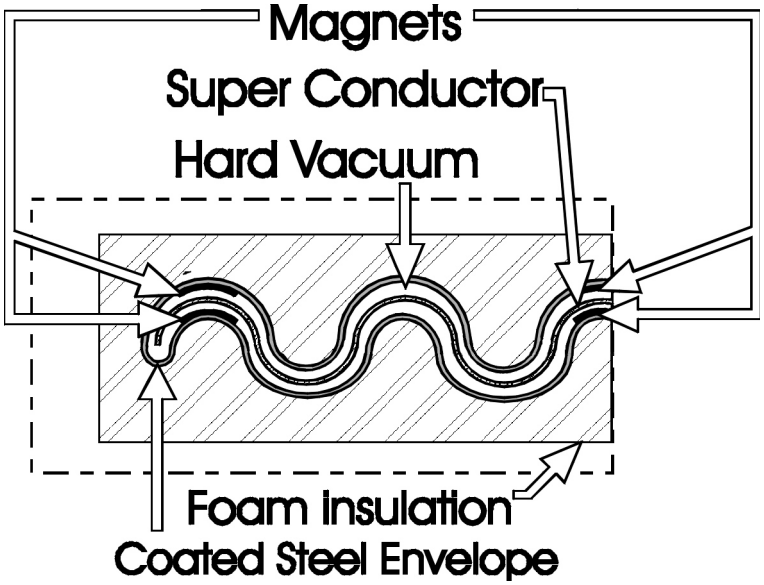
Dealing with a mother who had multiple problems with walking and on pain killers so she wasn't mentally clear lead to the thought this was needed. Early on she was dealing with a bad knee that at times just collapsed with no warning. She actually was afraid to walk even with the walker because of the total randomness of when this happened. The knee would often not work to get up so she was stuck on the floor. If a walker could be built with an inbuilt harness hook up, a winch, and some sort of falling sensor so it caught the person before they fell far. Elderly patients could then function without as much fear of falling and with a way they could recover themselves. If they could push a button and winch themselves back to erect and then go on about their task would be ideal. Their health would benefit from the ability to exercise while their mental attitude should benefit from the added mobility and independence If the system could let the patient carry their own weight most of the time and would only just serve to catch them would be best. In some situations it should be able to carry part or all of the persons weight while they walk. Ideally it should be built such that it could help while doing things like getting in and out of bed or chairs too.

Later when mom was dealing with a cracked vertebrae from falling and on heavy pain medications it was taking multiple nurses to help her out of bed to do anything. Here is probably where you can come up with the savings to pay for the machinery. If it could have been done with only one nurse and some sort of winch type walker the savings could have come from reduced personnel. The harness for this sort of use should be design to be comfortable enough the person could wear it fairly steadily and it also should allow them to use the bathroom without it interfering. This way the nurse or possibly even the patient themselves could make the hook up quickly and easily.

P. Problem: Insulation

What if you could build nearly perfect insulation? This came out of my thinking clear back when the liquid nitrogen temperature super conductors were just being discovered combined with a electro-magnetics class discussions.

If you took a super conducting panel and cooled it well below the super conducting point and put it in a closed envelope at hard vacuum and the envelope was lined with a series of magnets the super conducting panel would float between them on Meissner effect. The magnets would support the envelope keeping it from collapsing from the vacuum and touching the super conducting panel. This way it would have no physical connection to the outside outside world. Heat transfer boils down to conduction, convection and radiation so it has very little way to warm up. Conduction and convection are defeated by the hard vacuum and radiation is defeated by the fact that the panel is super conducting and therefore a perfect mirror. While the center panel stayed cold enough to super conduct the only heat transfer would be at the edges through the envelope material. One threat to this system would be leak off of the vacuum. Another threat to this system would be the residue atoms within the vacuum.(both that out gassed from the envelope over time and the residue of the cooling agent. Yet another threat would be edge movement of the center panel. Size change as the outer envelope changed temperature would be another threat. A final threat here would be vibration. If the assembly was shaken hard enough to induce a strong enough current density to cause break down of the super conducting properties of the center panel would be the other major threat.



So lets say you used some sort of corrugated steel panel to make your envelope. The corrugations would serve 3 purposes.(the center superconducting panel gets a mating surface shape) 1. The corrugations would provide valleys for the magnets and thus serve as anchor points for side to side movement of the center panel. 2. They would provide for the rigidity on the panels so they didn't collapse between the magnets because of the vacuum. This would serve to keep the thickness of the envelope down. 3. The corrugations would allow the outer material to flex a little with changes in temperature. The metal shell would serve as a Faraday cage protecting the panel from outside EM

sources protecting it from outside induced currents that could wreck its superconducting state. If you then coated the sealed steel envelope in some sort of high density plastic you would reduce infiltration of gases through your material and into the vacuum. Then if the whole assembly was molded into a foam shell, the shell would serve to reduce heat conducted at the edges, as a back up in case of panel failure and finally as a vibration damper reducing the risk of failure that way. If the magnets were mounted in exact opposition to each other they would only produce a crushing force on the center panel. Because repulsion is exponential they should never touch and their thickness would move the steel envelope between them out a short distance allowing move room for it to flex inward without touching. If the corrugations were arranged in oval patterns within a flat panel any rotatory motion within the panel would be eliminated without making sharp corners. There would have to be some magnets on each ridge so each ring was supported.

Now what about the loss of vacuum over time? If the center panel started cold enough any of the early nitrogen or oxygen that manage to leak in would condense on the panel. If you built capillary traps into the panel near its bottom a certain amount could be condensed and trapped within the panel protecting it from absorbing radiation and heating the panel. Preventing this is going to come down to quality of forming and sealing the envelope. The steel likely would need to be hot formed to prevent any stress cracks for example. Plating and/or otherwise coating the envelope should help eliminate most of the rest. Is there a chemical absorber that would work inside the envelope to catch a little more of the leakage? If you did all this how long would the center panel stay cold enough to remain superconducting? Could this be done economically? It is energy expensive but so is refrigeration over the typical life of a refrigerator or freezer. While basically flat panels would be one answer a five side box built as one assembly would be a better answer because there would be no edge leakage on the corners. Think of it, a refrigerator that only leaked heat right at the door seal. Maybe it won't work for household use but might it have other uses that would save enough to pay for itself? Maybe dewars could have it built in as an inner insulation systems. Cooling would not be a problem because the minute the super conductor warmed enough to stop working it would touch the cold center and restore the system. The big problem would be allowing movement without leakage.

Q. Problem: Sprinkler tracks

As we install center pivot sprinklers all over the state we have the problem of wheel tracks. The neighbor has been hauling gravel in to fill the wheel tracks in fields that were rock free. Eventually those rocks will end up scattered through the whole field and become a problem for agriculture. So can you come up with a better answer? Maybe raised ridges and clear protective hoods over the tires to keep the ridge dry? Maybe a species of grass you can lay as sod that will survive in that environment? Maybe the answer is something like the expanded plastic mesh they use to protect parks from tracks? Maybe the answer is filling the tracks with wood chips? Or maybe one of the soil hardening products that break down over time is the answer?

Maybe a crop for the wheel tracks? For example maybe you would plant something like asparagus along the wheel track ridge. Since it likes a raised ridge for weed control it would be helped that way. Its roots would solidify the soil reducing how deep the wheels sunk in. If you had a harvester that mounted on the pivots' towers you would have direct electric drive for a robotic picker maybe.

R. Problem: Sprinkler uses.

As center pivot sprinklers become common all over the west we are not taking advantage of what else they might be able to do. Think of it this way you have a tractor in the field that generates no new ground compaction, that doesn't have to knock any crops down when used mid season, is electrically driven so no direct emissions and that can drive itself around the field without supervision. Even better yet it provides a mobile source of electricity in the middle of the field to run other machinery like robots. And because the center tower never moves the sprinkler's location could fairly precisely be known at all times.

Sure sounds like it should be good for something. How do you take advantage of it? Maybe you run 2 low voltage rails from tower to tower. Hang a robot head from them that will scan back and forth between the 2 towers. It might be good for picking crops like strawberries or tomatoes, spot spraying for insects or weeds, simply taking pictures of the crops looking for stress, crop or soil nutrient analysis and many other things. You might even do away with herbicides completely if you could build the head so that it could identify weeds and kill them somehow. Maybe a laser beam, maybe a hot knife at ground level, maybe an injection of some sort of radio energy into a particular plant burning the root even below ground level? Some operations might be done while watering while others might mean making a dry trip or several dry trips around the field.

Another use might be crop moisture control. Hay as an example, when the leaves are too dry the stems are finally dry enough to bale to produce good hay. The older solution is to catch the hay with the early morning dew on the leaves making them higher moisture so they don't shatter but the stems are dry enough to produce good hay because they don't absorb moisture that fast. The problem is with modern balers and their high capacity we can't afford to only bale when the dew is on. Can you moisten the leaves just before bailing keeping them in good condition while it is baled so you can bale clear through the day instead of only for a few hours in the middle of the night. Same thing for crops like beans that are very sensitive to their moisture conditions. Can just a little moisture be added back if needed to prevent splits?

Another possible would be to eliminate swathing in the haying operation. Lets say that your head had a cutter in it and it just ran back and forth cutting the hay as the sprinkler went around. It is an operation that doesn't require huge amounts of horsepower applied to the ground. Mount rakes on the front tractor doing the baling and you could do the same operation in on fewer passes and without as much equipment or operators. The advantage is hay not in windrows dries faster Fewer passes would also reduce ground compaction and maybe damage to the crowns of the crop mildly increasing yield. Getting the hay off the field faster would reduce watering stresses.

Detasseling corn in seed growing operations would be another good use that would be comparatively easy for a robot to do.

Are there other tasks that you can think of that would save the farmer time or money or improve farming that the center pivots could do?

S. Problem: Protecting basement concrete.

In much of the state alkali and moisture combine to destroy concrete over time. This is costly directly but it also is an energy waster because of how much energy went into making the concrete in the first place. There are several sealants that can provide some protection and some of them like the tar based ones have been in use for a least most of a century. The problem is that if the concrete cracks then it lets the water work around them. Can you come up with a way to permanently protect the concrete? My best suggestions are the 1/8 inch thick or so sheet polyethylene that is available in huge rolls and /or the fabric that they use for roofing and swimming pools. Can you wrap the basement or the foundations with one of these thus protecting the concrete? The sheet polyethylene would need to be seam welded probably. So you would put down a box for the floor and sheets on the walls of a basement and then weld the components together. Maybe you can come up with some sort of plastic forming system that would snap together and the plastic would actually be part of the form? Water tight basements and radon blocking should be enough incentive to pay for this even if protecting the concrete isn't. Build foam sheets with sheets of plastic built in that can just zip together. Then you might have the rigidity to use the plastic directly as the form plus the foam could be protected from moisture too by the plastic. What is the best way to do this? Is there a better answer? Will it create other problems? For example if you had this envelope outside the concrete and insulation inside it would termites that would normally be exposed on the outside of the concrete be a problem? Can you maybe come up with an new foundation cap systems to eliminate this sort of problem? What about possible rodent damage either to the plastic or to the foam insulation it covered? Build in some sort of wire mesh into the plastic and blocking strips in the foam breaking it into grids? Any other problems to solve? How do you make it really economical?

T. Problem: Grasshoppers.

All over the state we have problems with grasshoppers. Is there some way to harvest them as a crop themselves? Use them as chicken feed or fish food or maybe just as protein in other animal feed? Or just take advantage of the organic gardeners trick and grind them up and spray them back on the area to repel grasshoppers? Use them to grow a grasshopper disease to use the carcasses as bait to kill even more? Build some sort of big wind machine that blows them off the plants in row crops and into a vacuum suction?. Or build something that takes advantage of their instinct like the inclination to jump and lets them catch themselves? If you look at the history books there are thousand of harvesters that have been built and tried so can you make one that works and is economical? Can you find a good value way to use this protein source?

U. Problem: Massive water lose from storage reservoirs from evaporation.

We experience massive water loss from the surface of reservoirs each year. What if we could reduce the loss, make some of the areas economically productive and improve fisheries?

For nearly a decade now I have grown tomatoes on a float on the reservoir. While they are growing in soil they are self watering by wicking the moisture up and weeding is minimal because of starting with fresh potting soil each year. The water provides a moat around the float limiting animal damage and insect damage is also reduced. Greater distance from shore would improve these effects. The farm magazines say that a closed canopy crop uses less water than exposed dirt. Will this apply to water also? If we could cover a percentage of the reservoirs with floats and we could grow a cash crop where recreation is the only profit currently. If this saves water then we would have that water to use else where. I know from experience swimming around the float that the water is cooler under the float in the heat of the day than it is right beside the float. This means that areas of these floats would help protect the fish from late season waters that are too warm. Cooler water also should evaporate less giving a second gain on this front. The hair roots from the plants seem to draw algae and marine insect life so the floats should be good for the fish in that regard too.

There are a bunch of problems to solve here: 1. Legal in that we would have to come up with rules for leasing surface area space for this and laws protecting them from vandalism and theft. Any changes in water use law would also have to be made 2. Cost effectively building the floats is another problem. My current float is 2 liter pop bottles, PVC pipe, extruded polystyrene foam, landscape fabric and bailing twine. It is fine where the waves are small but larger waves would destroy it and it is time consuming to build. You could still use the 2 liter pop bottles for buoyancy mounted in some sort of molded plastic framework? 3. Limiting leeching of fertilizers back into the water is another problem. I have been using potting soil wicks held together with landscape fabric. Likely a wicking fabric with a lower cross sectional area would reduce water contamination. 4. Protecting the floats from winds and waves. A suggestion here would be there was an article about 20 years ago in a science magazine on protecting shore line from erosion with bubblers sort of like fish tank stones. The bubbles in the water absorb much of the energy in the waves reducing the waves. If these were wind mill powered they would only run when the wind blew and the aeration of the water should there again help fisheries. By choosing where you dissipated the heat from compressing the air you would also be able to mildly heat or cool the water 5. Harvesting the crop in this situation would be another problem. What if you built a pontoon type boat so the harvesters could sit on either side of the float and pick under a roof for shade over head and just sail down each row of floats one at a time. See (fig U-1) The hulls could extend under the crop float to provide leg room for seated pickers. Water depth could be somewhat adjusted by taking on water ballast on an overhead tank. Or another harvest possibility is tow the floating crops in chains of floats to a central picking location whether human pickers or mechanical 6. What crops would work here? They would need to be high enough economical value to make it affordable and low enough water usage there was a net gain in water. If the float is covered in greenhouse plastic as tunnels and some water bottles are added above the water line for thermal mass the growing season can be stretched by roughly a month on each end. Thus longer season crops might easily be possible. Having the float on the water already mildly stretches the season even without a cover. A double wall cover might stretch the season even more.

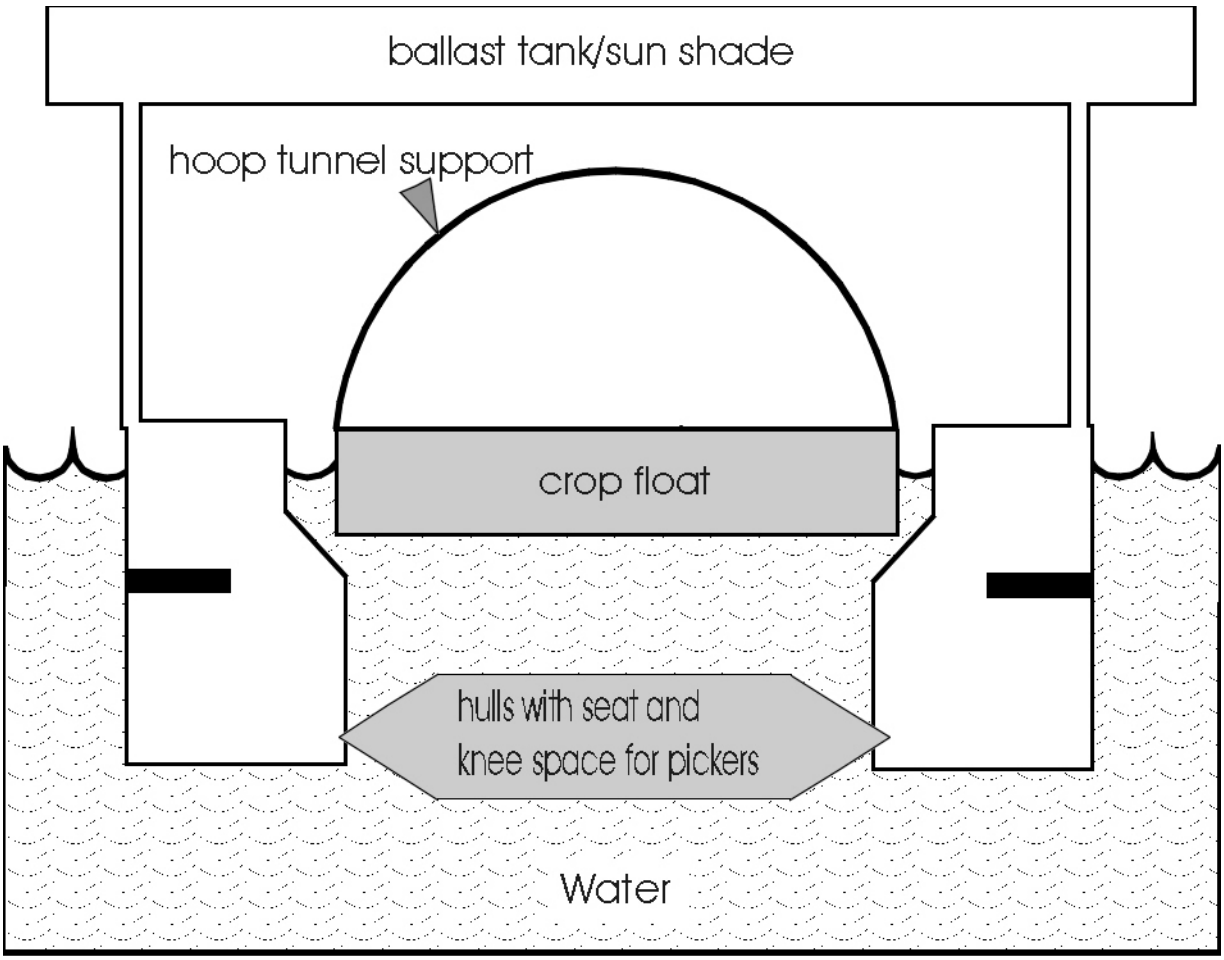


fig U-1

Can you add even more to this system? Maybe make the floats wave generators on large bodies of water? The floats would make transplanting whole sections of the garden to and from a greenhouse easy meaning even really long season crops are possible.

V. Problem: Water and sewer line replacement and the expense from tearing up streets. What if you could replace the line without digging it all up? Better yet what if the replacement pipe didn't have any joints to fail?

If you built a head with a water cutting jet or jets to cut up the old pipe and any other material you needed to remove and tied it to a big vacuum truck you could remove the old pipe and even enlarge the bore if needed. Now if the back edge of the head extruded new pipe then all you would have to feed down to the head to make new pipe would be power to heat and extrude the plastic and a ribbon of plastic to extrude with. The extruding action itself could be used to jack the head forward through the ground. It might be like a continuous hydraulic jack but more likely would be like a continuous screw thread so the proper extrusion pressure could be achieved by working against the tensile strength of the pipe.. This rotary motion would also serve to rotate the cutting head ahead of it for cutting the old pipe and if needed enlarging the bore. Now in the ideal world for sewer replacement probably the best answer would be if the line could get very steadily bigger or smaller slowly so there was never anyplace for anything to get hung up. You would also ideally need the ability to add on branch lines out to homes and businesses whether by having a smaller head to extrude them out from the main pipe after the main extrusion head has passed or by boring from the edge of the street and installing the line by heat fusing it to the main and then boring through the side of the main pipe. You would only have to tear up the street with a small holes every few blocks and could replace all the pipe between by simply letting the head follow the old pipe while it cut the old pipe out, vacuumed up the pieces plus any dirt needing removal and then extruded a new pipe in the bore. The head feeds would be water for the cutting jet, power for the cutting jet, power for the extruder and heater, some sort of plastic ribbon to extrude with and the vacuum to remove all the debris. The head might need to block the old pipe so vacuum wasn't applied on up the old pipe so some sort of inflatable dam might be needed to. You might want camera capability so you could see what you are doing each step of the way; especially while working around other buried wires and pipes.

Can such a unit be built? Can it be made fast enough to be satisfactory? Can you find good ways to handle junctions with smaller branch lines? Remember the less ground torn up the better and that long term reliability is the key.

W. Problem: Hazardous waste disposal.

We have many forms of hazardous waste in the state. The ideal answer would be to destroy them rather than put them in some sort of dump. The ultimate science fiction answer has been to flash all such materials to plasma and then separate them as elements and even as isotopes using a series of electric and magnetic fields. This would make the elimination of nuclear waste viable. While this is totally science fiction both because of the huge energy input costs and because we can't contain the plasma I have a question. If we took advantage of mountains or cliffs in the state could gravity and velocity be used to contain the plasma in one dimension so we only had to contain it in 2 dimensions which we can manage instead of the 3 dimensional control that has holes? If we could reduce the size of the waste stream reaching this could it be done? The ability to reduce nuclear waste to pure clean material and pure isotopes that could be cooked in the reactor again would allow you to destroy nuclear waste rather than storing it. Plus if it could be made economical for other hazardous waste much that is currently stored could be destroyed instead by simply converting it to pure elements. This could both help clean up our environment long term and help make nuclear a more viable power source. This one is out there but it doesn't hurt to ask the question.

X. Problem: Cell phone and TV coverage and maybe improve the ozone layer.

In sparsely populated areas like WY achieving good coverage over all of the state is hugely expensive. This idea originally came out of asking the question could we repair somehow the ozone layer. And that lead to how do we pay for such a thing if we could build it. That lead to replacing little used cell phone and TV towers with a broader coverage high altitude antenna.

Lets start at the beginning. We know the ozone layer has been sampled by balloon instrument packages. That means a balloon can get there. Okay so why can't the same thing work to carry an ozone generator and chlorine capture device up there? The problem is while that altitude can be reached the plastic that makes up the balloon skin has to be so thin it will only hold the lifting gas for a very short period of time. It also has to be able to stretch from a small size at the earths surface to large when fully inflated. The balloons are huge and incredibly fragile and the gas leaks right through the plastic. That brings the question of how might we reduce the need for replacement gas, increase lift in general and build a sturdier balloon.

From a Tarzan novel I first saw the idea of using vacuum as a lifting agent instead of helium or hydrogen. Could a rigid balloon maybe be the answer? Vacuum would provide greater lift and the structure to contain it would necessarily be sturdier. The problem to balance though is the greater weight from the structure. Could a giant Bucky ball be made of composite materials that was light enough but would still allow some vacuum to be applied. Remember that if the ball started filled with hydrogen and then you pulled its partial pressure down you could have both lift from the lighter gas and lift from the vacuum. A lower partial pressure inside would greatly reduce the diffusion rate to the outside. “What about the diffusion rate into the vacuum?”[2] Can this be dealt with?

Lets say you build a standard arched beam and a series of vertices. You would only have three components to mass produce. The 5 socket and the 6 socket vertices and the beams to go between them. Keeping each beam arched there would be light weight string or cable taking the tension load of the beam. Transfer the payload to a central lifting cable and hold things together with cables run from each vertex to a central hub like a suspension bridge. Between the beams string each triangle sort of like a tennis racket. This stringing is to improve strength but more importantly to give a surface for the plastic bag to rest on to keep it from collapsing. Then the outer skin is of course a plastic bag. Add a solar powered payload to run broadcast stuff to help pay for putting it up and also to run a vacuum pump to maintain lift and an ozone generator/chlorine capture unit. Launching the primary lifting agent would be gas but at top of the lift then the primary agent would be vacuum which should allow large aloft times. To maintain location, possibly a propeller of some sort would be needed.

This one sounds like sci-fi but could it be built given current materials? Remember if you can replace several towers with such a device you might be able to have both a one time infusion of cash for the construction cost and an ongoing fee for operation. It might also provide a good TV or radio broadcast platform to further help pay expenses. Even if it took a string of 5 or 6 such balloons to manage enough lift could it be made to pay? Maybe you would need a special launch vehicle to protect the balloons from till they got up to gentler wind heights? What are the winds at that elevation and could you keep the balloon stationary? Do you see other problems or solutions?

Y. Problem: Where to locate solar cells that cause no visual pollution and it always be kept free of coverings like snow or dirt.

The answer I thought clear back in the college years was under highways and side walks. There was a show on TV that talked about a section of glass brick highway in France that had been in use for hundreds of years so glass should certainly work as a highway material. So what if we could make the highway segments in a factory out of glass. By varying the properties of the glass we should be able to build optic concentrator cones into the highway so say light from a six inch diameter circle was concentrated on a one inch circle. An alternate answer would be to mirror the sides of glass cones with just enough breaks to anchor them into the other glass. Would this let you use better quality solar cells economically? Everyone shot this one down in college, mostly because it would be to expensive and to energy intensive to make the glass segments. In recent years I have seen a thing on line that someone is working on solar cells under glass highways. But it didn't say how beyond the general idea of a glass highway and solar cells.

Some things you might want to add. If you concentrate the sun you will generate hot spots so you will need to cool the solar cells. Maybe you will add a thermonic module to generate more power from the heat as it radiates the heat back to the rest of the highway surface. Or maybe liguid cooling of some sort and carry the heat to say a little heat engine generator combo in each mile. The heat difference could still be produced by using the highway as a heat radiator to produce the cool side. This also might allow for heating of buildings in more urban areas during the winter months.

The discussions from college years lead to asking how do you solve the energy problem and make it economical? My answer was this. To make a heat based solar heliostat field work when the sun isn't shining one of the common answers is to have it heating a phase change material to store the heat for when the sun isn't shining and then generating power from that stored heat energy. Most of the answers typically choose one of the alkali metals or alkaline metals or a salt as the phase change material. How about if we changed that and used sand/glass as the phase change energy storage media? Because of the need to cool the glass slowly the fields would need to be scaled large enough so it took days to bring all the glass melted below phase change temperature. Done this way the energy to melt the glass is practically free in that you are producing power with it as well and serving a useful purpose with the phase change energy and the waste heat. So the energy could be both renewable and useful while doing this. Another benefit is the glass would be recyclable.

Other thoughts: What about building all the line markings in at the factory? You could control the orientation of flakes of reflective material if they were a magnetic material and you oriented them with strong magnetic fields while pouring the glass, that way the markings could extend down into the highway. It should also make the markings show better in the dark if done right. This also might let you embed vertically oriented wear resist flakes in the glass to prolong the life of the highway, help aim the sunlight down by mirroring the surface of those flakes, create traction guide zones so the car tended to drift to the center of the lane and finally improve traction by providing sharp edges for the tires to hang on to. You will have power lines buried in the highway so would that make a power transmission system help make electric vehicles more viable? Possibles: a linear induction motor built into each lane or maybe a simple induction power transfer system and mount a pick up for it on the vehicle so that it floated along just barely off the ground. Say maybe a combination of small wheels for low speed and bump protections and ground effect air flow as speed increased to eliminate wheel wear at high

speed. These power lines might lend themselves to make melting snow and ice off the highway viable. Melt short areas every few miles off with power from the electric grid. Then let the power from the sunlight from the uncovered sections heat the next section in repeating fashion till the whole highway was melted clean. Also it might be desirable to build in some sort of tracking strip for future possible self driving vehicles. Likely it would be an embedded set of passive RFID chips that the car tracked. The chip could then be encoded with information on upcoming things like corners, stops, forks in the road, and maybe grade of the road. A different vein you might want to make all or some of the reflector posts small cell towers providing complete coverage. This might in the future also allow you to make a smart highway that the cars communicated things like wheel slip and temperature to so the highway itself could then warn other cars about about adverse conditions. Each car passing would act as a sensor reporting on the current condition of the highway and then the highway would feed that information back to the next car.

The highway would have an upper glass layer designed for easy replacement of segments. Below it would be a support structure with big dimples to force each section to a particular location. The lower section would have the power lines, possibly hot and cold liquid lines and probably conduits in it for things like fiber optics. Both upper and lower segments could be made in the same factory. Between each upper segment there would be an expansion strip. Possibly the section to section interface would include fingers like old bridge expansion joints to reduce road noise from section transitions. They would also include big round dimple sets to lock each segment to the next horizontally and vertically. To replace a segment you would lift 2 segments at a joint, hinging both up. To replace strips of highway you would do that, then just lift the next segments out. When you got to the end just hinge 2 segments back in. You might want some sort of traveling overpass so you only had to slow traffic down while you worked below it for major replacement jobs. So what else can you add? How do you make it work? Can you improve on it?

Z. Problem: At times it is advantageous for farmers to burn fields but it makes for bad air and health problems for people.

Can a tractor powered traveling burner scrubber be built? It should put out any fire as it travels, produce a clean burn and minimize the amount of particulate pollution. In the dream world it would also produce a controllable depth of soil sterilization for weed, fungus and insect control and it should actually generate stored power as it runs from the burning. It also should ideally be simple enough the farmer can build it themselves. How many of those goals can you reach.

It might look something like this: A large flat fire brick lined box open on the bottom with a continuous row of tires designed to float independently out the back to stamp out any unburned fire, A propane tank and a couple of burners up front to provide an ignition source, a large PTO powered fan ducted to various locations to create a swirling tornado of fire under the box and finally a scrubber of some sort on top to do the pollution control. It might also have a set of flails underneath to chop taller stuff like cornstalks or brush to get a cleaner burn while at the same time fanning and guiding the fire.

Can such a thing be economically built? Maybe it will be to complex and to expensive for the average farmer to buy but maybe he can rent it from the local coop when needed? Another use would be burning fire breaks in grass and brush lands during fire season and hopefully doing it faster, safer and with less man power than is currently needed to do the same thing. So spring and fall the coop might have the farmers as the rental market and the local fire districts through the summer fire months.

Appendix #2

Now for a few wild ideas that really don't benefit WY that have been added in the food for thought category.

2A. Peanuts.

Being a real fan of peanut butter and having heart trouble I wish someone would make or breed peanuts that made peanut butter that was very heart healthy. Can you get peanuts to produce high levels of the Omega oils. Do away with fish and fish oil and so on and instead have a peanut butter sandwich. Even better is if the peanut butter could be made to stay fully emulsified without hydrogenated oils.

2B. Hurricanes

Everyone talks about the power and the energy in a hurricane. What if you could tap that energy and haul it home? Suppose you built a huge ship designed to live in a hurricane, from the top side it would deploy a long string of wind mills flying through the air and from behind a whole row of submarine pods with propellers. Let the wind mills drag the ship and use the submarine pods with propellers to also generate power. Dump that electricity to the ship and convert it to hydrogen gas for storage on ship. Sail with each hurricane until it dies out or until it makes landfall where you can't follow. Sail down and pick up the next storm and repeat. While sailing to the next hurricane unload the hydrogen to a tanker. Spend half the year chasing storms in the northern hemisphere and half in the southern so the ships could be in fairly continuous year round use. Remember the power you can get from a given wind speed increases exponentially with speed. With 100 mph plus wind speeds suddenly your power generation will look good.

What might the top look like? First off a standard windmill won't work because you need something for the rotor to work against to generate power since you won't have a tower. Another problem is the cable tying a series of these together would invariably get in the rotor sweep unless it went right through the middle of the rotor which isn't practical. The obvious answer is of course counter rotating rotors that can react against each other. If they were on the same axis you would still have problem of the cable. As a result say you mount them on a long bar of some sort and run the cable up through the middle of the bar.

The next problem is how do you get them up in the air. Remember you not only need to support their weight but also keep the bar fairly level in extreme winds, lift the cable between each segment and finally overcome the Y axis component of their towing force. You designed each bar as a large flying wing and mount the rotors as trailing rotors at each end of the wing. Add control surfaces for flight stabilization and for steering. Use the lift of the wing to overcome most of the weight when they were deployed in high winds. Now even with all of this you would still need more lift. On top of the cable you put a really heavy duty lighter than air craft. It would have to be a rigid dirigible to withstand the weather. It would likely be fitted with a bunch of lifting rotors besides. If it was capable of lifting a few of the wings off the ship under static load vertically and as each of the wings began to get wind you could lift more and more off the ship till you had them all deployed like a kite. Remember that this kite has conductors between levels so it should be a lightning rod too so can you tap the static electric energy of the clouds in this design some how?

This creates a huge steerable sail to do the pulling on the top end. This would let the storm tow the ship along with it. At the bottom end you now need a sea anchor to pull against. There again the counter rotation problem sort of rears its head. While in water you could counter act it this would cost you efficiency. This means each propeller would actually be a counter rotating pair. You wouldn't want the drag of a bar between them in the water meaning these would be on a common axis. So how do you keep the cable from fouling then? How about if you deployed 2 tails behind the ship out in a V shape. The pods would steer themselves outward and the cables would be protected from fouling just like a down rigger lets you run multiple lures in fishing except instead of pulling down the pods would steer outward. This gives the advantage sweeping a larger area of water and reducing wake turbulence between pods.

As for the ship itself it will have to be special in a number of ways. Remember first it has to be designed to live in really rough seas and it has to be able to deploy both the kite and the tails while in moderately rough seas. It will also need to be able to sail backwards quickly for short periods of time as you may need that ability to increase air speed while deploying the windmill kite to have enough lift to do it in calm enough winds. Turning around with the kite deployed is problematic so it will be designed to either be fairly symmetric front to back or sail backwards while the kite is deployed. The ideal answer for stability is of course to make it a submarine. The problem is size needed to hold the kite components makes submarines almost impossible. How about if you built it twin hull with most of the buoyancy running below the water line like twin submarines. If the deck between was kept light weight and somewhat open then the water crashing down on it could drain through.(could this draining water be another hyrdo source for power?) Maybe the hydrogen would be stored as cryogenic liquid. With constantly passing wind and water getting rid of the heat should be fairly easy. But as heavy ballast might be desirable in such a ship storing the hydrogen in hydrides would also be practical. Liquid would probably allow faster transfer to another ship or shore station.

Could some such a ship set up be built with current materials economically to produce power? Remember you might have another small gain possible in that because storms grow exponentially so could a number of these ships reduce the severity of the storm by draining off a percentage of the storms growth rate. Remember even small difference in growth rate in exponential systems make a major difference in final size. A final tiny advantage would be continuous weather monitoring from within the storm maybe improving predictions.

2 C. Drought and Famine in Africa.

If you wanted to help at a small group or organization level, you need to find a reasonable cost way to begin to help them help themselves. Say the goal was a church group or a smaller community group to send support. In Africa that means either enabling them to grow enough food to feed themselves or to produce a salable product to pay for food imports. What resources do they have there? Lets assume for a minute it is extremely limited and the answer is manpower, sun, and dirt. The ideal product is labor intensive to take competitive advantage of the comparatively cheap labor, low bulk, low weight and decent resale value. So combine those two thoughts and you know what you are looking for as ideal.

Here is an idea that doesn't quite make the ideal but comes close. . How about ceramics or glass products. In most areas you can find clay sources from dirt for ceramics and in at least some areas sands that will provide a clean enough base for glass. Problem both require a fuel source. We do have the sun. So lets take the solar mirrors invented by SERI(US government labs from the mid to late 80's) and use them as our heat source. They are simply a mylar bag around about a foot wide strip of plastic and pulled to a gentle vacuum to form a parabolic mirror. The focal length is adjusted by strength of vacuum. Some hand operated vacuum pumps to run that. The mirrors are light weight and comparatively cheap. They couldn't be used in the US because the heliostats were too expensive and they need protection from the wind because they were fragile. If you used people to aim them and people to tear them down and fold them up in bad weather they should work there. Cost is small and they are light weight, compact and would be easy to ship in. Enough of them would give you a heat source for a kiln as well as waste heat for drying pottery, cooking and possibly water distillation. Take someone who really knows pottery and begin making pottery for resale. Ship it out on the same trucks and ships that are bringing food and supplies in.(which should cut the costs for shipping both ways) Only a small portion of the kiln time would need to be utilized for resale pottery. The rest could be used to make good quality bricks for housing. To start up the solution would be to pay for labor in food. It would take time to get artisans trained so it wouldn't be a quick start up but would be in the realm that a smaller organization might manage. It couldn't be a total solution it would be a baby step towards a solution. Glass would be the same thing but more gear would have to be brought in from the outside. If you adhered to KISS you likely still could keep it to human powered equipment and fairly cheap. Only a good crucible and some simple hand tools would be needed. The number of skilled workers in to teach in both cases could be fairly small and imports to do it could be fairly small.

As for growing their own food you need to find a way to cut crop water usage in the drought areas. The answer used in many parts of the world is green houses. Green house plastic is fairly cheap so if a durable and affordable frame work could be provided, they could begin growing their own crops in spite of the drought. There are a number of semi closed cycle systems being used world wide so by combining plenty of labor and the best of the ideas from those systems a workable system should be able to be constructed. There again if the glass was available from the previous suggestion it might be possible to build glass green houses locally with proper planning. What else do you need? For a greenhouse to work in drought areas likely you need some sort of condensing water recovery system. It would need to be affordable and durable and able to be powered locally. Done properly maybe it could provide some refrigeration for food storage at the same time? Possibly the greenhouse would have to have outhouses attached to gather more water? One of the first greenhouses set up might have a crop of bamboo started in one corner to provide framing material for future greenhouses? There are

problems here still to solve certainly. What needs to be added to make it a practical answer? Can you come up with better choices that meet the limits of what is available there to work with?

Credits

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