

Why the need for Alternative Energies?

Based on known oil reserves and the worldwide consumption rate, most estimates suggest this reserve has only 50 more years of production left in it 🖱️ its important that this is believed!

- In the US, 89% of our total Energy Budget is Fossil Fuel Based
- Fossil Fuel combustion represents a global environmental problem
- Most alternative energy sources have little polluting side effects

Clearly, environmental pollution is unavoidable so informed decisions must be made.

Forms of Pollution:

- Atmosphere - Global: 🖱️ [Greenhouse gases](#)
- Atmosphere - Global: [Acid Rain](#)
- Atmosphere - Local: 🖱️ Smog
- Groundwater - Local: 🖱️ Nuclear Waste (☠️)
- Surface Water - Local: 🖱️ [Oil spills](#)
- Thermal Pollution - Local and Global: Waste Heat
- Local Land Use: NIMFBY mail 🖱️ Not in My Back Yard: build that thang over thar

Global Impact of Sources of Energy Generation:

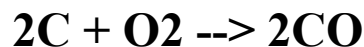
- Fossil Fuels 🖱️ totally disrupts the [Carbon Cycle](#) and is non-equilibrium. Eventually, enough Carbon Dioxide will be in the atmosphere to effect things seriously. We may, in fact be there already

- **Solar Energy** 🖱️ **Intensive use of Land Area due to low efficiency. Significant thermal pollution. For instance, a 1000 MW solar facility would dump 10,000 Megawatts of heat into the local atmosphere. Its unclear what the effects of this would be but this is like an [Urban Heat Island](#)**
- **Hydro** 🖱️ **The world or the US's potential has not been fully tapped. No pollution for this but serious alteration of free flowing waterways.**
- **Windpower** 🖱️ **structural/virtual pollution but not much else**

Air Pollution:

Normally the carbon content of fuels (which is high) oxidizes during the combustion process to form CO₂ (carbon dioxide)

Incomplete combustion leads to the formation of CO:



Sources of CO pollution: (million tons per year)

| | |
|-------------------------------|-----|
| Motor Vehicles -----> | 54 |
| Aircraft -----> | 2 |
| Coal -----> | 0.7 |
| Fuel Oil -----> | 0.1 |
| Industrial Wood Processing--> | 8.8 |
| Forest Fires -----> | 6.5 |

Automobiles dominate because the combustion of gasoline under conditions of high pressure is quite incomplete

Some Internet Resources on Pollution:

[Pollution Prevention Home Page](#)

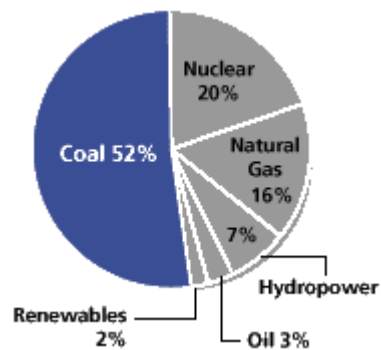
For the future our choices are:

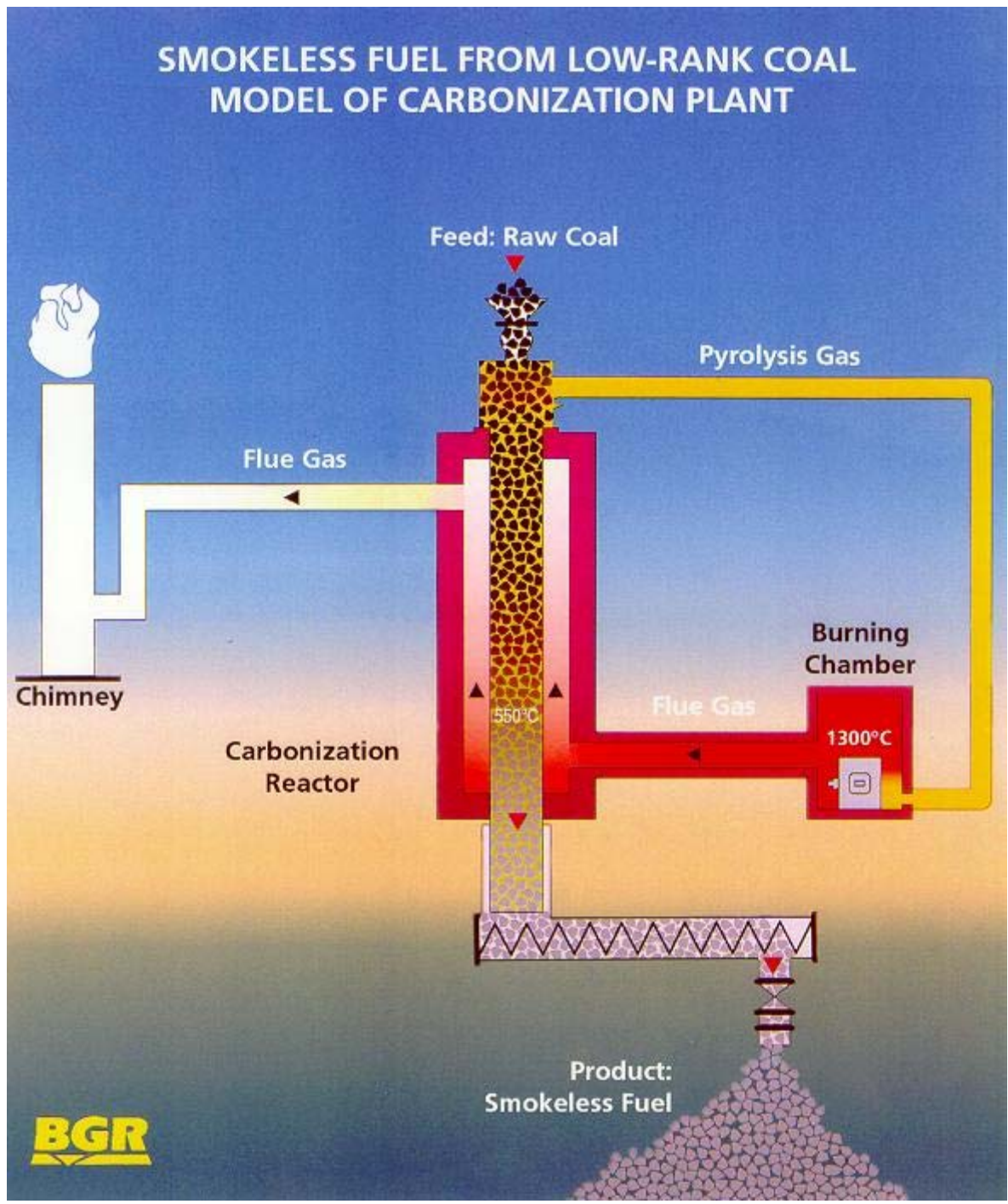
- **Invest in discovery of new oil reserves (e.g. Off-shore, shale oil, Artic Wildlife Refuge, your backyard)**
- **Invest in Clean Coal Technology as 20% of the worlds supply of Coal is in the US**

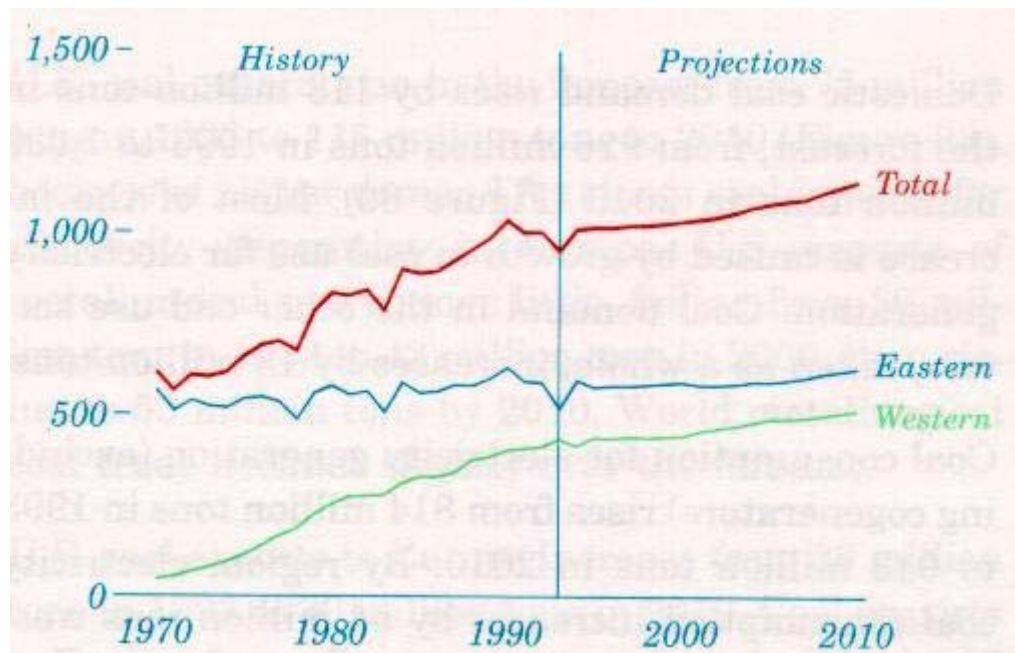
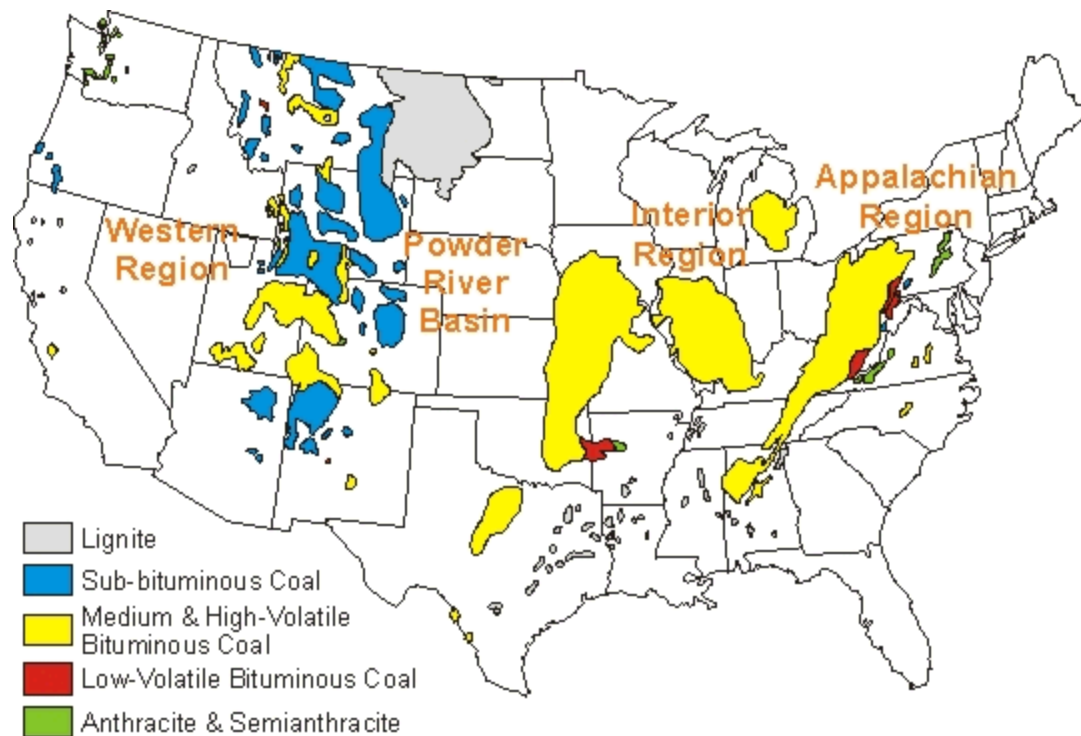


Jacksonville FL, Facility

Remember, even in the year 2000, Coal burning dominates the way the US generates electricity and production is increasing!







- **Invest in Renewable Energies**
- **Rigorously practice energy conservation and improved driving habits. Remember the 10% rule: 🖐️ if every American used 10% less energy per year than they normally would this would be equivalent to the entire amount of**

energy that China uses in that year.

Every form of energy generation has environmental fall-out.

However, this basic fact continues to elude people who somehow think some forms of energy generation are benign (only nuclear fusion is benign).

Most forms of alternative energy generation require much less of an organizational infrastructure. This means that a shift to alternative energies means a loss of jobs. This is undesirable to most politicians.

What happens if we try to be objective and evaluate our choices via some standard considerations, such as:

Evaluation Criteria for Alternative Energies:

- **Capital Costs**
- **Operating Costs**
- **Efficiency**
- **Is it renewable?**
- **Energy Storage Requirements**
- **Pollution**
- **Environmental Modification**
- **Levelized cost to the consumer**
- **Feasibility on Large Scale**
- **Individual Homeowner Independence**
- **Unit Capacity**
- **Loss of Jobs**

Comparative Table

| Evaluation | Solar Thermal | PV | Hydro | Wind | OTEC | Tidal |
|----------------------|----------------------|--------------|-----------------|-----------------|------------------|-----------------|
| Capital Costs | Large | Large | Enormous | Moderate | Enormous+ | Enormous |

| | | | | | | |
|---------------------------------|----------------------|-------------------------------|------------------------------|------------------------|-----------------------------|---------------------------|
| Operating Costs | Moderate | Moderate | Neglegible | Small | Unknown | Neglegible |
| Efficiency | 15% | 5--10% | 80% | 42% | 7% + | 25% |
| Renewable | Yes | Yes | Yes | Erratic | Yes | Yes |
| Storage | Not Needed | Unclear | Built-IN | Essential | Not Needed | Unclear |
| Pollution | None Really | Waste Heat | None | Visual | None | None |
| Levelized Costs | 25 cents KWH | 16 cents KWH | 4 cents KWH | 4.5 cents KWH | Unknown | Unknown |
| Environmental Impact | Moderate | Large | Enormous | Small | Unknown | Outrageous |
| Large Scale | Too Expensive | Possible but Expensive | Proven already | Very Possible | The Solution | Discrete Locations |
| Small Scale | NO | Difficult | Low Head --> Legal | Definitely | NO | NO |
| Unit Capacity | 1000 MW | Depends on Acreage | 2000-6000 MW | Highly Variable | As large as you need | 250 MW |
| Employment Opportunities | Few | Few | Few | Few | Lots to build it | Some |

What about Energy Storage?

Options:

- **Battery Farms:**

- **Acres of batteries; charged by transmission lines during periods of low demand**
- **Returned to transmission lines during periods of high demand**
- **Designed for load levelling**
- **One Acre could store about 400 MW-hours of energy and deliver 40MW of power (for 10 hours)**

We need better batteries period (also for electric vehicles):

US is investing in this

- **Pumped Hydro:**
 - **Not many locations lend themselves to this**
 - **Process is 64% efficient which is pretty good**
- **Flywheels:**
 - **Need to optimize energy-to-mass ratio which is material dependent**
 - **Fused Silica has 25 times the energy storage per kg than lead-acid batteries**
 - **Flywheels are promising**
- **Hydrogen**
 - **Very high energy density storage per kg**
 - **No naturally occurring sources**
 - **Separate H from H₂O is energy intensive**
 - **Not economically viable unless shipped large distances from point of production**
- **Compressed Air**
 - **Thermodynamics tells you that when you compress air the temperature goes up 🖐️ melts the pressure containment vessel**
 - **Have to cool the air as its compressed 🖐️ energy intensive**
 - **Not very practical**

Bottom line(s):

Wind energy coupled with advanced battery design has real promise and that promise is now being turned into real implementation. Wind power does exist.

With the development of the [Advanced Gas Turbine](#) energy co-generation at biowaste facilities becomes possible. Moreover, the

AGT provides a viable alternative to coal fire steam plants, using natural gas imported via pipeline from Canada. A [local example](#) will be on line in 2003.

OTEC provides a truly large scale solution but may be too expensive to ever implement 🖱️ what does this tell us about our priorities?

Solar PV does not look economically viable on the large scale. On the small scale, improvement in solar shingle technology is good for the consumer.

As of 2001 there remains little incentive to not look for new oil reserves. Just look at the price of gas at the pump 🖱️ it remains low.



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