Putting Waste to Work: Creating Energy and Fuels while Recovering Resources

A Systems Perspective

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Life is a process of creating in a changing context.

> *When we don't see the changes, opportunities look like problems.*
>
> *Old Theories and belief systems fail in new contexts.*

In order to reach a higher understanding of our world, we must build alliances among people who have different visions and understandings of what they want and what they expect from us. **Think of the "blind men and the elephant" story.**

Engineers are trained to create solutions by using materials, computers and machines.

> Some think of themselves only in that way (these are the ones who give others headaches). Engineers who enjoy working with non-engineers create better solutions.

Entrepreneurs and politicians are social engineers; We all must be entrepreneurs and politicians -- like it or not.

> Our primary task, as human beings, is to work with people who have different skills and different perspectives on the world, and to integrate with them in changing relationships and processes in order to to solve problems and create positive value flows.

System Sustainability

The Engineering Challenge: "Embrace the Whole"

- **Energy is not fuel alone**; it is a set of components in an ecosystem. A dynamic set of forces that support growth only when dynamically balanced, and dangerous when static or extremely unbalanced!
- **The opportunity before us** as engineers, entrepreneurs, politicians and citizens is to create systems that help us to dynamically optimize our fuel/energy/resource mix for sustainable human development.

3/8/07 Sustainovation Presentation

Our fossil fuel addiction and wasteful habits are making the U.S. way of life increasingly vulnerable. We import fossil fuels that are exhaustible, polluting and scarce. Fossil fuels require government subsidies and they harm their customers, workers, and neighbors with second hand smoke and other hidden costs. We need to break this addiction!

Our industrial society *has developed a bad habit* of throwing away natural resources after use– as if they were inexhaustible. These wastes are contaminating our land, water and food,requiring ever more expensive infrastructures. The expenses of throwing them away, healing the sicknesses they cause, and repairing the damage to our ecosystem are paid by taxpayers. This doesn't make sense. We need to break this habit!

E3 Regenesis Solutions, Inc. (E3R) develops solutions that produce clean renewable fuels(including ethanol and hydrogen) from waste while providing energy and reclaiming wasted resources. E3R solutions enable energy, the environment and the economy to reinforce one another and to exponentially benefit the community (E^3). Our technology mix and business processes can enable leaders, producers and consumers who ally with us to create innovative full-cycle systems of production and consumption in which our natural resources are profitably reclaimed, recycled and reused (3R).

Peak Oil

A Supply and Demand Analysis
What is right and what is wrong with this model?

http://www.hubbertpeak.com/

- It is a limited resource model -- And resources are limited! But Oil is not our only resource!
- How does this it help us understand the problem?
- What does it tell us about ourselves?
- What analytical model would be better?
- What are some missing variables?

Single Source and Single Customer Business Models are prone to disasters!

Why are they so common?

Single Factor Analyses always spells trouble!

Yet, people like them because they are simple.

The problem is, ***reality*** is not that simple.

The 20th century socioeconomic model, that relied on depleting limited fossil fuels, wasting other resources, polluting our ecosystem and competing with other living beings to control resources needed by all is a formula for disaster.

Forest to Desert Lu Yongru (age 14) Hebei, PRC 2002

Waste is a name we give to raw materials we are not using productively. This painting by a 14 year old in China shows a sophisticated understanding of what happens when we take resources without replacing them. It is not just the environment that suffers! **If we use them, they are not waste; if we waste them, they are worse than useless to us!**

All processes (living and non-living) use natural resources and transform them into forms they cannot use, but all resources can be used by other process. The key is to match the processes (as nature tries to do) so there is no waste.

Since we all resources are limited, we need to learn from nature how to reclaim resources and put them back to work. If we succeed, we can create a sustainable supply of resources for the future.

Wasted resources deplete and contaminate our environment: They make life less healthy, more expensive and barren, as demonstrated in this painting.

Children's Paintings used with permission of The 1990 Institute.

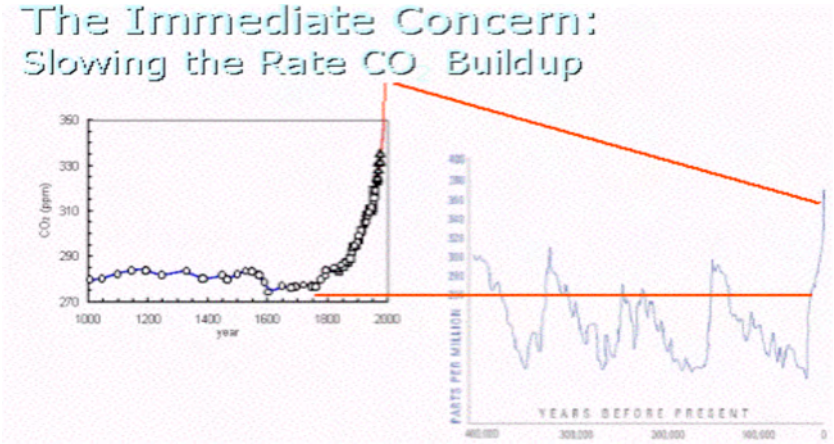
We are coming to realize that waste is simply a name we give to the raw materials that we are not using productively.

Nature does not create waste. While all processes (living and non-living) use natural resources and transform them into forms they cannot use, in nature, these resources become raw materials for other processes. But we are making waste so fast that mother nature cannot keep up.

We need to learn from nature to reclaim our wastes if we want a sustainable supply of resources for the future.

Most important for our future, wasted resources contaminate our environment, making life less healthy, more expensive and less sustainable.

We persist in our unhealthy ways only because we do not understand the consequences of our ways. It is like having our mothers clean our rooms until we are on our own and realize that if we want a nice room to live in, we have to clean it. Mothers who do not teach us to clean our own rooms often have to kick us out before we realize our responsibilities.



The planet has a long history of reversing conditions that led to CO2 cycling between 180 parts per million (ppm) and then spiking to 280ppm. However for the last 400,000 years we have not discovered a period where the planet has reversed a spike created at the rate of increase of the current rise nor at levels now exceeding 380ppm. Within the lifetime of most people now living this level will exceed 500. If the rate of reversal triggers threshold events of climate change at an increasing rates as well, the slow steady changes in climate may become a series of abrupt changes.

We have to put the energy/fuel debate into the context of climate change and species survivability. It is not simply a question of when the resources will run out. We must also look at keeping our ecosystem livable.

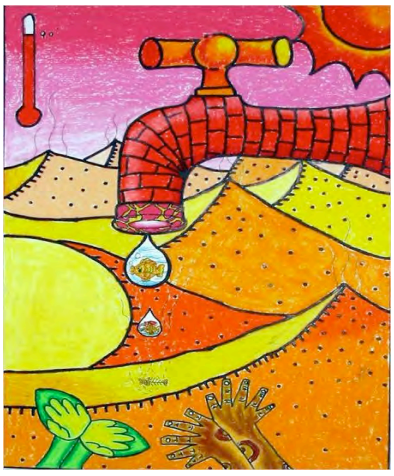
It is amazing, to those of us who see the systematic relationships, that much of the debate on energy independence totally ignores climate change and air quality -- *as if they were not important.*

When we move to renewable fuels, we are not relieved of the responsibility to maintain the ability of the land to produce both food and energy -- while supporting the rest of our delicately balanced ecosystem.

This is a slide from a presentation by Danny Day of Eprida:

http://www.eprida.com/hydro/ecoss/presentations/DOESeq/index_files/v3_document.htm

Climate Change: not just Global Warming
For example, Water and Soil Degradation



Saharan Water: Zhu Siying Age 6, Hubei, PRC 2002

Changes: Zeng Fei (age 15) Jiangxi, PRC 2002

This art work was produced in a contest among 1 million Chinese children whose assignment was to paint about their environment.

The contest was sponsored by the 1990 Institute, the China National Children's Center and SEPA, the State Environmental Protection Agency of China in 2002. The winning 100 paintings toured museums and art galleries in the USA for three years under the sponsorship of the 1990 Institute.

"*Saharan water*" shows awareness even at six years old that the world's useful water resources are in decline due to human activity.

"*Changes*" shows the awareness of a 15 year old howt depleting our forest resources leads to death. The Chinese characters represent "Forest," "woods"," tree" and "a grave marker" borrowed from Christian culture.

Climate Change:
Solar Dimming and Toxic Emissions

It is popular to wear a Gauze mask Li Xiaoxiang (age 10) Hubei, China

The Sandstorm I s Coming Zhu Xi (age 9) Yunnan, China

3/8/07 Sustainovation Presentation

Two young artists from different parts of China described their experience of increasing pollution in their environment. Li Xiaoxiang (10), described her painting with the following words:

"I've been to an industrial city that has many high-rise buildings, vehicles and people. The city has been nicknamed "Dust Bin" -- because of the dust and smoke from all those factories. When it rains people have to wear face masks and hide under heavy-duty umbrellas. Look, wearing face masks has become a fashion in this sad city. How I wish the sky would become blue again and there would be no more dust or smoke! Then the city can get rid of its nickname "dust Bin."

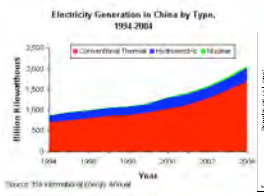
Li Xiaoxiang

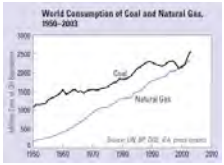
Solar Dimming hides the effects of global warming by preventing the sunlight from reaching the earth. So both problems have to be solved at once. This phenomenon became obvious on 9/11/01 when US air traffic was halted. Suddenly the sun became brighter! Climatologists then realized that the warming effect of GHG emissions had been hidden from view by pollution. They then tested their theory in other locations around the world where air traffic and industrial pollution did not occur. These tests confirmed the relationship.

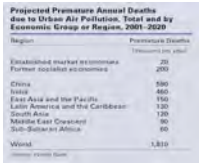
Compare US, China and India with the World

Country	Population 2006	TWh/year	MWh/Capita	Year	Pop Growth	GDP $Trillion	GDP Growth
USA	298,444,215	4,054.6880	13.5861	2004 elect. Estimate	0.91%	$12.98	3.40%
China	1,313,973,713	2500	1.9026	2005 elect. Estimate	0.59%	$10	10.50%
India	1,095,351,995	0.6306	0.0006	2004 elect. Estimate	1.38%	4.042	8.50%

Purchasing Power







USA, China and India are compared above in terms of energy use, population, energy use per capita, population growth, GDP (in trillions of US$ purchasing power) and economic growth (GDP).
More critical than our share of resources is the impact of fossil fuel use on the global climate, air and water quality. As we switch to renewable energy, we also need to pay attention caring for the soil, plants and animals that we need to keep the ecosystem productive.

Note: A terawatt is one million megawatts.

Projecting this out for the next few decades, we can see that we are in this together. We must cooperate to create energy efficiency, lower emissions and manage resources instead of competing over scarce resources.

Gathering data from the CIA World Factbook, and the US Energy Information Administration, we can easily see that the challenge before us is not simply energy or fuels but a complex set of challenges that include population growth, resource limitations and air and water quality as a small subset of systematic variables that we need to manage.

Sustainable Systems

Cybernetic, Local, global and multidimensional

Energy and Resources are dynamic components of ecosystems

- They adapt to internal and external conditions
- They support growth when dynamically balanced
- They are dangerous when static or extremely unbalanced

Neither Energy nor Matter can be created or destroyed

- However, they can be transferred, transformed into waste, or recycled.

Our Job is to Keep Them in Balance as We Transform Them.

The Taiji(太極) or YinYang (陰陽) symbol expresses the dynamic balance of Nature -- The "unity of opposites" in constant flux.

Our fossil fuel addiction and wasteful habits are making our way of life increasingly vulnerable. We import fossil fuels that are exhaustible, polluting and scarce. Fossil fuels require government subsidies while they harm their customers, workers, and neighbors. Now that we understand it, ***we need to break this addiction***!

Our industrial society has developed a bad habit of throwing away natural resources after use – as if they were inexhaustible. These wastes are contaminating our land, water and food,requiring ever more expensive infrastructures. The expenses of throwing them away (waste management), healing the sicknesses they cause, and repairing the damage to our ecosystem are hidden charges, paid by taxpayers. This doesn't make sense. ***We need to break this habit!***

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Systems, Models and Consiliance

- Thomas Kuhn, The Structure of Scientific Revolutions (1962)
- Fritjof Capra, The Tao of Physics (1975); Green Politics (1984)
  - The Hidden Connections: A Science for Sustainable Living (2002)
- Robert Merton "The Latent Functions of the Machine"
  - Machine Politics. Gang Power, Terrorism; Function and Dysfunction.
- Hernando De Soto:
  - The Mystery of Capital (multiple dimensions of property)(Squatters)
  - The Other Path (Fighting Terrorists Strengthens Them; Empowering Grass-Roots Creative Producers Removes Power From Terrorists.
- Paul Hawken, Amory & Hunter Lovins, Natural Capitalism
  - Capitalize natural resources "as if living systems mattered"
- Open Source, Mega-Patents and GIN's (Alliance Systems)
  - Empower creators of IP (Tynax; Energy Voyager; ASAP, etc.)
- The Globalization and Localization of Communities. (Not Unicode)
  - Systems within Systems -- sports analogy. (Bay Localize)

Consiliance. There is a progression in the thinking of these theorists that helps us to integrate perspectives, solve today's problems and realize that "All knowledge is related."

Kuhn described the fact that scientific breakthroughs have come only when outsiders bring new perspectives into the analysis.

Capra describes the parallels between physics, plasma mechanics, social systems and their inter-relationships.

Merton pointed out how past terrorists (urban gangs, organized crime, and machine politics) were created by dysfunctional social systems. Since the systems did not provide innovative solutions for changing times, extra-legal organizations emerged to provide them -- at a price.

De Soto showed how squatters developed the US economy using cowboy justice because the legal system failed to support the economy. Eventually the laws changed to support their innovative solutions.

Hawken, Lovins and Lovins show the fallacy of privatizing limited natural resources in a way that encourages wasting them. Instead, they argue, we should protect them and make them more productive as renewable capital that can continually grow our economies.

Open Source, Alliances and GIN's are evolving naturally and if we encourage them, we can stimulate continual innovation for the common good.

Fossil Fuel Dependent Systems are Dangerous

They Lead us Back to Mercantilism

Do you know the term "Mercantilism?" It was the 19th century practice of nation-states acting like companies.

When people adopt the assumptions of the scarce oil and gas model, without developing alternative fuels, the results will be

A self-fulfilling prophesy.

Oil and Gas are in limited supply, the more we hoard them the scarcer they will become. However, energy is not a scarce resource unless we put too much of its burden on oil, gas, and coal.

From a paper by Mikkal Herberg, "Asia's Energy Insecurity: Cooperation or Conflict?", National Bureau of Asian Research, Presented to the Conference on Remaking Economic Strengths in East Asia: Dealing with the Repercussions of Increased Interdependence, Institute for East Asian Studies, UC Berkeley, April 8-9, 2005.

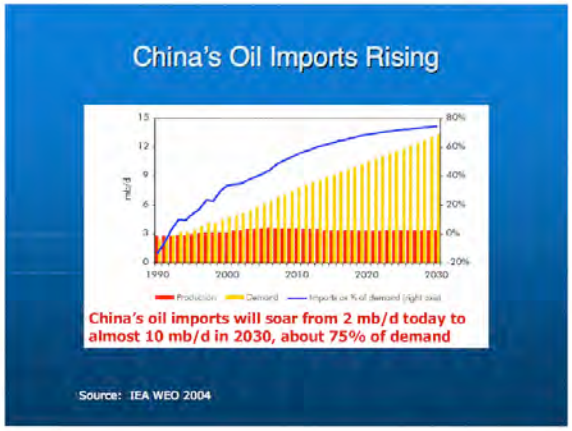
China's Energy Market Searching for a Strategy

China has started 5000 Recycling Industries and built 25,000 Industrial Parks.

E-Waste recycling:

2002: 0 Tons

2004: 5100 Tons



State Council 2005-2006 Plan:

1. Resource efficient Production.

2. Circular Economy

3. Save Water and Energy

4. Comprehensive use life cycle plans.

5. Clean Production

6. Legal System Reform

• At the same time -- Tens of billions of dollars of **unapproved** investments in new Chinese power plants are prompting a crackdown by the central government. ***Local governments refuse to wait for a plan***. (*Like USA*)

• MANILA, Dec. 9, 2004 (Xinhua) -- The Asian Development Bank (ADB) has approved a 35 million-US dollar loan for a hydroelectric project in northwestern Chinese province of Gansu.

More from a paper by Mikkal Herberg, "Asia's Energy Insecurity: Cooperation or Conflict?", National Bureau of Asian Research, Presented to the Conference on Remaking Economic Strengths in East Asia: Dealing with the Repercussions of Increased Interdependence, Institute for East Asian Studies, UC Berkeley, April 8-9, 2005.

Contrary to popular belief in the US, the Chinese government is doing its best to work on the problems of fossil fuel shortages and ecological damage from using polluting fossil fuels. Although it has more political focus than the US government, it has less to work -- fewer political resources and less control over local governments than we are led to believe by the popular press.

This chart shows that China is not ignoring the problem, but neither does it have a clear solution. It is not a problem that any government can solve by itself.

U.S. and China

Shared Energy Efficiency Problems Demonstrated

- **"Consumer goods emphasis" and "free market forces"**
  - *drove down energy efficiency since the late 1990's*
  - *drove energy intensity up since the 1990's* (more energy/unit GDP)
- **"Free Markets" and "Mercantilism" led to shortages**
  - *externalized costs, promoting waste and inefficiency*
  - **Widespread power shortages increased since 2001**
  - *yet market signals failed to adjust supply and demand*
- **Neither signed the Kyoto Accord**
  - *Fear that policy will not work as well as the free market to put science to work and develop adaptive, sustainable systems.*
  - *This demonstrates that our markets are not free! They send wrong signals.*
  - *We must manage market signals, creating a level playing field to maximize innovation for a healthier global system.*

Data are charted in a report by Mark D. Levine, Lawrence Berkeley National Laboratory. "Energy Efficiency in China: Glorious History, Uncertain Future: March 2005.

In fact, the pattern is not one of simple increases in energy use with development.

GDP has gone up faster than energy use during periods in the latter half of the 20th century.

But after 1998, energy use jumped up, along with waste, and continued in the first half decade of the 21st century.

This is Our Choice

Crisis (危機) = Danger + Opportunity

1. **Let *fear* direct us; fight to control and to waste resources. Let the ecosystem self-correct:**
   - **Peak Oil (gas, coal, population), and war….**
   - **Air, water, soil and climate degradation will force us to change.**
2. **Collaborate and Integrate:**
   - **Build adaptable systems and regenerative solutions**
   - **Expand with the universe** -- *into infinity*.
   - **Realize that *Murphy's Laws*** are creating opportunities!
   - **Share IP:** Global Innovation Networks (**GIN**)
   - **Discover new efficiencies** in ***location*** and ***community (e.g. Cool Cities, Smart Growth, Triple Bottom Line, etc.)***

National Policies cannot solve the problem alone. We must organize at all levels so that our aggregate efforts will make solutions possible.

Many US cities and states have joined together and started cleaning up their emissions and slowing their waste generation.

For one example of this phenomenon see the "Cool Cities Project" which is described on the Sierra Club website. There are many other programs, including the "Smart Cities" initiative.

Potential for the Future: Price These Values

Sign in a Suzhou's Tiger Hill Park

Reflections

Zhou Shasha (age 13) Guizhou, China

This sign and the painting by a young Chinese artist show us some choices very clearly. We are not used to seeing these choices presented so starkly because it takes time for the results to happen. Yet, since a 13 year old can picture it, we adults should be even better able to understand it.

Realizing the systematic character of energy and resource shortages leads us to an obvious conclusion: We must work with allies to maintain and improve not only our energy resources and our environment but our entire ecosystem to make it sustainable, healthy, enjoyable and profitable.

We need a system paradigm that does not promote waste and which does not promote competition that promotes waste. Instead of competing to maximize waste, we could set the rules so that companies compete to be the most sustainable and cooperate to recycle waste and energy. In other words, we could choose socially responsible cooperation and competition.

Biomass Policy: Ethanol Only?

A political leadership that believed in energy security … would put a bounty on each unit of net energy gain in a final bioenergy end product whether it be for heat, power or thermal applications. It's called parity, sending the right signals to let the marketplace work, rather than the government picking "winners" with taxpayers money.

It's interesting in Europe where carbon taxes prevail, biogas and bioheat are becoming more popular than liquid biofuel strategies. The reason being, biogas and bioheat recover more net energy gain per acre or ha than liquid fuels options which makes them more economically viable.

If you run the numbers, the worst thing you can do in temperate regions of the world on an acre of farmland, is to grow annual grains and oilseeds and turn them into liquid biofuels. As planting season approaches North America is soon to be covered in a sea of corn. Corn ethanol plants are political projects not … an energy security mission. There is an urgent need for the US to develop an economic system that reconciles capitalism with environmental sustainability.

The Europeans are further along this path than the rest of us. If the US is afraid of carbon taxes, they could start by creating a green carbon incentive, perhaps $25/tonne of C02 abated. This would … ***unleash a new economic brand "green capitalism"*** ... Europe is already sowing the seeds of a new green capitalism, fertile soil for growing a green energy society.

Roger Sampson, REAP-Canada

This appeared in March 2007 on a bioenergy blog -- in response to a series of arguments over - which energy sources are better and whether government should be involved at all. Some writers argued that government is inevitably controlled by special interests (policies, such as corn ethanol supports and fossil fuel supports are their evidence. They argue that for the public good, government should stay out of the energy business. But, governments have a constructive role to play in setting up and enforcing the rule of law among competing interest groups. Without them, we would simply have interest groups fighting each other. Public interest groups can help politicians resist the temptations of selfish interest groups.

I would add; a good policy will not simply limit GHG footprints but also toxic emissions that add to the public health bill and to the cost of maintaining public (and private) facilities.

As for biogas and bioheat, anyone can understand that it is more efficient to use the gases and heat directly than to process them into fuels or electricity. However, increased portability makes it worth converting some of the gases into liquids or electricity (CHP). The net loss of efficiency, translates into a gain in portability.

In any case, policy serves society best when it encourages renewable energy that has a smaller carbon footprint and a smaller toxic footprint than petroleum-derived liquid fuels.

The Role of the Private Sector? Here is one Example of an Oil Company Becoming an Energy Company

In the last 40 years the world's population has doubled, and forecasters estimate that it will double again in the next 40 years. The International Energy Agency (IEA) and our own scenarios expect energy use to grow by more than half over the next quarter century. Demand could double by 2050.

Stabilising (sic) greenhouse gas (GHG) levels in the atmosphere this century is one of the biggest challenges facing a rapidly-developing world. It will require delivering at least two times more energy in 2050 but without higher GHG emissions than today.

•We are working now to help make the changes needed and to capture the business opportunities created.
* According to the UN Intergovernmental Panel on Climate Change. Stabilisation (sic) occurs at 550 parts per million CO2.
We will:
* manage our GHG emissions (target: 5% below 1990 levels by 2010)
* help customers reduce their emissions by providing more natural gas and advanced transport fuels
* invest in technology to capture CO2 from fossil fuels
* work to build at least one large-scale business in alternative energy
* support policies that use markets to encourage GHG reduction

We were one of the first energy companies to acknowledge the threat of climate change; to call for action by governments, our industry and energy users; and to take action ourselves.

From the Shell Sustainability Report 2005

Some some oil companies now see the need to innovate to reduce GHG emissions and promote energy efficiency. People argue over whether this is "greenwashing" or not.

However, the mere fact that they are taking a public stand on these issues demonstrates that they recognize their importance. Moreover, even if it starts as "greenwashing," the adoption of such policies will force them to take action as well. In fact, customers and stockholders can use the company's own policies to hold them responsible. In the end, companies that adopt truly sustainable business practices will profit from them. Shell, among others, has demonstrated this result.

Therefore, it is not constructive to simply condemn it as "green washing."

Governments and Businesses cannot do it alone!

Sustainability requires all of us to change our thinking and behavior to:

1. Empower ***full-cycle*** energy/resource regenerative processes
2. Monetize ***multiple bottom line values***
3. Put ***supply and demand*** to work for all of them!

Forest: Li Jiajin (age 12) Guizhou

Plant Trees. Ma Yan (age 11) Xinjiang

- Innovation/Creativity
- Economic Health
- Mental Health
- Social Health
- Environmental Health
- Justice
- Political Development

Local, National, Regional and Global

The Garden City, Zhu Wei (age 13) Shanghai

Welcome to the Green Dragon City
Zhang Jun (age 11) Guangxi

A short list of values that could profitably guide our system designs:

Economic Development	Political Growth
Scientific Growth	Intellectual Growth
Religious Freedom	Political Freedom
Social Justice	Economic Justice
Environmental Justice	Circular Economics
Zero Waste Production	Zero Emissions
Renewable Energy	Population Management
Disease Management	Resource Management
Appropriate Growth	Waste Recovery (such as mining landfills)
Clean Air	Clean Water
Fertile Soil	Local Self-sufficiency

Multiple Energy Streams are needed to Create Sustainable Solutions

- Biomass Power and Fuels
- Coal and Gas Electric Generators
- Purchased Electricity
- Biofuels from crops
- Methane Bio-Digesters
- Wind, Solar, Geothermal, etc.

1. **Lower in cost to build and deploy than fossil fuel based technologies.**
2. **Less expensive to operate than fossil fuel technologies.**
3. **Produces by-products for sale that are not available with other power plants.**
4. **Will actually improve other systems, not put them out of business.** For example, replacing the coal-burning component of a coal-fired power plant can convert it into a zero emissions plant that is more efficient.

Actual cost-benefit comparisons depend upon knowing local conditions. We cannot provide an exact comparison without conducting research in a specific location.

Nevertheless, when comparisons have been made, the case was clear: Plasma conversion systems cost less and produce more benefits than conventional power generation systems. They also work well with other renewable systems, complementing the benefits they offer.

The Biomass Energy Components: Potential in California

Total energy potentials for available California biomass feedstock by energy product category (2006 biomass resource base).

Category	Biomass (Million BDT/year)	Energy in Product (Trillion Btu/year)	Total Capacity
Electricity CHP Heat	32	118 (35 TWh) 230	4,650 MWe 9,050 MWt
Heat	32	350	11,700 MWt
Biochemical Biofuel	32	188	2.3 BGY ethanol equivalent
Thermochemical Biofuel	27	250	1.7 BGY diesel equivalent
Biomethane	5 + Landfill gas and WWTP	106	106 BCF/y methane
Hydrogen (bio + thermal)	32	305	2.5 Million tons/y

BDT = bone dry ton. BCF = billion cubic feet. BGY = billion gallons per year. MWe = megawatt electric. MWt = megawatt thermal (heat). TWh = terawatt-hour (billion kWh). WWTP = wastewater treatment plant. 1 ton = 2000 lbs. Biochemical conversion is based on fermentation to ethanol. Thermochemical is based on gasification followed by Fischer-Tropsch synthesis. Biomethane is methane derived from anaerobic digestion of biomass. Biofuel capacities shown are based on assumed low yields for dedicated crops (see section 5.2.3 of A roadmap for the Development of Biomass in California for more detail).

This chart appears in the California Energy Commission Report "A roadmap for the Development of Biomass in California" PIER Collaborative Report, CEC-500-2006-095-D October 2006, p. 11.

"Although not all the biomass will be used for energy, the total energy containd in the biomass now considered to be available for ultilization in California is large, exceeding 500 trillion Btu per year (Fibure 1.4), or roughly 6 percent of California's primary energy demand."

Biomass Energy Potential in California By Source

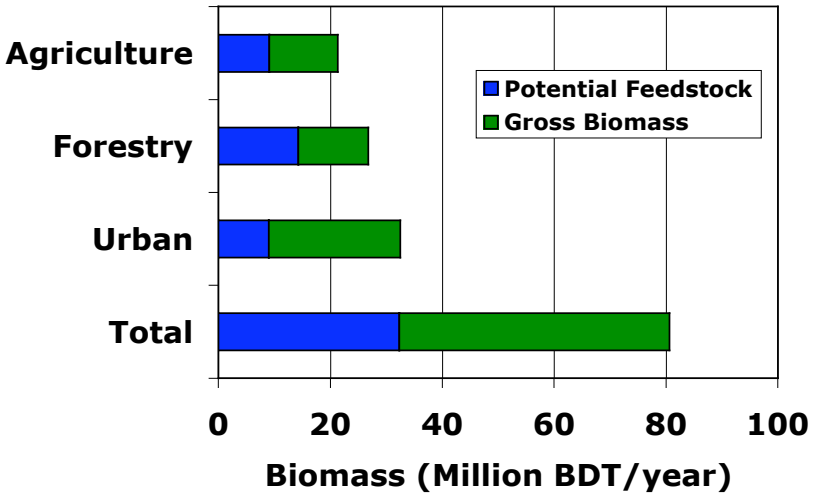


Figure 1.3. Gross annual biomass production in California (2005) and amounts estimated to be available for sustainable use. BDT = bone dry tons. Approx. 10% each of statewide demand in each of electricity and transportation sectors.

The CEC Roadmap, page xii, spells out these benefits from using biomass for energy:

Benefits of using biomass include:

- reducing the severity and risk of wildfire,
- improving forest health and providing watershed protection,
- improving air and water quality,
- restoring degraded soils and lands,
- reducing greenhouse gas emissions,
- improving management of urban wastes,
- reducing dependency on imported energy sources,
- creating new economic opportunities for agriculture and other industries,
- improving electric power quality and supporting the power grid,
- creating jobs, and
- economically revitalizing many agricultural and rural communities.

Biomass Energy Potential in California By Source

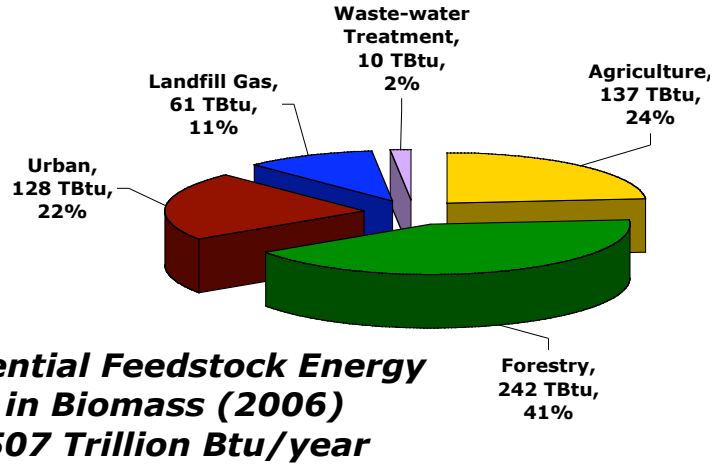


Figure 1.4. Energy potential in annual biomass considered to be available from agriculture, forestry, and urban wastes in California, 2006.
TBtu = trillion Btu.

The CEC Roadmap, page xiii, spells out these barriers to using biomass for energy:

Despite these benefits, there remain a number of barriers to development:

- biomass feedstock acquisition costs add to cost of production, reducing economic competitiveness,
- limited long term contracting opportunities make financing difficult,
- siting and permitting processes can be arduous and complex,
- utility interconnection processes can be difficult and expensive and net metering is not uniformly available for all forms of biomass generation within capacity limits,
- many new technologies remain to be fully demonstrated and commercialized,
- there is limited public awareness of the benefits and costs of biomass management.

Biomass Energy Potential in California 2005 - 2050

With improved efficiency there is potential to replace 1/5th to 1/3 of California energy with biomass

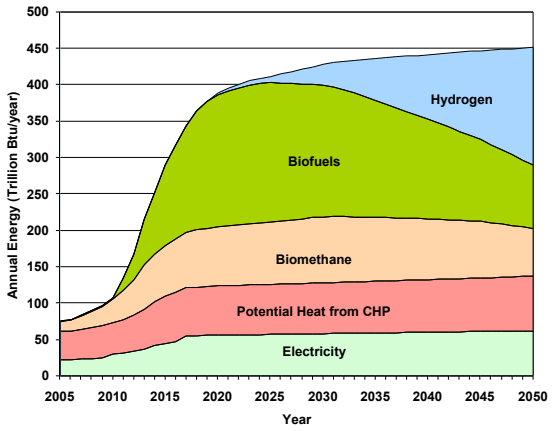


Figure 1.5. One scenario of in-state biomass development through 2050.
Shown are quantities of biomass used for electricity and heat through combined heat and power systems; biomethane; biofuels from both thermochemical and biochemical processes; and in the longer term, hydrogen. Feedstock supply includes increasing amounts from dedicated crops added largely by 2020.

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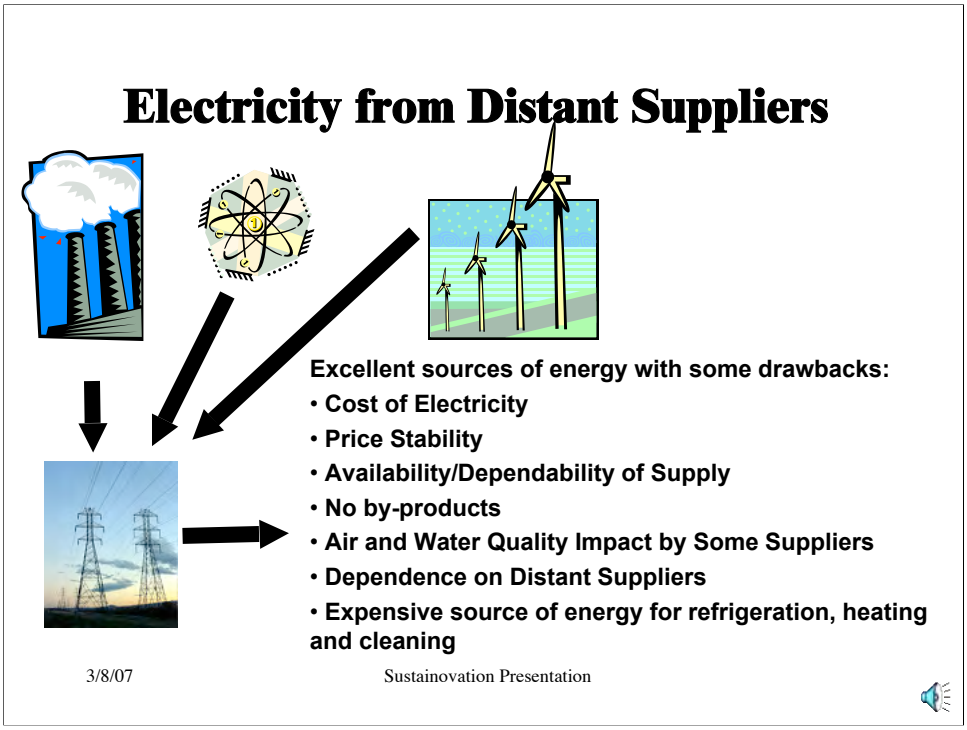
The CEC Roadmap, p. xii, energy potentials from biomass: (emphasis mine)

By 2050, as the state shifts to greater use of hydrogen in transportation and other energy sectors, biomass could be supplying a large amount of renewable hydrogen. Greater use of combined heat and power systems fueled by biomass could reduce demand for natural gas in process and industrial heat and cooling operations, helping to increase the overall energy efficiency and reduce carbon impacts of the state.

Major opportunities for in-state biomass development include: expansion to nearly 2,500 megawatts of electric power and 18 billion kilowatt-hours of electrical energy, one to two billion gallons per year of biofuels, 100 billion cubic feet of biomethane, and more than a million tons per year of hydrogen.

But California's energy appetite is huge—peak power demand in excess of 50,000 megawatts with annual electrical energy consumption of 300 billion kilowatt-hours, gasoline and diesel fuel demand approaching 20 billion gallons per year, and natural gas consumption of more than 2 trillion cubic feet per year. Potential contributions from biomass are therefore about five to ten percent of state demand in transportation with similar levels in the electricity and natural gas sectors. **As the state improves its energy use efficiencies, biomass might contribute a fifth to a third of energy supply in selected sectors.** Simultaneously, biomass can be augmenting supplies of high-value chemicals, structural materials, and other renewable bio-based products with improved environmental and consumer health attributes.



Just for comparison, lets look at the price of electricity purchased from the grid. Lets assume it costs roughly 10 cents per KWh retail (it is rarely that inexpensive). We can not expect it to stay at that price for the next 10 years.

In most locations we will be able to sell biomass electricity for 7 cents per KWh and still be profitable. The facility derives most of its income from sources other than the sale of electricity, so its net cost for electricity is lower than other producers. The price of electricity will vary from location to location because of local circumstances. We can usually design systems that will be cheaper.

Biomass fuel supplies are local and a source of income, not an expense: sewer sludge, manure, chicken litter, offal, green waste, MSW and other waste materials usually generate tipping fees.

The prices for the products these systems manufacture are likely to go up. E3R and its allies will create newer products from waste as we gain experience and meet new customers.

Plasma conversion does not pollute like standard power plants.

E3R solutions are local businesses. There will be nothing to buy from distant suppliers. E3R customers will have a clean *local* supply of power and fuels.

Coal Fired Electric Generators

- **Cost of Fuel is low at source**
- **Abundant Feedstock**
- **Already in place and producing**
- **Supply chains are Well Developed but …**
- **Cost to Clean up the Smokestack**
- **Cost to Permit**
- **Efficiency of Feedstock Use**
- **Transportation of Feedstocks**
- **Dependence on Distant Suppliers**

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Coal fuel use will not be significantly reduced any time soon. Therefore, we should develop improved efficiencies and cleaner fossil fuel processes. if they do not reduce their ecological footprints, they deserve to be taxed, and if they do reduce them, they should benefit along with the rest of us. A good analogy might be this: smokers who quit smoking.

Plasma Arc Conversion. The coal molecules are disassociated, releasing energy in the process. There are several distinct advantages to the process. First there is no outside air used in the process. Therefore the total mass in pounds of discharge after conversion is only 1/300. Instead of eleven pounds of greenhouse gasses discharged into the atmosphere from a coal furnace, there is nothing at all discharged into the atmosphere.

Because there is no nitrogen introduced into the system as there is with incineration, the conversion System derives approximately 250% to 300% more heat energy from the same amount of coal. The System is capable of converting any and all grades and consistencies of coal, even grades of coals that are not suitable for incineration processes.

In sum, plasma conversion of coal to energy meets all environmental criteria and concerns. It optimizes the BTU value of heat energy recovered per pound of coal. It may use any and all types of coal without the need for preprocessing. All products, such as carbon dioxide, water, sulfur, mercury and minute ash are purified and recycled as useful products for market.

Methane Biodigester Generators

- **Free Feedstock and simple process for producing methane**
- **Time to Produce Methane: 25 days**
- **Work to maintain it is considerable**
- **Safety: storage & transport of methane**
- **Low efficiency: Fuel to Energy**

- **Gas generators less efficient than steam generators**
- **Volume Capacity & Land Use: is this efficient land use?**
- **Sale of by-products: aside from methane the main by-product is digestate for fertilizer. However, the digestate is not balanced properly for mass application to growing crops. Thus the market for digestate may not be as attractive as it appears at first look.**
- **Digestate can be feedstock for thermal conversion biorefineries.**

A Bio-Digester takes 25 days to process manure.

An anaerobic digester in Chino, California, is now converting manure from 10 nearby dairies into 210,000 cubic feet of biogas per day. The biogas supplies the fuel for one of two gas-fired engine generators at the facility, generating 500 kilowatts of electricity. The digester, owned by the Inland Empire Utilities Agency (IEUA), processes 225 tons per day of fresh manure from about 3,750 cows. IEUA started up the facility in May 2005 and is using electricity produced at the site to remove salt from groundwater.

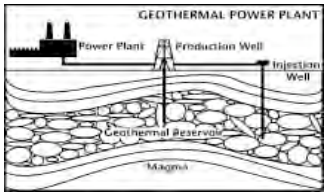
(www.greennature.com/article1600.htm)

A plasma conversion plant, processing manure from 225 tons of manure a day could produce at least 20 MW/h (assuming a BTU value of 6,000/lb. Plasma conversion could derive over 100MM BTU/h -- the equivalent of 31MW/h.) The heat from the the boiler that is not used for electricity could easily be used to desalinate or otherwise purify water directly while generating electricity for other purposes.

Alternatively, the plant would produce refrigeration, steam, and ethanol, plus other by-products.

Of course, we must calculate the quality of the manure/sludge, the heat content, and the cost of preparation, e.g., drying.

Wind, Solar, Geothermal, etc.



Clean Renewable Power, yet …

- **Wind, Solar Depend on Weather**
- **All Depend on Local Conditions**
- **Potentially less expensive**
- **Zero by-products**
- **They can power Biorefineries to produce transportable fuels.**

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Geothermal, Solar and Wind power are fully renewable. No resources will be depleted. They should be used when feasible.

These "green" technologies will be adequate and profitable for specific sites. They are our allies, not competitors.

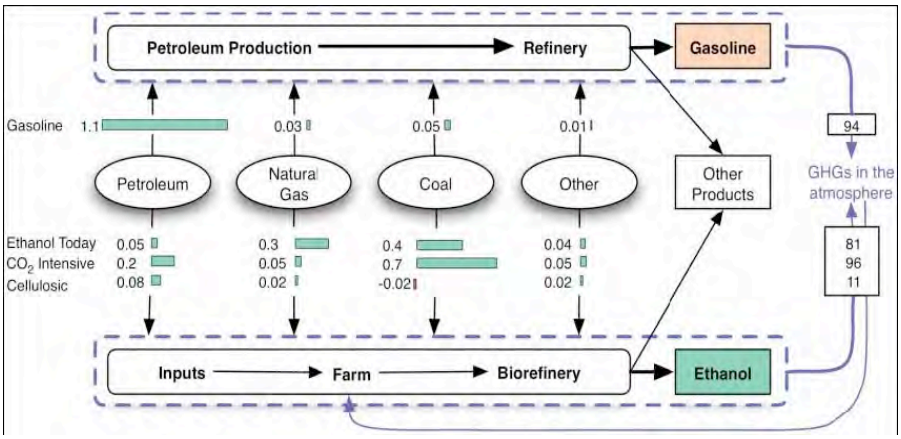
However, they are not always available and do not recycle waste.

E3R waste conversion systems make excellent complementary solutions. Depending upon the waste stream, electrical output can be reduced to take advantage of power from Wind, Solar and Geothermal sources and applied to making fuels and chemical products. They could also produce electricity when wind, solar and geothermal sources are not producing enough electricity.

E3R conversion systems both recycle waste and relieve stress on the grid -- which otherwise would have to provide power when other renewable resources are not available.

Recycling solutions that convert waste to usable materials with or without generating power can also be allies. We encourage them and work with them. When they cannot handle the waste or when they need power that a we can provide, we enhance each other's businesses.

Crop-based Ethanol
GHG and Energy Costs Compared



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Farrel, et. Al. Basically, the cost in energy and GHG emissions to produce ethanol today (2006) is less than to produce gasoline. Second, these costs for cellulosic ethanol will be less than for corn ethanol.

And these results can be improved!

It is clear that if one uses clean renewable energy sources to process biomass into syngas, heat and fuels, the result will be a smaller ecological footprint. Therefore, those who do it will benefit from the policies you recommend -- as will the world.

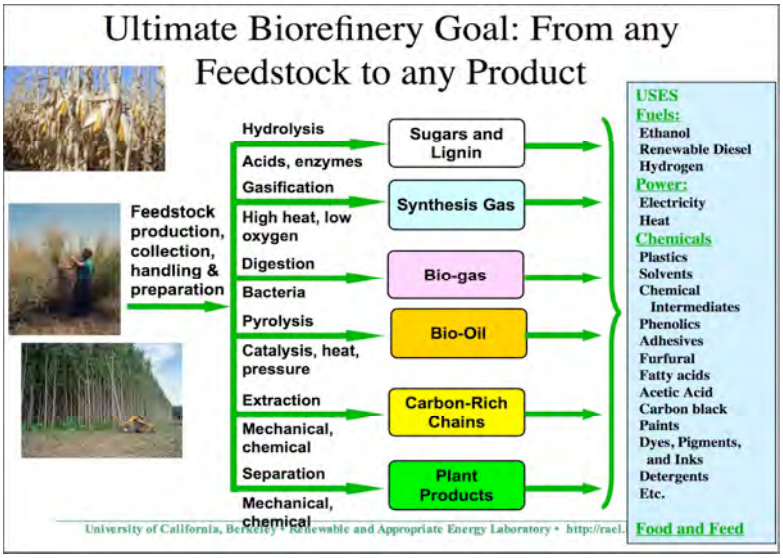
Add waste to the list of feedstocks:

If we carry the logic of reduced carbon footprint forward, we will then see that some crops are more efficient than others and that WTE (Waste to Energy) and WTF (Waste to Fuel) will be more efficient than growing crops, harvesting them, then processing them for Bioenergy.

Diversify!

Regardless of which approach is better in a given place and time, we need to avoid making the single-source mistake again. If we diversify our sources we make ourselves less vulnerable.

Crop-based Biorefineries



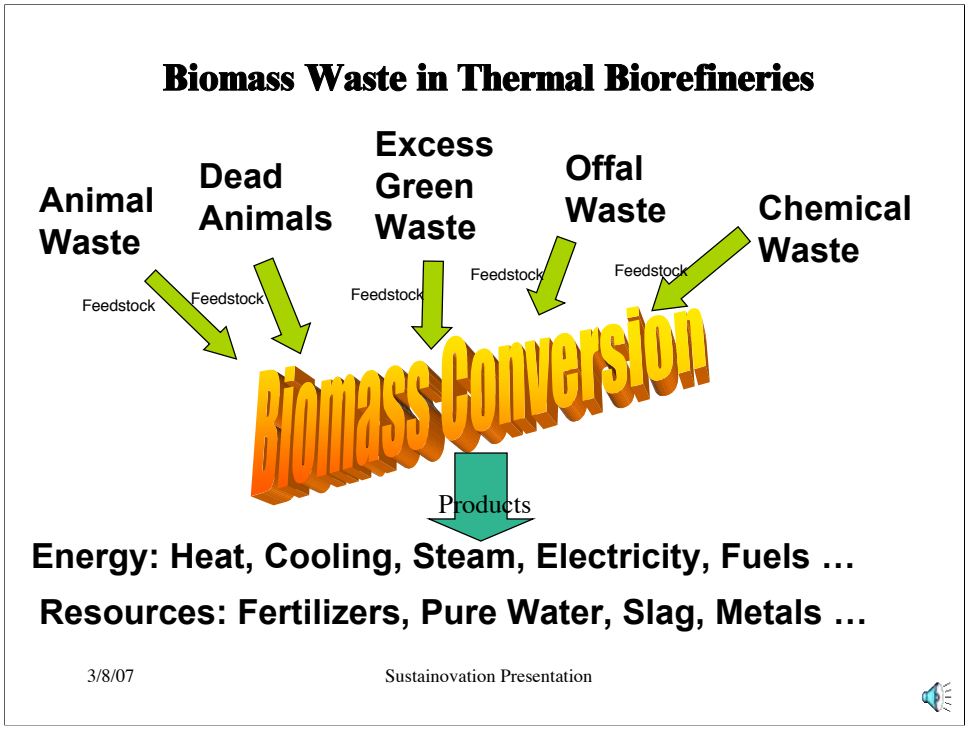
Renewable energy and fuels:

Choices among multiple feedstocks

Choices among multiple products

Choices among multiple processes

Tailored to local climates, soils, terrains and markets



SYNGAS IS THE PRIMARY BY-PRODUCT

The primary commercial product derived from gasification is SYNGAS.

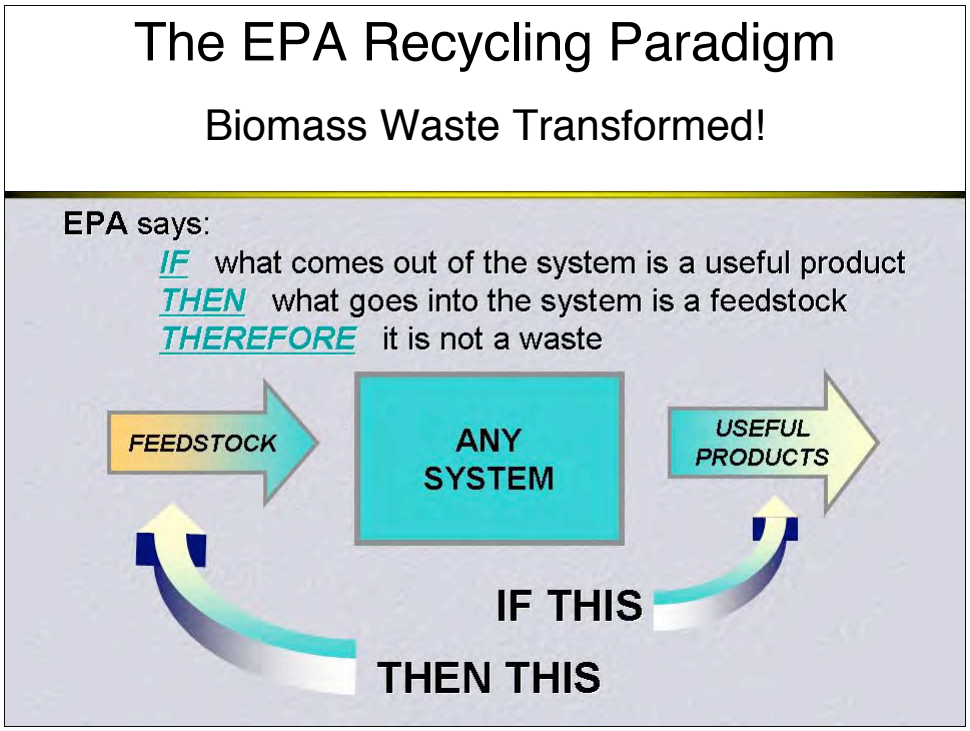
After scrubbing the acidic constituents from the gas stream produced by the thermal treatment, the gas is introduced into a BIOREFINERY purification system. Moisture and various gases are separated from one another by this system. The raw molecules than can be refined into useful products.

WATER AS A PROCESS PRODUCT

Moisture is a component of the original feedstock. Additional water is introduced with the feedstock into the system and as a coolant to moderate internal temperatures. All of this water is removed from the system as distilled and purified water. We have a choice as to how pure we want to make it. At a minimum, it will be pathogen free and usable for irrigation. If we want to further purify it into drinkable water, there will be an additional cost in energy.

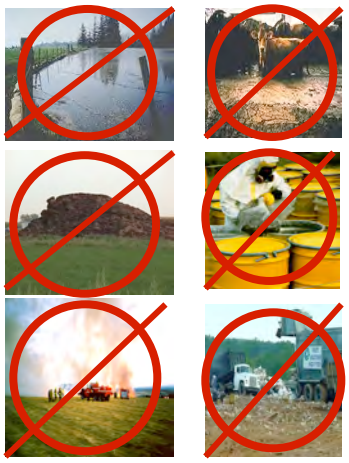
OTHER PRODUCTS

Other products include phosphorus, ammonia, some liquid nitrogen, potassium and ash (which is cleaned, mixed with cement and made into cinder blocks). Other chemicals that may be produced for sale depending upon the composition of the feedstock.



Even when a thermal converter is designed for zero emissions, many people refuse to believe it is possible. (Partly because they have been lied to in the past.)

Biomass Waste Reclamation Provides Much More than Renewable Energy



1. Reduced Waste Emissions
2. Heat, Cooling, Steam and Electric Energy from Waste
3. Liquid Fuels from Waste
4. Local Energy Self-sufficiency
5. Clean Distributed Energy for Government Offices, Homes, Farms and Businesses
6. Less Expensive Power
7. Reclaimed Land for Production and Enjoyment
8. Green Collar Jobs
9. Tax Credits and Green Credits

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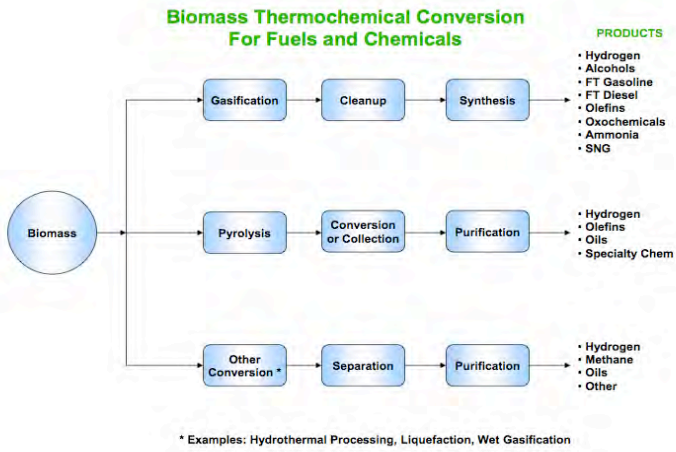
Compare the California Energy Commision's Roadmap that spells out the benefits this way:

- reducing the severity and risk of wildfire,
- improving forest health and providing watershed protection,
- improving air and water quality,
- restoring degraded soils and lands,
- reducing greenhouse gas emissions,
- improving management of urban wastes,
- reducing dependency on imported energy sources,
- creating new economic opportunities for agriculture and other industries,
- improving electric power quality and supporting the power grid,
- creating jobs, and
- economically revitalizing many agricultural and rural communities.

The Science of Biomass Recovery with Energy Generation (NREL):

Not just Biolological Conversion



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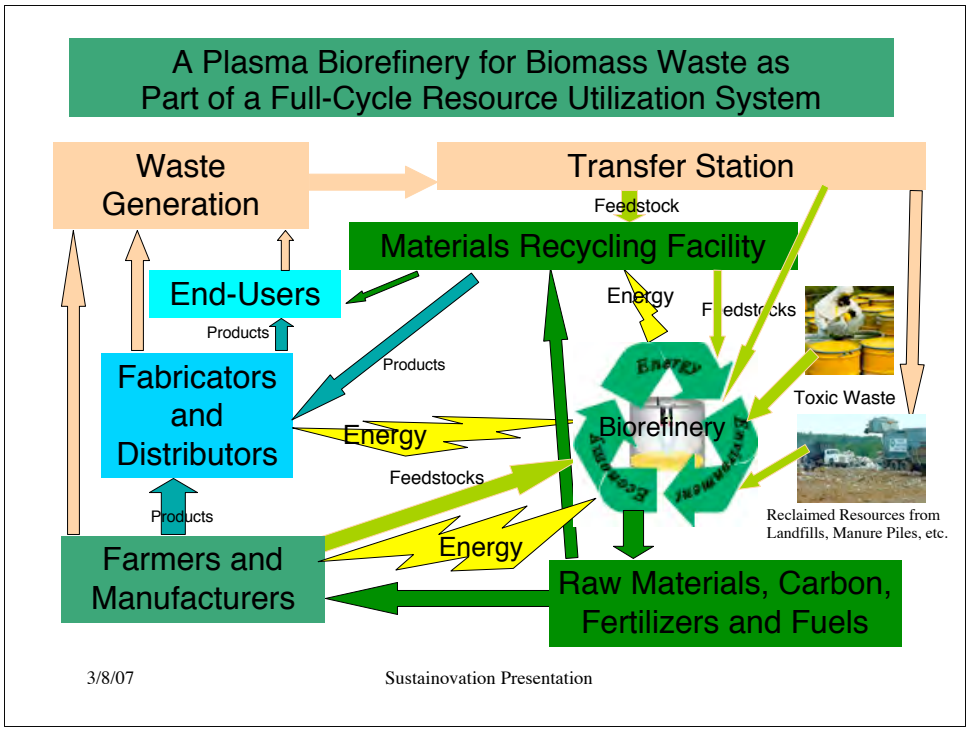
This chart, taken from the *NREL Biomass Gasification Overview*, Richard L. Bain, January 28, 2004, shows the creative and proven possibilities for converting biomass waste and crops into fuels and chemicals through gasification.

The biomass waste available for conversion is substantial. Substituting it for fossil fuels could considerably extend the life of fossil fuels and ease the social impact of peak phenomena. E3 Regenesis works primarily in the area of commercializing biomass thermochemical conversion and integrating it with other forms of waste recycling and recovery.

In 2002 California established its Renewable Portfolio Standard (SB1078). It requires the state to generate 20% of its electricity from renewable resources by 2017. The Energy Action Plan II increased the goal to 20% by 2010 and **33% by 2020,** a goal previously endorsed by Governor Arnold Schwarzenegger in the letter he sent to the California Energy Commission on August 23, 2005 in response to the Integrated Energy Policy Report as required under SB 1389.

See also: Governor Arnold Schwarzenegger Press Release August 23, 2005. http://www.governor.ca.gov/state/govsite/gov_htmldisplay.jsp?sFilePath=/govsite/press_release/2005_08/20050823_GAAS37505_EnergyPolicy.html&sCatTitle=Press%20Release



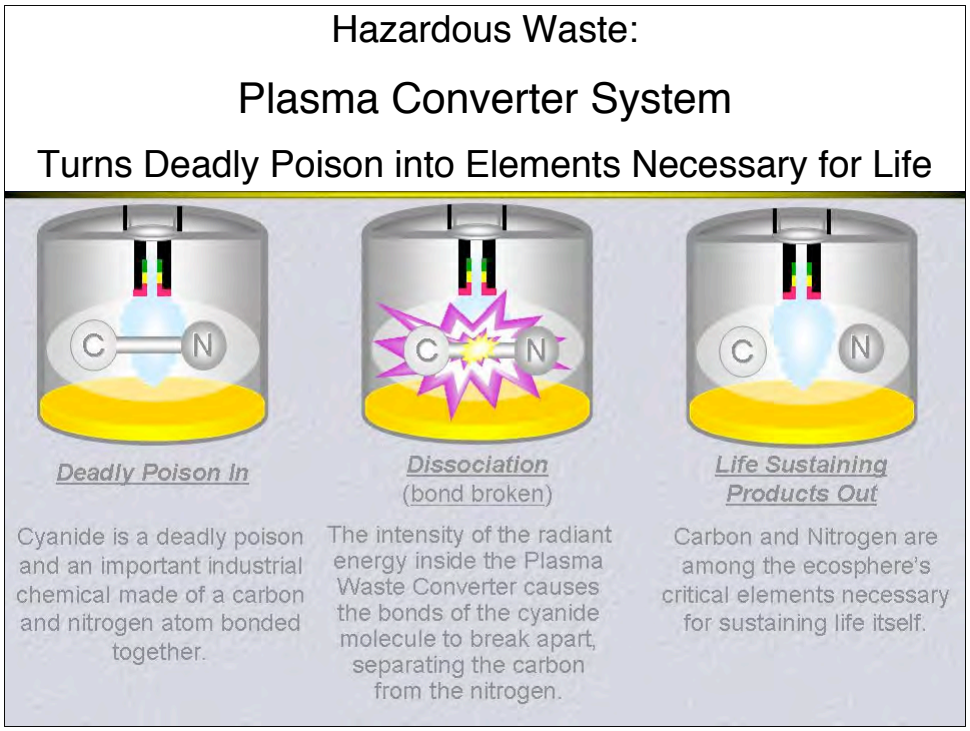
This is not a closed system, yet, with creative designers at every stage we can approximate a closed system with full recycling.

We can also bring in energy crops when other conversion methods are less economical.

Energy from other suppliers can complement the energy we produce either through the electric grid or through other fuel sources.

Recycled raw materials and food will come in to manufacturers, fabricators, and distributors.

Once the process becomes full-cycle, we can mine the landfills for more resources that have been wasted in the past.

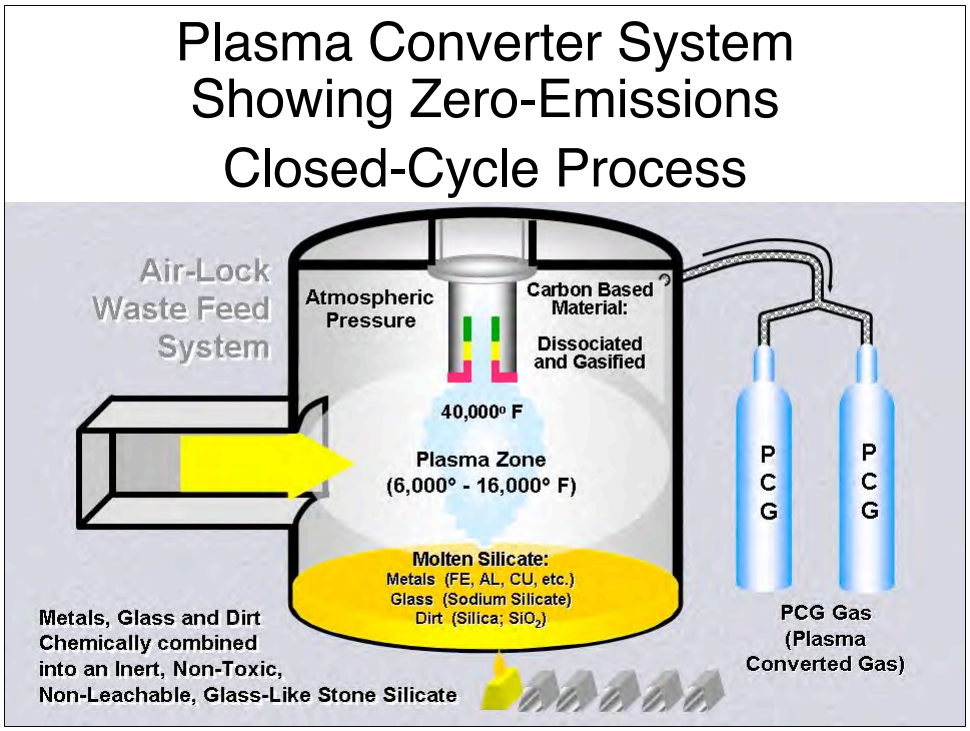


Hazardous Waste:

This is only one example of hazmat treatment.

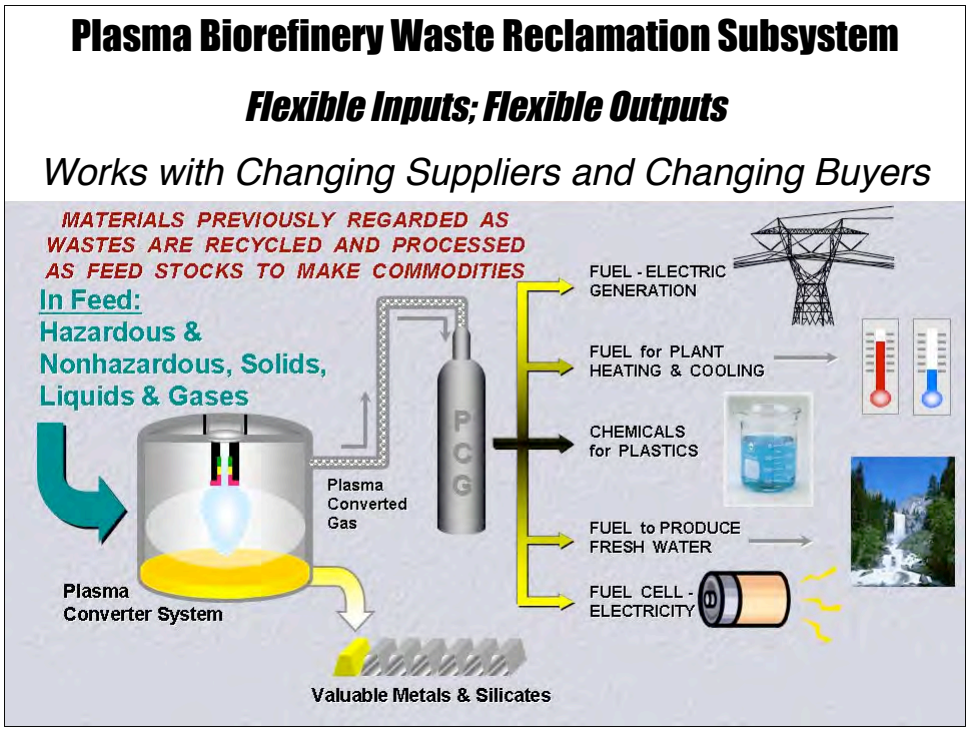
Other such wastes include medical waste, BSE or Bird Flue infected dead animals and birds.

And many more.



The system is a closed cycle, so zero emissions. Of course, there will be some from materials handling prior to conversion. We must be careful to control those.

The total process emissions will be considerably less than emissions from landfills, diary lagoons, composting and from biomass rotting in the fields.



This is a closed system. No smokestack and no drain.

Everything can be converted to something useful.

Sequestering Carbon as Products

New Products for Sale:

- Dry Ice for shipping and cooling needs
- Carbonic solvents for cleaning and sterilization.
- Ammonia, Nitrogen, and other chemicals custom mixed to meet farming or industrial needs.
- CO_2 for greenhouses to enhance plant growth, sell to dry cleaners, ice blasters, soft drink makers, meat processors, enhanced oil recovery, and more.

Dry Ice and Liquid CO_2 for Food Processing and Handling

Clean Fuels, Fertilizers and Industrial Chemicals

Dry Ice for Ice Blasting

Solvents gases and Firefighting Chemicals

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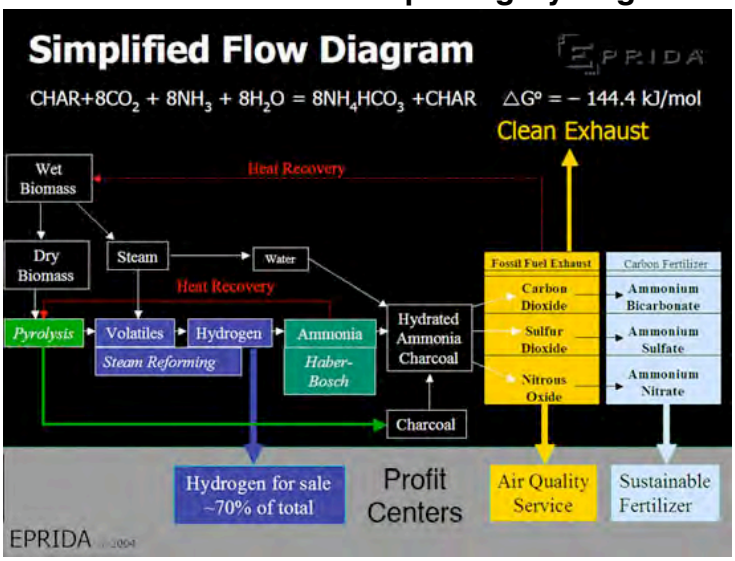
These are only a few traditional products that are made from CO2. The Co2 is traditionally extracted from the air, using electricity derived from fossil fuels. Therefore, making it directly from biomass will reduce the carbon foot print of manufacturing CO2 for these purposes.

Of course, there are other processes that can sequester the Carbon in products such as nanotubes, carbon fibers, and soil amendments.

A Pyrolytic Biorefinery Sequesters Carbon
(as Biochar Fertilizer while Capturing Hydrogen for Sale)



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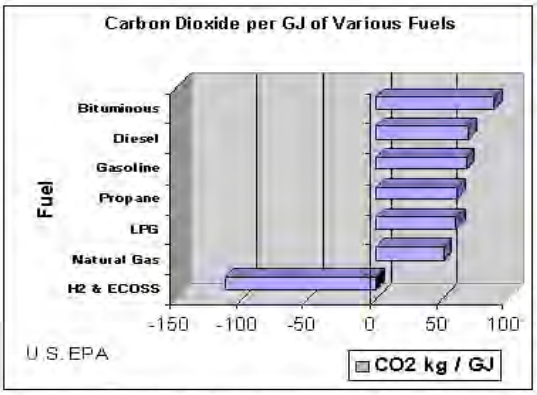
Biochar is a soil amendment made from activated carbon that not only enhances soil fertility, but also holds the nutrients until plants need them. Biochar is not only carbon negative, it produces a kind of fertilizer that is long-term, super rich, and will not be depleted by water. It will hold its nutrients until the plants need them. This system uses crops and manure as feedstocks.

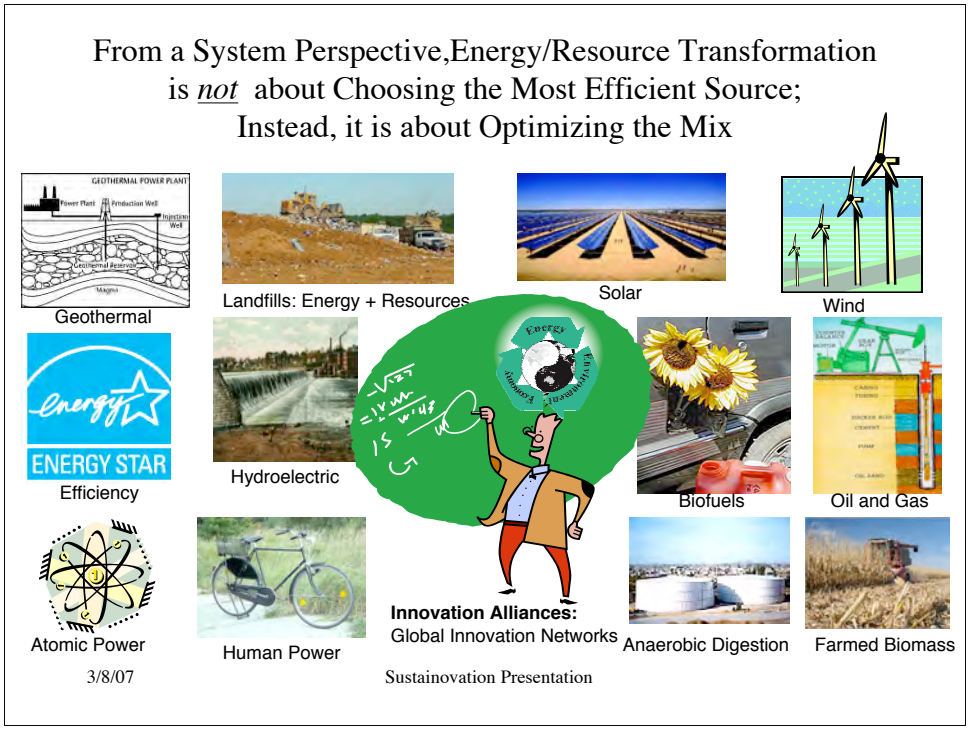
The hydrogen is not necessarily an end-product either. It can be refined into liquid fuels if the market requires liquid fuels.

Cleaning up Fossil Fuels: Hydrogen plus Biochar (Ecoss)



From above we see that 1Gj of hydrogen produced and used will represent 112.5kg of utilized and stored carbon dioxide. Therefore, taking the atmospheric rise of 6.1GT(IPCC) and dividing by 112.5kg/Gj = 54.2EJ. This number falls amazingly along the 55EJ (Hall) estimate of the current amount of biomass that is used for energy in the world today. While the technical potential is many times this for future utilization of biomass, this shows a chance for a pro-active approach.

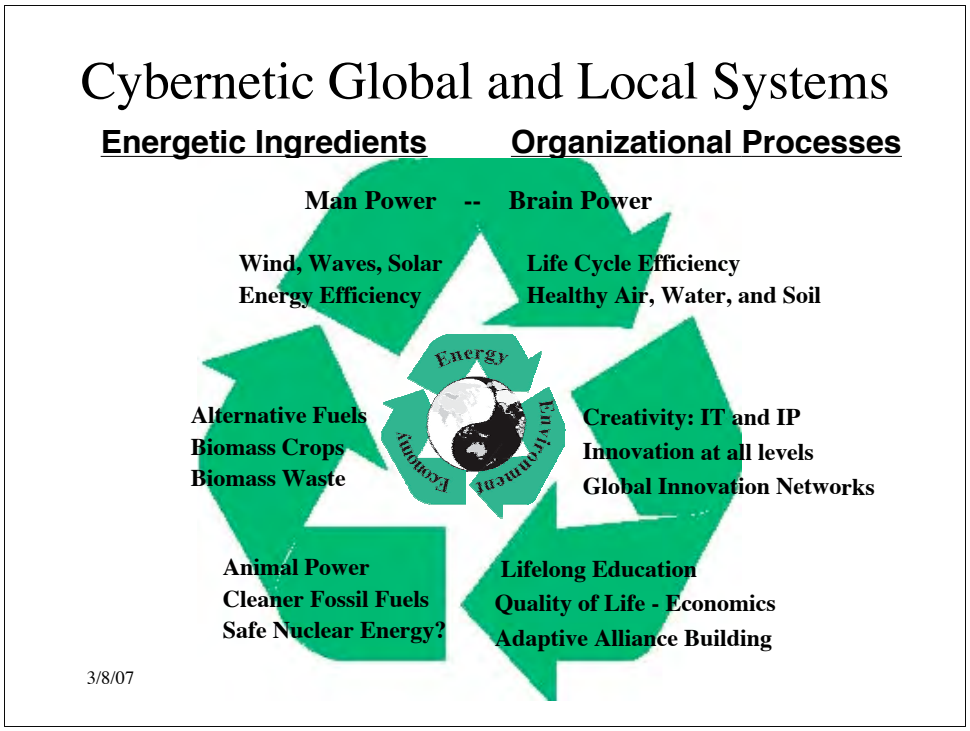
Eprida biochar called “Ecoss” makes the soil more robust and fertile.



There is a lot of arguments in the literature about which form of energy is optimal and how to make the best use of it. There are attacks on renewable fuels, many of which are funded by oil companies. There are attacks on ethanol by makers of other kinds of biofuels. There are al lot of criticisms of biofuels for taking land away from food production and depleting the soils. There are even attacks that claim it takes more fossil fuels to make biofuels than you get as a result!

Regardless of their funding, such arguments usually overlook the obvious need to balance multiple energy sources.

What is optimal depends upon location. System analysis requires an inventory of resources and needs for each site, then an estimate of how they will change in the near term. Based on that information, we can calculate the relative benefits of each energy/Resource transformation Mix. When some transformation tools are missing, then we may expect the addition of those tools to make a significant contribution to efficiency and adaptability.



The left side shows pure energy variables.

The right side shows related variables that are critical to overall sustainable success.

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A Chinese saying attributed to Confucius, points out that no matter how old we live to be, and no matter how hard we study, still fail to understand at least 30% of what we need to know:

活到老，學到老，還有三分學不到。

So, we must remain humble and open to learning from others.

We will benefit most when we teach each other and and learn from each other.

Any questions? Please ask.

We look forward to your questions and to exploring potential collaborative integration activities.