The Path to Low Cost Abundant Energy.

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Contents

Executive Summary

The energy policies of the US cannot continue on their present course. Prices for dwindling supplies of fossil fuels are rising fast, and will rise even faster soon. People will be unable to afford basic heating and lighting or transportation. Meanwhile evidence mounts that we are doing irreparable harm to our environment. The nation's voters will not long tolerate such conditions without laying down an overwhelming mandate for action.

We offer a three pronged approach designed to mitigate and then solve these problems in a financially beneficial, politically practical, and environmentally and thermodynamically correct manner. These will consist of short, medium, and long term efforts.

The short term approach focuses on legislative actions, conservation efforts, and use of fossil fuel alternatives that are immediately at hand and practical. Small scale use of renewable energy is also employed. These will yield some immediate relief and progress, and set the stage for more.

The medium term approach uses effective legislation to enable more gains, making possible some economies of scale and wider adoption. More conservation measures will assist in stemming the growth in demand for fossil fuels. Meanwhile, the first large scale renewable energy systems will be brought on-line onto the nations' electrical grid.

Not only will this produce many gigawatt hours of badly needed, non fossil fuel energy, but they will establish economies of scale in renewables, while bringing new technology to bear.

In the third and final phase, the process of conversion to renewable energies will be continued to completion. Enabling legislation, combined with the enormous profitability of renewable energy investments will make this a natural and desired consequence.

Utilities will convert to renewables in accordance with the plan and specific thermodynamic designs we have laid out. Usage of fossil fuels will be relegated to niche markets. The gains will encompass financial security, business profitability, ecological salvation, and the elevation of the lifestyle of all persons.

The final conclusion is that a phased, well thought out conversion from our almost total dependence today on imported, expensive, and damaging fossil fuels to renewable energy sources can be made. The result will be a prosperous society, freed from the expense of fossil energy, the uncertainty of supplies, and the environmental harm entailed. All persons will benefit.

Introduction.

In the United States we have recognized that we have serious issues concerning energy supplies and the cost of energy. There are several aspects to the problem.

Firstly, there are the financial issues. The costs of most types of energy are either at, or well beyond, their historic highs. It is widely recognized that these costs will now escalate steadily, as supplies dwindle and demand increases. There is concern about the impact of these costs on the financial well being of our people. Competition with the growing needs of Asian and other economies will further drive prices upwards, especially in the short term.

Worse than this, all types of businesses have been placed under great financial stress, to say the least. Farmers cannot afford fuel to power their equipment. The future of the family farm is threatened. Businesses must pay exorbitant rates for the energy they use in manufacturing and other activities. In an effort to stay afloat, many businesses are being forced to lay off uncounted thousands of workers. Everyone's standard of living is suffering.

Even the large companies producing today's fossil fuels must look to a future of uncertain supplies. They must find ways to diversify and stabilize their portfolios of energy and equipment. The days of large profits, even for them, are numbered.

Then there are the international issues of security of supply. Most of the remains of the world's dwindling Oil supply are located in Countries that are, to say the least, unstable and potentially hostile. Some feel that the US is are already at War over Oil. While certainly the American People would never countenance the taking of the Oil property of foreign peoples by military force, it is also true that attempts to stabilize the governments of certain foreign countries would lack their present urgency if doing so were not in the "Self Interest" of the US. The same can be said of other Nations who have similar valid concerns.

There is a growing concern about Global Warming. Increasingly it is being recognized that profligate use of fossil fuels has led us to the brink of disaster in this regard. Recently, the news has held accounts of the Governments of entire nations appealing to the UN to act, to prevent the complete submersion in the Sea of their whole countries. While, here at home in the US, many coastal areas are at risk. And we are increasingly subject to wild extremes of weather and unusually violent storms, leading to much loss of life and property.

There is a wide consensus now that these problems exist; that they are real. People are beginning to ask about solutions. But there is no consensus on how to move forward. No agreement on what steps to take. No understanding on

which solutions are to be preferred, or even if there exists a comprehensive solution.

It shall be the business of this white paper to outline the best solutions. Here we will explain the paths forward and delineate the steps necessary. In the process it will be seen that the solutions can be in every way positive. That it leads not only to abundant, affordable energy, but also to the solution of the above problems, as well as financial growth and security.

What is the Problem ?

This paper concerns itself with the pressing issue of securing low cost, abundant energy for the US, and indeed the world, while at the same time, forging solutions to the associated problems of global warming, security of supply, and financial growth and stability. This is an immense issue, and the problems resist a simple statement.

For the sake of both brevity and clarity, we will attempt to summarize the problem below, without exploring the details of each facet of it. Thus we may list the issues as follows:

Financial Impacts of Energy Costs

Energy costs are already high by historic standards. It has become obvious to everyone that these prices are only the beginning of what is to come.

As fossil fuels become more scarce, energy costs will inevitably rise much higher. In addition, world population increases will continue, leaving more people to compete for an increasingly scare resource. Obviously, this will drive prices higher still.

Continued terrorist acts will produce both real and perceived threats to the lines of supply. This will act to make the costs of energy not only high but also unstable and unpredictable. This level of unpredictability will carry its own level of instability into the financial markets.

It is obvious that high and unpredictable fuel costs will impact the financial performance of the Nation, and the financial well-being of every person. This is enough to greatly reduce the standard of living of every person in the US and the world.

This problem is already serious. Many businesses have failed that would not have otherwise. Other businesses are forced to cut costs sharply, costing thousands of persons their jobs and security.

Manufacturing businesses are under particular stress. They are forced to enter into an unhealthy cycle of international competition that ultimately costs manufacturing jobs in total, and lowers everyone's standard of living. Expansion of business and thus creation of jobs is greatly impeded, to say the least.

Farmers pay an especially high price when energy costs soar. While farmers must use energy rich fertilizers and fuel consuming heavy equipment to produce vital food supplies, they find it increasingly difficult to recover these costs. The future of the family farm is seriously threatened, while even the largest farms are under intense financial pressure.

Adequacy of Supply:

As our population continues to increase, and as we act to preserve and improve the quality of life of each of our citizens, there is an obvious need for greater supplies of energy. We may fairly say that there is a minimum per capita energy requirement that must be met.

It is at the least improbable that any efforts at stabilizing population growth would ever succeed to the extent of ending, or even significantly reducing the population growth rate. As it stands now, only a great disaster would have the potential to accomplish this. Obviously, we would seek to avert such a disaster.

Given the inevitability of population growth, it follows that the secured supply of energy must increase in like manner, or serious disruptions will occur. Although energy conservation is of great value, and is to be sought after, it ultimately is not the answer, as the continued growth of the population will finally overwhelm any possible conservation regimen.

However, domestic production of energy in the US from fossil fuels peaked long ago. Alternatives that have been pursued up until now such as Nuclear, have come with their own huge costs, and have proven inadequate or grossly undesirable. Thus we have been led to the importation of vast amounts of foreign fossil fuels.

Ultimately, this cannot be sustained. Not only will we destroy life on the planet through the unconstrained use of the remaining fossil fuels, but these fuels are finite in supply. They will run out. There is no question of this, it is simply a matter of time. Thus, as matters now stand, there is no assured path to an adequate supply of energy in the US for the future.

Security of Supply

At present, the US, and indeed the world's energy supply is heavily dominated by fossil fuels. There are significant nuclear and hydropower resources, but these are not likely to expand much beyond their current levels of contribution. In the case of Hydro this is because many of the best resources are already developed, while there is strong opposition to overdeveloping those few which remain. Nuclear power expansion is almost impossible, given the huge costs, waste issues, and universal opposition to such a course. Of course one of the greatest concerns here is also that nuclear technology may also be misused to create weapons.

Since fossil fuels will therefore be the dominant source of energy unless something else is done, it can be seen that security of supply will be a major issue. This is because of the obvious fact that most of the world's remaining dwindling supply of fossil fuels lies in the hands of countries which are unstable at best, and openly hostile to the interests of the US at worst.

However much we may act to "stabilize" these countries, this situation is basically unalterable. These regions will never be the stable, democratically ruled nations we would wish them to be. Nor will their policies ever come to favor the US to the extent we would wish.

As a result, Terrorism, whether state sponsored or not, will remain a way of life in these countries. This will threaten the stability of energy supplies coming from these countries no matter what else is done. Furthermore, the official policies of these countries will certainly always favor their own financial and political interests at the expense of those of the US. Thus, even before the supplies run out, their availability to the US is a matter of grave doubt.

Global Warming

Many persons once scoffed at the idea that human activity was gravely altering the climate of the earth. Early adopters of this belief were derided as being alarmists, and ill-informed crackpots.

This is no longer the case.

An overwhelming body of scientific evidence now exists which proves conclusively that global warming is a fact. Indeed, many are beginning to believe that it not only exists, but has already progressed much further than even the believers had thought.

It is now well understood that the consequences of uncontrolled global warming would be catastrophic. Entire island nations would be wiped out. Coastal regions of all countries, including of course the US, would be devastated. Coastal cities, including New York and many others, could find themselves partially or completely destroyed.

If the use of fossil fuels is allowed to continue, and even expand, up until such use is finally ended by running out of these fuels, then the worst possible scenarios foreseen for global warming will take place.

This will leave us without fuel, precisely at the time when immense populations, and a grossly unstable environment, will scream out for the expenditure of massive amounts of energy to offset the destructive effects of global warming, and to preserve our very lives in the face of these effects. Consideration of global warming alone, without the other great issues of supply, security, and finance, would lead us to the obvious conclusion that we must not allow the unrestricted use of fossil fuels to continue beyond the present times.

The Outline of the Solution.

At present, the US is expending vast resources in a vain attempt to support the status quo in energy. A less wealthy Nation would not even be able to attempt efforts of this magnitude.

Consider that at the present day, counting both civilian and military personnel, and those on the scene and those supporting them at home, we have perhaps 300,000 persons or more engaged in work to “stabilize” or “pacify” areas in the world from which we either derive our fossil fuel supplies, or from which terrorist attacks against them may originate. This involves the direct expenditure of at least a billion dollars a day. Further, we have lost over 3000 American lives in the effort.

Despite this heroic effort, we are no closer today to stability or peace in these regions. There is no real prospect that there ever will be peace or stability in these regions. Besides this, we cannot use these fossil fuels anyway, without disastrous results. So, what is to be done?

The answer is obvious. We must make a clean break with this policy. We must move instead to a sustainable future, while preserving stability for the present, and bringing some measure of immediate relief to our people.

In the US, we must undertake a very diverse set of complementary activities that will all act together in pursuit of our goal of abundant, low cost, sustainable energy. These will combine, both in the short term and the long term, to assure that our goals are reached.

The eventual scale of these activities must be massive. A scale not less than the scale of our present efforts to maintain the status quo. We must deploy our resources productively, on this large scale, to incrementally change our entire energy supply to a sustainable, renewable, carbon neutral future base.

In outline form, here is the solution.

The Short Term.

In the short term there are many varied programs that can be undertaken with immediate payback, both in financial terms and in terms of relief for people.

A. An effective legislative program must be put forward at once to move us quickly forward. The legislative program must advance each of the items listed below. It must remove barriers and supply incentives to proceed as outlined. Feed in tariffs, grid interconnection, investment incentives and tax breaks are among the instruments to be used to shape policy and encourage positive actions. Further details are listed in the sections below.

B. Conservation Efforts.

1. Enabling legislation should both support and reward conservation efforts, especially in the early adoption stage. Later, when the benefits become more obvious and the products more available, such rewards will be less needed.

   Beyond support and rewards, in some cases the use of conservation principles may have to be mandated, if only to level the financial playing field. In this area it may be necessary to require that new construction be done to minimum green standards, such as including more insulation, better heating and cooling plant, superior windows, efficient lighting, and the like. Otherwise there will always be a certain percentage of builders who will compete on price alone, and will, in the long term, “cheat” their buyers by saddling them with inferior housing.

2. In the area of transportation, efforts should be made to utilize less fuel for this purpose. Fuel efficient vehicles should enjoy advantages in taxation and purchase incentives over less efficient models. Fuel taxes are not the answer here as they penalize everyone. Rather, direct taxation of the vehicles themselves when sold, plus incentives available to purchasers of efficient models is the appropriate, and fair, approach.

In order to reduce fossil fuels used in transportation, several steps can be taken. These include:

- Purchase Hybrid autos that combine electric motors and batteries with a backup internal combustion engine. Most of the time, this auto will run on electricity, rather than fossil fuel. Mileage of the vehicle will increase dramatically. If the electricity used comes from renewable sources, then even more fossil fuel will be saved.

  Since this option is very expensive today, this is a good area for incentives to be included in the legislation mentioned. Otherwise a typical person will perhaps not be able to justify the expense for such a vehicle. One could start by requiring all Government owned autos to be of this type.

  Next one could require all government vehicles, including localities to be of this type. Grants could be offered to speed up the process and also to lessen the financial burden on less affluent localities.

  By requiring these steps, sales of hybrids would increase considerably. More dealers would carry them. Price competition would improve. And Detroit would be encouraged to produce more such vehicles.

- Use vehicles powered entirely by electricity, such as the proposed Chevy Volt. This displaces a portion of the fossil fuel that would otherwise be used. Some sustainable sources of electricity exist that will save even more fossil fuel.

- Address the largest uses of fossil fuels in transport by encouraging use of the most effective transportation modes. Specifically, haul trailers on trains until they reach the vicinity of their destination, when they can then be hooked to tractors for local delivery.

Then encourage mass transit use compared to use of private automobiles. Similarly, encourage travel by train compared to travel by plane, as far better energy economy is realized in this way.

Address the large amounts of fuel used by heavy equipment, such as construction vehicles, farm vehicles, mining vehicles, and the like by encouraging the adoption of more efficient models.

Any forms of alternative fuels used should come only from sustainable sources. Care should be taken than the actual production of the fuel itself does not consume more fossil fuel than is actually saved in its use. This point is very important.

One must not inadvertently use more fossil fuel in total, in order for a smaller number of individual users to consume less.

3. Owners of existing homes will nearly always benefit from the addition of more insulation, and energy saving windows. Attractive financing or even grants, should be made available for these purposes. At the same time, free energy audits would assist homeowners in making informed decisions about how best to spend their money in this area.

- Insulation is probably the least costly and most effective investment that a home owner can make in the energy area. Adding ceiling or attic insulation plus wall insulation will save both heating and cooling costs. Savings can be very large, particularly if little or no insulation is present to start with. Lower income home owners, who often live in the oldest homes, could be given either low interest loans or grants for the purpose. Using this grant money to re-side their home and add wall insulation in the process will also improve neighborhoods.

- Energy efficient windows are also a very cost effective investment. They, like insulation, will last for the life of the home, and will yield savings in both heating and cooling. Insulated doors are also available.

- Proper use of window shades, that block high angle solar radiation will save cooling loads in the summer, while allowing in lower angle solar radiation for heat gain in the winter.

- Installation of a modern hot water heater will save energy. Further insulating this device with a blanket made for the purpose will make additional gains. As an energy audit will show, most people are unaware of the large percentage of their energy budget that is spent heating water.

All of the items in category 3 above, for homeowners can yield substantial financial benefits in the short term. They are all low in cost, especially the various forms of insulation. Compared to money spent, for instance, on a new auto, these items offer much larger gains and a faster payback.

On the other hand, we must all replace our autos at regular intervals. Take advantage of the regular replacement interval to upgrade the efficiency of your automobile. However, most people should prioritize their home energy savings first, unless they are not the owners of their own housing.

4. Although not strictly a short term item, legislation should favor construction of new homes that are inherently energy efficient. Use of prefabricated wall and ceiling structures containing large amounts of built-in insulation, for example, should be encouraged. More details will be listed in this area in the sections on longer term plans. Legislation may have to do more than just favor such homes, it may have to level the playing field by mandating minimum standards.

5. Changing to modern, energy efficient furnaces and air conditioners will also yield large savings to the owner of the typical existing home. Since nearly every home must have a furnace or an air conditioner, or both, special attention should be paid to incentives in this area.

This is the next logical step after insulating a home and changing windows and the like. Now that the total energy requirement has been reduced, a smaller and much more efficient model of furnace or can be installed. This ensures that the least amount of fuel is then used to service the smaller load. The same may be said of the air conditioner.

6. Energy efficient appliances and compact fluorescent lamps can save significant energy in the home. These should be advertised and encouraged. Many people have no idea how much energy they expend in lighting their homes and businesses. Advertising based on education in this area would help.

7. Since consumers are often not aware of the options for saving energy that are open to them, an educational program should be started in this area. It should be supported financially by the legislation. Utility bills are

an obvious outreach area. Require utilities to distribute an educational brochure in this area.

8. Utilities can also make gains in the area of conservation. Short term investments with immediate payback in energy savings in existing plants should be encouraged. Likewise, efforts made to improve existing electric infrastructure, especially where line losses are concerned should be encouraged. In many cases today, especially in more rural areas, the lines are carrying their absolute limits of power, and must be upgraded, eliminating much resistive line loss.

Much work such as replacing older transformers, raising line voltage back to nominal values from sub-nominal (where it now stands in many places in this country), and reducing losses through faulty insulators and contacts with tree limbs, poor quality connections and the like should be done. It should be required.

C. Development of Small Hydroelectric Power.

Many mature devices are already on the market to produce electricity from very small streams. These devices produce power in the range from a few hundred watts to a few thousand watts.

There are an enormous number of small streams, especially in the many hilly portions of the Country, where a small percentage of the flow could be diverted invisibly, and routed to these small hydro devices. Each could then be grid connected, and thus, in concert, deliver many megawatt hours of energy per year to the grid.

Many companies already produce small hydroelectric power production devices. These businesses have established dealers in the state. It would be straightforward to expand the dealer network. In addition, new plant capacity for production of the devices should be built.

The distributed nature of this resource would avoid grid feed in limitations while at the same time stiffening the grid generally. They would act to directly displace much fossil fuel now used to produce electricity. And they would produce a profit for those investing in them. This activity should be specifically encouraged.

D. Renewable Energy.

Our Country has abundant sources of renewable energy. Two of the most obvious are solar and wind. Yet, adoption of these technologies has greatly lagged. In many cases this is simply because of a lack of information, or ill-informed, very small and localized opposition.

We have abundant wind resources available. Modern wind turbine designs are able to utilize far lower wind speeds than the devices produced only one or two years ago. That opens up large areas of the country to their use. In many cases family farms could be saved by having lease income from turbines located on their lands.

For the present, until wider ranging plans can bear fruit, this small scale adoption of wind should be encouraged. Legislative relief may be required to remove the burdensome permitting process. Attractive incentives and feed in tariffs should be offered.

There are also terrific off-shore wind sites available. Here, out of sight of land, very large wind machines could be installed. While this is not an overnight project, the enabling legislation should be put in place now, to allow the process to start. It is worth noting that these turbines would be located within direct reach of the most energy use intensive locations in our Country, thus yielding their benefits to the greatest possible numbers of persons.

Next consider the use of PV cells. Although every State does not enjoy the solar resource of, say, Arizona, the sun does shine everywhere, every day. Even on cloudy days, PV power can be produced. And PV cells work better when they are cold than they do when hot.

Installation of solar PV cells on homes and businesses should be encouraged. Attractive interconnect terms should be put in place. Solar cells can be installed immediately, sometimes within days. Each watt-hour of power produced saves the owner money, while directly displacing the use of fossil fuels. Solar cells have an extremely long life, and will pay for themselves plus earn a profit. As economies of scale kick in, the up front costs will be driven down, and the payback will come sooner.

E. High Efficiency Batteries.

Since we have established that almost all of the systems advocated, from hybrid cars to renewable energy plants all require batteries for energy storage, this should be an early focus.

Many companies already offer these devices, so they are readily available. But more energy density and storage and recovery efficiency would be desirable. Although attaining this goal is longer term, the first step of funding research at local universities should be taken immediately. Local companies should be encouraged to participate in the activity.

Battery technology has advanced in recent years by leaps and bounds. Anyone using cell phones or laptops is well aware of this. But costs must come down further and storage capacity must increase. The research should forward these goals.

The Intermediate Term.

First of all, more legislative action of the appropriate types will be required. Roadblocks to the adoption of alternative fuels, renewable power, and intelligent dispatching of energy must be eliminated. A system of penalties should force the reluctant away from fossil fuel use when practical alternatives exist. A system of rewards and incentives should benefit those who make progress in the desired directions. Financial instruments should be put in place to encourage and reward financial investments in the right fields. And government sponsored development and research dollars should be made abundant.

Further, investments and legislation should be put in place to support early adopters of hydrogen. It will be found effective to produce hydrogen in an environmentally sound, and financially rewarding manner, using renewable energy to power the process. However, hydrogen use should be limited to those niche markets for which better renewable alternatives are available. There should never be an attempt to switch to an all hydrogen economy.

For an example, wind or PV power can be used to power the hydrogen conversion plants. This ensures that the energy stored in hydrogen will have come, as much as possible, from renewable sources, and will not have exacerbated the fossil fuel shortage in the process. Meanwhile the beginnings of a hydrogen fuel infrastructure can be established. And early users of hydrogen fueled devices can be rewarded with financial incentives.

A much more aggressive and proactive approach to more development of renewable energy sources such as wind and PV should be put in place without delay.

Arrangements should be made for the first, large-scale, grid connected renewable energy power plants to be placed online on the nations electrical grid.

These early plants could be built in those places with clearly superior wind and PV resources.

Much would be learned from this. New technology would be developed. Economies of large scale would begin. And of course, many thousands of gigawatt hours of renewable energy would be produced for use.

More development of alternative transportation and power generation fuels must also be undertaken. Hydrogen, and electrically powered equipment must be made available. The nations businesses will benefit greatly from the large increase in demand for these products. Much use of fossil fuels can be avoided as well. Renewable energy would be used in production.

All of these efforts will combine in setting the stage for the long term. New technology, large financial investments, economies of scale, demonstrated effectiveness and reductions of risk will all play a role.

Businesses, individuals and legislators will be ready and informed so that the next stage can proceed expeditiously and effectively. Resources will be conserved rather than wasted.

The Final Energy Sources.

Since fossil fuels will ultimately become too expensive for use, and too damaging to life there is no question but that our final energy sources are to be completely renewable. For these we must employ Solar Photovoltaic, Wind Energy, Solar Thermal and Biomass, and all the others. We must meet the entire energy needs of our country from these four sources alone.

Can this be done practically ? The answer is a simple yes. The details will be expanded on in the later sections.

The result will be a nearly infinite supply of clean, renewable energy, with no possibility of disruption of supply, no issues of pollution or global warming, and no escalation of price over time.

The Distribution and Storage of the Energy

Our final energy sources must be built in numerous, decentralized renewable energy power plants. Each plant must be designed to supply the entire energy

needs of the region it is intended to support. In addition, a generous surplus of energy must be available for export to other regions, to accommodate downtimes for maintenance, as well as outages and other problems.

For all this to work, the form of the energy must be electric. This is the highest quality energy, and the most easily transported and produced. It can also be stored.

To facilitate the use of these quantities of electricity, the national power grid must be completely rebuilt, on a suitable scale.

When other forms of energy are needed, such as heat or fuels for transportation, the electrical energy can readily be either converted to these forms, or used to produce them.

The Financial Means of Accomplishing the Goal

Both the power plants and the grid facilities will be expensive. Obviously significant financial resources will be called for. It is obvious however, that these resources will be available and must not be wasted.

By the end of the time allocated to the short term and medium term Energy initiatives above, significant progress will have been made. There will be less dependence on fossil fuels than would otherwise have been the case. Significant development of alternatives will have taken place. Economies of scale will have reduced the costs of these alternatives.

If we had many thousands of workers, and billions of dollars to spend, this renewable energy system could quickly and painlessly be built. In the process, we would end our dependence on foreign supplies of energy. All of the money spent would be spent in the US. This would create millions of jobs in industry and elsewhere, and create great wealth for American citizens. And of course, we would immediately end the senseless wars of “pacification”. Thousands of lives would be saved.

Since in the end our dependence on fossil fuels will be over, the persons now engaged in military and commercial efforts to rebuild and pacify the middle east for example, will find their tasks either mostly complete, or less vital to the national interest. Their return home will free up billions of dollars and the labor of many thousands of people for diversion to this project should we so choose.

When the system was complete, it would be ours to keep and use forever. No other country could deny us access to it. The huge amounts of low cost energy it

would provide would greatly benefit American industry. This would make us more competitive on the world market, bringing us still further financial benefits.

Thus, rather than being a cost imposed on society, this project would apply already available funds much more productively, to benefit Americans for generations to come.

The Benefits

In addition to the benefits already mentioned, the growth of carbon in the atmosphere would be halted, and then reversed. Since the US uses much of the world's energy, we alone by undertaking this effort could product this result.

The rest of the world would see our success, and would eventually follow in our path, as their resources allowed. This would further improve the world situation.

With an end to global warming, and the stabilization of the environment, would come a reversal of the damage to the environment that we have seen thus far. We would also see the elimination of other kinds of pollution, such as acid rain.

The remaining supplies of oil and other fossil fuels could be put to much better use than that of burning them. For instance, plastics and pharmaceuticals rely upon hydrocarbons for their production.

The financial benefits, already alluded to, would ensure that our Nation enters upon a sustained period of prosperity. This would benefit everyone, without imposing a cost for future generations to bear.

Energy security and abundance, would likewise persist for the indefinite future. This would allow our people to undertake virtually any project they chose. Benefits to society are the inevitable result. In a period of sustained stability and prosperity the efforts of man could be directed to the arts and sciences, with resulting benefits to all.

The Design of De-Centralized, Renewable Energy Plants.

The fundamental requirement for this design is that it be able to produce an uninterrupted supply of high quality power under all conditions whatsoever. For this reason it includes diverse sources of renewable energy.

These are:

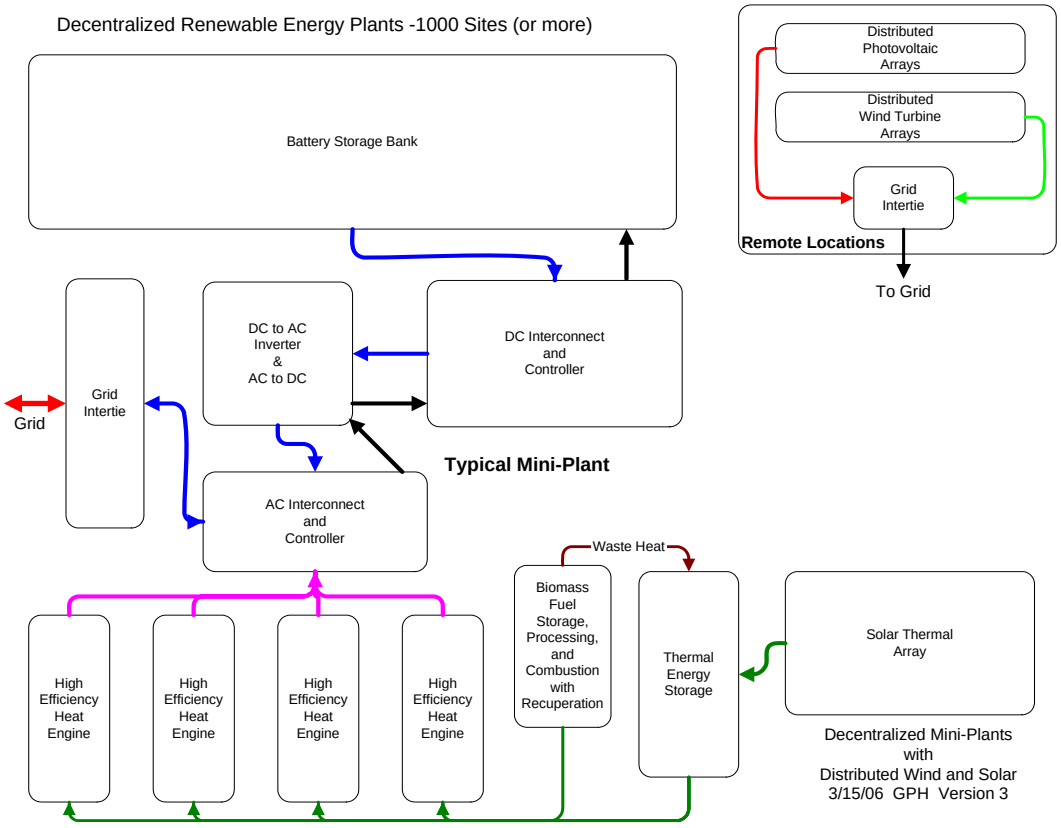
Solar Photovoltaic

Wind Turbines

High Efficiency Heat Engines fueled with either Biomass or Solar Thermal Energy.

Each of these sources would be sized appropriately to be able to supply the full rated output of the plants.

Below is a schematic of the typical decentralized energy plant.



In addition, large banks of storage batteries would be provided. These would be used to smooth out moment to moment fluctuations in the power output of the plant. Such fluctuations would occur during a wind gust for example, or during a period when a cloud drifts in front of the sun, momentarily reducing the output of the solar array.

These batteries would also provide the needed output during the period needed to start up the Heat Engines, following the setting of the sun, or a sudden drop in the wind, or the like. They would be sized to provide full plant output for an hour, which is more than sufficient time for this purpose.

Under favorable conditions, when both sun and wind are available, even higher levels of power would be available than the rated output of the plants. Besides recharging the batteries, this means that very large amounts of power would be available for export via the grid to other areas. In this way, by sharing power between plants, it is expected that use of the Heat Engines may be kept to an absolute minimum.

The Heat Engines, when burning biomass as their fuel, are still carbon neutral, and thus do not contribute any harmful carbon dioxide gas to worsen global warming. They also provide a guaranteed market for our Nation's farmers to sell excess biomass products at a good price.

The rated power of the plants, and the total number of plants, will be designed such that several times the present day energy needs of the country for all purposes combined, are available. This allows for a very large growth in energy consumption in the country, without any need to redesign the system. In this way, the design will be seen to be adequate for the needs of several generations without replacement or redesign. Only periodic maintenance and repair will be needed.

Since only minimal amounts of biomass fuel are needed, and since solar and wind power are free, this means that the combined costs of operation, once the plants are built and paid for will be very minimal. This in turn means that power will be extremely inexpensive, and essentially unlimited in its availability.

It is estimated that the present rate of US energy consumption – for ALL purposes – is about 3.345 Terawatts. We would design for several times this need. Then divide the resulting total by the total number of plants desired. This would give us the needed output capability for each plant. Then each plant would be conservatively designed to easily generate its assigned output.

For example, suppose we design for 10 times the need. This would be about 33.45 Terawatts. Then divide this among 1000 plants. This would yield a requirement of 33.45 Gigawatts per power plant. If a larger number of plants are built, each can be smaller. This is just an illustrative figure.

With this as a target goal, then we will develop below the details of how much solar and wind energy, heat engine capacity, battery storage, and so forth will be required in each plant.

The basic requirement for capacity will be driven as follows. Each of the two primary resources, that is wind and solar, will each by itself be able to supply the entire required output. The reason for this is obvious, as the Sun never shines at night, nor does the wind always blow when desired. Thus we will often have one source but not the other.

The third source, the Heat Engines, must likewise be able to carry an appropriate load when necessary. However, it may not require the same degree of over design as the solar and wind resources. This is because we will attempt first in all cases to avoid the burning of fuel in favor of using free power, shipped in via the grid from other plants. Thus perhaps instead of being over designed by a factor of 10, as given above for the other two sources, a factor of two may suffice. This allows much long term growth, as well as ample downtime for maintenance, while still meeting the needs.

Thus, in summary, each of the power sources is to have a rated power generation capability as follows:

> 33.45 Gigawatts of Solar Photovoltaic per PV site.
>
> 33.45 Gigawatts of Wind per wind Site.
>
> 6.690 Gigawatts of Heat Engine Generation from Biomass and Solar Thermal Collectors.

Several high efficiency heat engines will be provided at each engine location. Together they will combine to produce their needed total output.

It is expected that some use of the Heat Engines will be made on a daily basis. It is too much to hope that there will always be enough wind or sun at every moment. On the other hand, the full output of all Heat Engines combined will seldom be needed. This means that these engines can be operated flexibly as required, with only one or two operating, and more brought on line if and when needed. All engines will be used on a rotating basis, to equalize wear, and assure that all are exercised and known to be in good operating order at all times.

It is clear that not all of these resources will be co-located. That is, although our example cites 1000 plants, each plant would be further split up by resource.

That is, wind power generation would be done at sites best suited for that purpose. That is, sites which are endowed with an excellent wind resource. They must also be spaced sufficiently from other development to avoid concerns about noise, safety, and the like.

PV sites have more flexibility by far. Much of the PV resource can be located on existing and future buildings. Every building has a rooftop for instance, and can have some of the resource distributed there. Other good locations are covered parking areas, as well as actual field installations. More focus can be placed on PV installations where the resource is better, while wind can be emphasized at other sites.

The other components, such as batteries and thermal engines, tend to need more professional attention on a regular basis. As such they should be located on small mini-sites where fuel can be stored for them, and maintenance and upgrades can be easily made. This also provides many sites from which the total resource on line can be monitored and controlled. The engines can thus be brought on-line as needed, in a timely way. And battery capacity can be added to at sites where experience shows it to be inadequate.

Solar Photovoltaic Power.

Solar Photovoltaic power is the most reliable source of power we have in our power mix. That is because the Sun shines every day without fail. Naturally, on some days the sky is overcast. But even on those days, modern solar cells are quite capable of providing a very useful amount of output. The obvious design procedure is to design for the overcast days, and then have a surplus on other days.

In line with this design philosophy, we assume that there are only 300 watts per square yard of solar energy available. We further assume that the cells used are only 15 % efficient. This gives us a solar yield of 45 watts per square yard. This value is extremely conservative.

There are 3,097,600 square yards in a square mile. This means we can expect a yield of 139,392,000 watts per square mile. This is 0.139392 Gigawatts. So each of the 1000 sites must have a distributed covered area of 239 square miles. This is a space of about 15 x 15 miles, located mostly on building facades and roofs.

To continue our example of 1000 sites nationwide, this means that each solar site must have a total capacity of 33.45 Gigawatts. This capacity can be located all over the place, on existing buildings, on new buildings, in fields, and so forth. So while we are calling this a PV “plant” it will actually be totally distributed over a large space per site. In the 1000 such spaces nationwide, the entire required amount of PV power needed for the nation will be produced – for all forms of power, not just the electric power, but power for heating, transportation, and so forth.

Where possible, the solar cells will be mounted on Sun tracking mounts, that track the passage of the sun in two dimensions. This will maximize the output of the panels at every point in the day, and at all seasons. In addition, maximum power point tracking solar inverters/controllers will be used, which will ensure that the maximum possible amount of energy is extracted from the cells at every point during the day. The mounting of the cells well above the ground will ensure abundant cooling for the cells, which minimizes their operating temperature and thus maximizes their output.

On most days, the output of the solar arrays will exceed their design ratings. This excess power will be available for export to adjacent areas via the grid.

Wind Power.

On 1000 sites nationwide, we will locate wind turbines which are capable of providing an output of 33.45 gigawatts of energy per site. Since the wind resource at each site will not necessarily be perfectly optimum for wind generation, in general it will be essential to use Turbines whose design has been optimized for low wind speed power generation.

This means that sufficiently tall towers must be used, to keep the hub height of the turbine well above ground level. In addition, longer blades will be used, giving a greater swept area per turbine. And finally, the blades will be shaped optimally for the wind speeds expected.

Modern turbines, rated at 4 megawatts each will be used. To achieve 33.45 gigawatts of output, we will employ 8,612 turbines at each site. They will be spaced appropriately, which will minimize any interactions.

On most days and nights, given the height of the towers, and the optimization of the designs for low wind speeds, the wind array will be able to produce a very large percentage of its rated output. To ensure that an even greater percentage of rated output is available, we will employ a surplus of turbines above that required to just meet the rated output. A starting point for this would be to employ 10,000 turbines at each site.

On favorable days and nights, the array will thus be capable of producing a surplus of power, above its rated value. Since this surplus will be unneeded locally, it will be available for export to the grid, to make up for any shortfalls at adjacent plants.

Again, even though we imagine 10,000 turbines to be associated with each of the 1000 plants, these can be further distributed throughout the area served by the

plant. This means that they will likely be divided up into several smaller wind farms, each located in an optimum wind location to the extent possible. Many will be located offshore, out of sight of land.

Energy Storage in the Batteries.

Obviously, the power provided by each facility has to be absolutely stable and reliable. The frequency and voltage must be held constant, and sufficient wattage must be available at all times.

There will be both short term and long term fluctuations in the availability of wind and Sun of course. Long term shortages, such as calm winds for a whole day, and of course, lack of sun at night, will be accounted for by the Heat Engines. The short term fluctuations, such as wind gusts (both up and down) or clouds drifting in front of the Sun, will be handled by the battery storage system.

Sufficient energy must be stored in the batteries to accommodate any conceivable short term fluctuation, as well as to provide backup power while the heat engines are started at the beginning of a long term fluctuation.

Since the rated TOTAL output of each plant is only 33.45 gigawatts, then to provide two hours of backup power, we need at total battery storage of 66.9 gigawatt hours of energy.

This is no problem. There are 1000 amp hour batteries, with 48 volt outputs, readily available for this use. Thus each single battery provides 48,000 watt hours of storage. We thus need 1,393,750 batteries per site.

This is no big deal. Stacked 4 high, this is an array of about 590 x 590 batteries. Since each battery needs just over a square foot of space, we need about 350,000 square feet of storage space, which is simply the equivalent of a large shipping warehouse.

Obviously, additional batteries will be provided to ensure that drawing the rated total amount of energy from the battery reserve will not totally discharge the battery bank, thus damaging it or shortening its life. The real total battery bank size thus will be about 1,500,000 batteries.

Since the total energy draw will not in fact be 33.45 gigawatts, given the over design of the system, this means that battery power alone will be able to sustain power output for many hours in a typical scenario. In fact, some modest amount of power will even be available from the batteries for export to the grid to

adjacent areas, for a modest period of time. This will ensure rock solid stability of the grid in the face of extremely adverse circumstances.

As mentioned previously, the batteries will be located at the mini-sites, where centralized management and maintenance is available for them.

Backup Power from High Efficiency Heat Engines.

The heat engines will of course be used at those times when the other sources are just not available in sufficient quantity. This may happen regularly, but the total capacity of all the available heat engines will almost never be needed. Rather there will generally be a need to use only one or two of them, which can be done on a rotating basis to equalize wear and assure maximum availability.

Energy for the Heat Engines will either come from burning of Biomass, or from the Solar Thermal Collectors. Both of these sources will be able to recharge the heat storage tank, so that Biomass will only have to be used when the heat storage is depleted. This will further reduce the amount of Biomass that will actually be used.

Biomass is an excellent source of energy. It can be produced in any quantity needed at reasonable prices by our nation's farmers. It is renewable, with an essentially infinite supply thus available over time. It is carbon neutral. And, there is little or no release of other pollutants, such as sulfur, since biomass is free of these impurities.

The Solar Thermal collectors may be of the Solar Trough design or the Parabolic Dish design, depending on the temperatures needed by the heat engines. Once heat is collected, it will be either sent directly to the heat engines, if they are running at the time, or it will be stored in the heat storage tanks.

To use the various heat sources effectively, we will require a high efficiency Heat Engine.

The basic heat engine design will consist of the following elements:

A Universal, External Combustor.

This will be designed to accept a very wide range of biomass fuels and burn them efficiently and cleanly. There will be a fuel feed system that will grind up the biomass and feed it into the combustion chamber at the proper controlled rate.

A Heat Recuperator will be used to vastly increase the thermal efficiency of the system. This will pick up waste heat from the exhaust of the combustor, and recycle it back to the input of the combustor, preheating the incoming combustion air.

Stack scrubbers and catalytic converters will be use to totally clean the exhaust.

Solar Thermal Collectors and A Heat Transfer System.

This will collect the heat from the combustor or the solar collectors, and transfer it to the heat engine.

The Heat Engine Itself.

These basic components will be used to build an array of several Heat Engines at each site. Together they will add up to the required capacity of 6.690 gigawatts. One or two extra engines will be provided, to allow for maintenance or other unexpected downtime.

Using an array of smaller engines allows them to be brought online one at a time, as their capacity is needed. They can likewise be disconnected sequentially, as the need is reduced. This is much more efficient that using one or two huge engines to meet the load.

Redundancy of this sort keeps the system reliability extremely high. The failure or unavailability of one or two engines will not imperil the overall system.

Note that heat engines are very fast to start up and shut down. This greatly facilitates load management.

As mentioned previously, these engines will also be located at the mini-sites, where they can be maintained, fueled, and operated properly.

The Power Grid.

Obviously, with 1000 major power generation sites nationwide, the power grid will have to be significantly enhanced, to enable efficient distribution of the power. It is very clear that new transmission lines will have to be built. They will have to interconnect the 1000 sites directly or indirectly, to facilitate power sharing. And sufficient grid capacity must be provided to allow for redundancy. The blackout scenarios seen recently in the Nation must be avoided in the future.

Fortunately, in this country we already posses a very large and well developed power grid. Much of the required expansion can be accomplished by improving the existing grid.

There are three extremely effective strategies for improving the existing grid by a factor of many times over. These are:

Moving to Higher Voltage Lines.

Most of the existing lines, particularly in local and regional grid segments, operate at far less than the optimum voltages. These lines can easily operate at two, three or four times their present voltage levels, with the proper modifications of course.

At the same time, the intent would be to avoid the use of the controversial Super High Voltage lines. They will not be necessary with this scheme.

Paralleling more Lines Together.

In the existing grid, for every one run of wire, or line, add two or three additional wires in parallel. This can be done in the same space, with suitable modifications to the support structures and insulators.

Upgrade all Transformers.

Essentially all the large transformers on the grid would be replaced. In their place, new transformers designed for the higher voltages and wattages would be used. These would also be more reliable modern designs, that would be far less likely to fail. They would also permit modern, remote control strategies to be used, further improving the grid.

Obviously, by making an average 3 fold increase in voltage, and using an average of 3 lines in parallel, the capacity of the grid would be increased by 9 fold. By adding new transmission lines in addition, the required capacity can be realized. This grid will also be more stable, reliable, and controllable.

Using the Power Effectively – for All Power Needs.

Electrical Energy is the highest quality energy type, and the most flexible in its use. It can also be readily converted to other forms as needed. Since an essentially infinite supply of Inexpensive electrical energy will be available, some level of inefficiency in power conversion is acceptable, although proper design will minimize this.

The following notes illustrate briefly how electrical energy will be used effectively to meet the various kinds of energy needs.

Heating

Electrical heat would be the heating system of choice. This is because electric resistance heating is 100 % efficient. All energy delivered to the heaters is converted into useful heat.

In addition, with a power factor of 1, there is no waste circulating energy in the power grid. This reduces transmission losses and the need for excess generation and transmission capacity.

Since in this scenario, electricity would be cheap and plentiful, the present premium paid by users of electric heat (compared to say, gas heat) would be eliminated as well.

Lighting.

Compact fluorescent bulbs would be the lighting source of choice. Plentiful supplies of electricity would make these a very economical and energy efficient source of light.

Fluorescent bulbs also generate less waste heat energy. This would limit cooling loads in buildings.

Modern, natural color fluorescent bulbs give a more natural light than the older lamps they replace.

Finally, these lamps have extremely long useful life spans.

Business.

The greatest benefit to business would be the stable, predictable, financial conditions. Businesses thrive best under such conditions.

By eliminating pricing uncertainty from energy costs, the ability of businesses to grow and to raise capital would be greatly enhanced.

The low cost of energy would translate to higher profits. Lower costs also mean better international competitiveness.

Investors would also benefit, as the value of their investments appreciates over time.

The present negative effects of energy speculators would be eliminated as well.

Manufacturing.

Plentiful, cheap electricity would especially benefit manufacturing, by greatly reducing a major cost component of US manufactured goods. This would lead to a competitive advantage. This is turn would lead to the creation of more jobs and to greater profits.

The security of supply would also be a major benefit. Lenders will be more likely to finance long term investments in plants and capital goods if a long term advantage in the marketplace is assured.

Transportation.

For transportation needs, a portable energy source is obviously needed. It is clear that direct connection to the grid is useless for this need. Some forms of transport, such as automobiles, can run effectively directly on electricity, which they may obtain initially from the grid, and then store on board in batteries. Other forms of transport cannot employ this approach.

It is in these latter cases that hydrogen fuels may play a productive role. Hydrogen is not an energy source. Rather, it requires the use of energy to produce useful forms of hydrogen.

To produce hydrogen renewably, the plentiful grid supplied electric energy from wind and sun will be used to run hydrogen electrolysis plants. Thus no fuel source is involved. The hydrogen is broken down from sea water. The low cost of the electricity used, and the complete absence of the use of any carbon based fuel make this approach extremely attractive.

This hydrogen can then be used to power trucks, trains and the like. This leaves only a small number of cases where higher energy storage density is essential, such as in the case of aircraft, where fossil fuels may still have to be used. Such a small usage of fossil fuels is considered acceptable. One could also consider using carbon neutral fuels such as renewably produced Ethanol or BioDiesel in these cases.

Note that it has already been demonstrated elsewhere that neither Ethanol or BioDiesel can be used as the primary transportation fuel, in place of hydrogen, since it is manifestly impossible to produce enough such fuel with the available farmland and other resources.

What are the Benefits of Fixing these Problems?

The benefits are overwhelming. We list a few of them here, in no particular order.

There will obviously be a very significant and very large increase in the wealth and prosperity of all Americans. With an unlimited supply of secure and inexpensive energy available, all members of our society will share in the wealth this will create.

The enhanced competitiveness of American industry and business will result in the natural creation of many millions of new, high paying jobs. If we are wise, we will make our investments in American Industry and Business, thus keeping this wealth at home.

The US will enjoy complete energy independence. No other nation or group of persons will be able to threaten our supplies. Nor will they be able to affect the pricing of energy in this country. The energy we use will be not only unlimited, but infinite in terms of its long term supply, and never increasing in price nor subject to shortages or price manipulation.

With an unlimited energy supply, We will be able to accomplish virtually any project we desire. Ultimately, one can do anything desired, if one can control the necessary energy reserves.

There will be an end of wars fought over energy; over oil supplies. No more of our troops need die in foreign lands in an ultimately futile attempt to assure ourselves of a share of dwindling foreign energy supplies.

There will be an end to global warming. None of the new energy supplies will in any way emit any greenhouse gasses. This of course is aside from any fuels burned on an occasional basis by the backup generators. However the size of this use will be incidental compared to today's levels and can be done using carbon neutral fuels.

There will be a vast reduction in pollution. No more acid rain, or mercury emissions or the like from power plants and factories. All new sources will be completely clean.

With no need for foreign supplies, physical security for America can be much more readily assured. We can control access across our borders as completely as we may desire.

There will be no need for us to police the world or use military force to assure our supply of energy. Military action can be limited to that required to assure our physical security and of course in pursuit of human rights.

Much more could be written about the benefits, but at this point the point is made. The benefits are tremendous, and extend across all parts of society and business.

How do We Pay for it ?

We approach affordability from two directions. On the one hand, during the short and intermediate term efforts, the costs of various options to fossil fuels will have been greatly reduced through technology developments and through economies of scale. On the other hand, fossil fuels will have become far more costly, because of population growth demanding larger supplies in spite of efficiency and conservation gains, and because of their relative scarcity.

Various estimates have been made, and indicate that when all costs, both Military and Commercial, are considered, and when all losses are added, that we are spending more than 1 Billion dollars per day on pacification of the middle east, protection of their peoples and our own from terrorism, and to prevent destruction of vital infrastructure. This spending is also intended to help maintain our access to world oil supplies, and also to protect them from attack by others or from being controlled by elements hostile to the interests of the US.

Of course this effort is doomed to eventual failure. And it comes not only at great financial cost but also at a great cost in lives and suffering.

The suggestion is obvious. By a phased elimination of our reliance on the dwindling supply of foreign oil, we will save billions of dollars. This money can be invested very profitably at home, in the blossoming renewable energy field. Economies of scale will further lower costs. Vast profits would be made by investing in renewable energy sources and selling the energy.

This project would be easily affordable with billions of dollars per year available for it. No new taxes would be required. The jobs it creates would be permanent. The revenues from the power generated would ultimately make even more resources available to the project. Best of all, no one would be at risk serving in a doomed cause in a foreign country.

In Conclusion.

Our proposal has three phases, short, intermediate, and long term.

In the short term, efforts would focus on conservation, developments of alternative fuels using available resources, and the beginning of a renewable energy infrastructure.

In the Intermediate term, the alternatives would be taken to higher levels and their use extended to more areas. Conservation would be taken to the next level. The first truly large scale renewable energy systems would also be built, providing meaningful amounts of clean power, and economies of scale not seen before in this industry.

Our long term proposal is to build a completely new US power system, based 100 % on renewable energy sources. This would build upon the gains and progress already made.

These renewable sources are to be solar photovoltaic and wind energy, plus solar thermal energy, with carbon neutral biomass fuels available in reserve, in highly efficient heat engines used to level loads and for backup.

All energy needs of the US would be met using electrical energy generated at several central sites, and delivered over a rebuilt grid structure.

The amount of energy delivered would be many times more than what we use today and many times the amount that we need for any foreseeable future. Our energy supply would thus be unlimited in any practical sense, and extremely low in cost.

This would enable complete freedom of energy use, with no negative side effects such as global warming or pollution.

Our energy supply would be completely secure and totally under our own control.

We would pay for it by reaping the savings from greatly declining use of expensive fossil fuels. We would have instead invested in renewable energy resources whose operation yields enormous profits. The need to stabilize large regions of the world would be over, or completed. We would save lives and suffering, create millions of new jobs, and usher in an era of unprecedented US prosperity.