

ALTERNATIVE ENERGY COSTS



PRESENTED TO APEGM

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**This photograph shows
wind-swept snow in sunlight.**



**Sun and Wind are leading
sources of alternative energy.**



ALTERNATIVE ENERGY

**WHAT IS NOT
'ALTERNATIVE ENERGY' ?**

NUCLEAR FISSION

FOSSIL FUELED ELECTRICITY

HYDROELECTRICITY

ALTERNATIVE ENERGY

WHAT IS NOT 'ALTERNATIVE ENERGY' ?

NUCLEAR FISSION REACTOR

**This was once seen as the fuel source
of the future.**

**It offered low cost, little local pollution and
limitless fuel resources.**

**Construction cost escalation and 'bad
press' have kept this industry from growing.**

ALTERNATIVE ENERGY

**WHAT IS NOT
'ALTERNATIVE ENERGY' ?**

FOSSIL FUELED ELECTRICITY

There are innovative ways of making electricity from fossil fuels, but they are rejected emphatically by activists.

ALTERNATIVE ENERGY

**WHAT IS NOT
'ALTERNATIVE ENERGY' ?**

HYDROELECTRICITY

The cheapest, most flexible, reliable & benign way to make commercial electricity.

**Not popular with 'fringe' activists,
for a range of reasons.**

ALTERNATIVE ENERGY

**WHAT IS
'ALTERNATIVE ENERGY' ?**

**COAL was the glorious source of
alternative energy hundreds of years ago.
It was better than wood
in so many ways.**

ALTERNATIVE ENERGY

**WHAT IS
'ALTERNATIVE ENERGY' ?**

OIL was the next “alternative”.

The first oil wells went commercial just as the world was running low on whales to turn into lubricants and ‘lamp oil’.

ALTERNATIVE ENERGY

**WHAT IS
'ALTERNATIVE ENERGY' ?**

**Every activist entity seems
to have its own definition.**

**Most focus on renewable sources and
minimal negative environmental effects.**

ALTERNATIVE ENERGY

**WHAT IS
'ALTERNATIVE ENERGY' ?**

**Some alternatives are meaningless
in global terms.**

**Collecting rancid cooking oil from a burger
place works for the first guy to ask, but is
just waste re-use,
not a “new source of energy”.**

ALTERNATIVE ENERGY

**WHAT IS
'ALTERNATIVE ENERGY' ?**

**Electricity from the sun and the wind
are the most popular.**

SOLAR ENERGY

SOLAR THERMAL

We have asked the sun to dry our food and salt for thousands of years.

We ask it to warm our tap-water and homes.

We focus it on a target to make steam and electricity.

(aka Solar Thermal Power Technology)

SOLAR ENERGY

SOLAR THERMAL

**Electricity made this way
costs as little as \$69 mwh.**

SOLAR ENERGY

SOLAR PHOTOVOLTAIC

PV

Photocells convert light into electricity.

Flat slices of silicon crystal are doped and made into expensive panels.

Other materials offer good performance with much lower initial cost.

SOLAR ENERGY

SOLAR PHOTOVOLTAIC PV

Panels are commonly mounted at a fixed angle, to maximize incident light.

**Tracking the sun with them can
double installed cost,
but can make 20+% more power**

SOLAR ENERGY

SOLAR PHOTOVOLTAIC PV

**Menard's now offers a 60w panel for \$300.
With DIY installation, installed cost \$320.
With 250 days of 8 hours at 60w, and \$30 a
year in 'cost', this is about \$0.25 per kwh.**

**THIS PRICING MAY INCLUDE
US GOVT SUBSIDIES.**

SOLAR ENERGY

SOLAR PHOTOVOLTAIC PV

Batteries and an inverter not included, but PV is still better than a fossil powered gen-set for a minimal-power remote cottage.

THIS IS SEVERAL TIMES THE RETAIL COST OF POWER ON THE PRAIRIES.

SOLAR ENERGY

SOLAR PHOTOVOLTAIC PV

**Future PV cells may be tiny.
Think of the sparkles in metal-flake paint.**

**Current photocells are sliced from 6" to 12"
diameter bars of very pure silicon.
Hailstones, birds and wind-driven debris
can ruin these expensive installations.**

SOLAR ENERGY

SOLAR PHOTOVOLTAIC PV

**These tiny cells use about 1% of the silicon.
They would be placed by robots onto
resilient substrates. They can be run in
series for high voltage and thus tiny wires,
isolated in groups with cheap controls.**

SOLAR ENERGY

SOLAR PHOTOVOLTAIC PV

When developments like this become commercial, cost can drop by a factor of 10.

If this happens, and world-wide production increases 20 fold, cost would drop, perhaps by another factor of 10.

SOLAR ENERGY

SOLAR PHOTOVOLTAIC PV

At this point, these systems will displace all fossil powered remote electrical systems.

They would be by far the cheapest 'distributed' source of clean electricity.

It is reasonable to expect that these would make large wind power largely obsolete.

SOLAR ENERGY

SOLAR PHOTOVOLTAIC

PV

PV is the most expensive alternative energy.

**Large PV farms now cost \$200-300/mwh
(California RETI data)**

**PV has the greatest potential for
dramatic cost reductions.**

TRENDS

**WIND IS MUCH MORE EXPENSIVE
NOW THAN 5-10 YEARS AGO.**

**GEOHERMAL SITES ARE NOW MORE
EXPENSIVE, AS
SPECULATORS BUY THEM UP.**

TRENDS

**MASS-PRODUCTION HAS NOT MEANT
LOWER COSTS**

**A symptom of the non-free-market forces
that drive alternative energy...**

SOLAR ENERGY

CONCENTRATED SOLAR PHOTOVOLTAIC CPV

A large scale mirror system is cheaper per square foot than a photocell. A shiny trough does not have to move to track the sun.

Twice the light on a photocell makes nearly twice the electricity.

CPV is much cheaper than PV for commercial Solar Power “farms”.

SOLAR ENERGY

CONCENTRATED SOLAR PHOTOVOLTAIC CPV

Mirror system can be a fixed shiny trough.

**New flexible materials are available with
very high reflectance,
and great resistance to weathering**

SOLAR ENERGY

It seems that every corporation with a large roof has announced a big photovoltaic installation program.

Recently, this includes GM, Porsche, VW Ferrari and a variety of warehouses.

SOLAR ENERGY

PRICING

**ALL OF THESE ANNOUNCEMENTS
INCLUDE DATA ON CAPACITY.**

**None will venture into the actual
capital cost, subsidies or \$ 'saved'.**

SOLAR ENERGY

PRICING

One eye catching online PV promotional ad features \$ signs. They quote test results showing their cells had the lowest cost / kwh, and the second highest kw / unit of sunlight.

When you search their site, nowhere can you find cost data.

SOLAR ENERGY

PRICING

**Is it just coincidence that promoters
and the media are so averse to
the mention of cost information?**

ALTERNATIVE ENERGY

WHAT ELSE MIGHT BE
'ALTERNATIVE ENERGY' ?

- **DIGESTER & LANDFILL OFF-GAS**
- **GEOHERMAL ELECTRICITY GENERATION**
- **BIOMASS-TO-STEAM-TO-ELECTRICITY**
- **WOOD OR CROP WASTE**
- **ALGAE**

DIGESTER & LANDFILL OFF-GAS

PRIMARILY METHANE

CAN BE BURNED TO MAKE HEAT

**FOR SPACE HEATING OR
TO KEEP THE DIGESTION GOING.**

DIGESTER & LANDFILL OFF-GAS

THIS METHANE

**CAN BE USED IN A PISTON ENGINE TO
DRIVE A GENERATOR.**

**IF TOO DILUTE OR ERRATIC ON ITS OWN,
LANDFILL GAS CAN BE BLENDED WITH
NATURAL GAS TO POWER
A PISTON OR TURBINE GEN-SET.**

GEOHERMAL ELECTRICITY GENERATION

WHERE SUBTERRANEAN ROCK IS $>200\text{C}$

Water is pumped down a well, becomes superheated, and used in turbines to generate power. Volcanic areas have great potential.

Manitoba has no geothermal potential.

MB heat pumps use the 10C soil near the surface as a sink for refrigeration systems. These use electricity to pump heat into and out of buildings.

GEOHERMAL ELECTRICITY GENERATION

Geothermal plants are very much like thermal (coal to steam) electricity generating plants, but with no fuel cost and no GHG emissions.

The hot water used can be corrosive.

This increases the cost of operation.

GEOHERMAL ELECTRICITY GENERATION

Iceland and San Francisco are famous for their use of Geothermal energy.

The Yellowstone area could generate as much electricity as the world now uses.

The western states have countless volcanic sites to be exploited for power generation.

GEOHERMAL ELECTRICITY GENERATION

With favorable conditions, power can be made for under \$25/mwh.

With a standard plant design, engineering and operation costs of geothermal plants can be drastically reduced. Construction costs are not likely to change much.

BIOMASS-TO-STEAM-TO-ELECTRICITY

Biomass is renewable.

Net GHG reduction over fossil fuel.

(The carbon borrowed from the air by green plants is just 'returned' by burning this material.)

BIOMASS-TO-STEAM-TO-ELECTRICITY

Fuel sources:

Crop waste (straw etc.)

Crops grown just for fuel

(i.e. algae living on power-plant flue gas)

Forest industry waste

BIOMASS-TO-STEAM-TO-ELECTRICITY

Problems:

Cost to haul biomass to process plant.

Briquetting problems.

Cost to dry some potential fuels.

BIOMASS FOR HEAT

Problems:

SIMILAR TO ABOVE BIOMASS ISSUES.

**FOR REMOTE FUEL NEEDS, DELIVERY
COSTS CAN BE LOWER THAN FOR
TRADITIONAL FUELS.**

WIND-TO-ELECTRICITY

LIMITATIONS: SITING

Neighbours may complain.

Best winds often not near cities.

**Long AC transmission can cost / lose
enough to offset the advantage of a
faraway windy locale.**

WIND-TO-ELECTRICITY



LIMITATIONS: COST

**WITH SUBSIDIES, LARGE WINDMILLS
ARE QUITE PROFITABLE.**

WIND-TO-ELECTRICITY

LIMITATIONS: COST

WHEN MAINSTREAM POWER IS VERY COSTLY, IT DOES NOT TAKE MUCH SUBSIDY TO MAKE MONEY ON WIND. SOME OF THE TIME, WHOLESALE POWER IN BOSTON COSTS MORE THAT THE REAL COST OF WIND. ARCTIC SETTLEMENTS CAN BE SIMILAR.

WIND-TO-ELECTRICITY

LIMITATIONS: COST FACTORS

There is far more wind capacity installed in North America than a few years ago.

Capital and power purchase agreements are much more costly than 5 years ago. (Excel)

California estimates \$60-130/mwh.

COST OF ALTERNATIVES

**THE COST OF THE VARIOUS
ALTERNATIVES IS REGION SPECIFIC.**

**IN LUSH LOCALES,
PELLETIZING BIOMASS AND BURNING IT
FOR STEAM AND ELECTRICITY IS CHEAPER
THAN IN THE DESERT,
WHERE SOLAR IS AT ITS BEST.**

COST OF ALTERNATIVES

**THERE ARE A FEW TABLES OF COST DATA
OUT THERE, EVEN THOUGH MOST IN THE
INDUSTRY WILL NOT TALK COSTS.**

**I USED DATA FROM SCIENTIFIC AMERICAN,
AND AZ AND CALIFORNIA GOVTS**

COST OF ALTERNATIVES

**IN THE SW USA,
WIND COSTS \$60-135/mwh
SOLAR PV IS NOW ABOUT TWICE THE
PRICE OF NEW SOLAR THERMAL,
WHICH IS SIMILAR TO OFFSHORE WIND,
AT \$150 TO 200/mwh**

COST OF ALTERNATIVES

THE ACTUAL COST OF BIG US OFFSHORE WIND IS NOT A VERY FIRM NUMBER.

CAPE WIND HAS BEEN STRUGGLING FOR SEVERAL YEARS WITH SOME SILLY BUT POWERFUL OPPONENTS.

IF THINGS HAD GONE SMOOTHLY, THEY WOULD HAVE BEEN VERY PROFITABLE.

COST OF ALTERNATIVES

**THE CHEAPEST OF THE CURRENT CROP OF
ALTERNATIVES ARE:**

BIOMASS BURNING FOR HEAT + POWER

HYDROELECTRICITY

LANDFILL GAS TO POWER

GEOHERMAL ELECTRICITY

COST OF ALTERNATIVES

**THE US PRICES OF THESE
ALTERNATIVES ARE:**

BETWEEN \$20 AND \$100 / MWH

**THIS IS CHEAPER THAN NEW PLANTS FOR
OTHER ALTERNATIVES.**

**COAL IS STILL THE CHEAPEST TO BUILD IN
MOST PLACES.**

COST OF ALTERNATIVES

**ALTERNATIVE ENERGY IS THE MOST
SECRETIVELY PRICED OF COMMODITIES.**

**THIS MAY BE AN ARTIFACT OF ITS
PRECARIOUS POSTION.**

**It has had double digit growth for several
years, largely based on fears of global
warming and limited global resources.**

COST OF ALTERNATIVES

**IF ALTERNATIVE ENERGY HAD BEEN
EVALUATED ON THE BASIS OF ACTUAL
COSTS AND BENEFITS,
IT WOULD BE A FRINGE INDUSTRY.**

COST OF ALTERNATIVES

**A LONG-TERM CARBON-TAX SCHEME
COULD DRIVE FOSSIL FUEL PRICES 'HIGH
ENOUGH' TO BRING ON LARGE-SCALE
ALTERNATIVE POWER.**

**A NEW TAX OF 30c TO 50c PER kwh MIGHT
BE UNPOPULAR WITH VOTERS AND
INDUSTRY**

FUTURE ALTERNATIVES

**WIND WILL GET INCREMENTALLY MORE
RELIABLE AND A BIT CHEAPER**

**GEOHERMAL ELECTRICITY COULD
DOMINATE WITH VERY LOW COSTS,
IN 'VOLCANIC' REGIONS**

**SOLAR COULD DROP THE MOST IN PRICE,
BUT IT IS VERY EXPENSIVE NOW**

FUTURE ALTERNATIVES



**OTHER ALTERNATIVES WILL REMAIN
MINOR PLAYERS**

**HUMANITY WILL DEPEND ON
'CONVENTIONAL' FOR
GENERATIONS TO COME**

