

The Real Cost of Alternative Energy Generation

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Why Are We Talking About Alternative Energies ?

Human nature to talk about better ways to satisfy human needs and wants.

Politically correct/popular thing to do

We need to expand our knowledge base to solve energy problems

Environmental costs of old technology energies are unacceptable

Energy is a major cost factor in everything we do

Using alternative energy sources creates new problems for PQ guys to solve

The “Evil” Trio -- Coal, oil, Nuclear

Political Correctness is low and falling

Environmental impacts unacceptable

- Air – smog and carbon from coal and oil
- Waste disposal of spent fuels for Coal and Nuclear costly

Power plant safety a major concern

Old technology is cost competitive baseline

Trio provides over 90% of world's electricity

World Wide Electricity Status

Billions KWH	2008	2009	2010	2011
Generation	1,9161.1	19,062.3	20,253.9	21,020.9
Consumption	17,410.0	17,316.8	18,501.4	19,298.5
Renewables	3,731.9	3,871.4	4,177.1	4,402.4
% Renewable	19.5	20.3	20.6	20.9

Electricity Costs by Country

Country	Industrial	Household	Ratio H/I
Denmark	104.15	383.43	3.68
Mexico	114.74	90.20	0.79
Italy	291.79	288.40	0.99
Norway	57.56	135.98	2.36
Japan	194.27	276.76	1.42
Germany	148.71	338.75	2.28
USA	66.98	118.83	1.77
US \$/MWH			

Fossil Fuel Subsidies

- Subsidies – Government keeps fuel/electricity prices below market / cost to produce
- 2012 estimates \$51 billion
 - 68% oil, 24% electricity
- Rising import costs make current levels unsustainable
- Smuggling a Major Problem
 - Increases cost to the government
 - Reduce tax revenue
- Distort Market and Generation Facility
- US example
 - Wind farms 2.1 cent/KWH subsidy
 - Utilities must buy excess electricity in period of lower demand

Alternative Energy Sources

- Solar – Photo voltaic cells, direct/concentrated heat
- Wind power
- Bio-mass
- Water power – falling, tidal currents, waves
- Fuel cells
- Hybrid systems - gas/thermal
- Geo Thermal

Traditional Costing

- Cost to customers per KWH
- Levelized Cost Factors
 - Fuel, Generating Equipment
 - Depreciation, Transmission Cost, Maintenance Profit
- Subject to Government Regulation / Interference
- Assume a steady state operational environment
- Common Basis for Business Decisions

Cost Factors

- Capital Cost
 - Fossil Fuels – low
 - Wind turbines/solar PV – high
 - Solar thermal, wave & Tidal, Waste – very high
- Fuel Costs
 - Fossil fuels, Biomass – high
 - Nuclear – low
 - Renewable – “ZERO”
- Other Cost Factors
 - Wastes, Disposal nuclear and coal
 - Insurance
 - Parasitic loads of plant operation
 - Research and development new technologies
 - Satisfying government Regulations
 - Government incentives, tax credits, etc

Comparative Cost (New Plants)

- Coal 96-116 \$/MWH (combined cycle)
- Gas 66-128 \$/MWH (Turbines)
- Geo Thermal 48 \$/MWH
- Bio Mass 103\$/MWH
- Wind 80-204 \$/MWH (offshore)
- Solar PV 130\$/MWH
- Hydro 85 \$/MWH

Energy Intensity by Countries

- Unit of Measure MTOE / GDP (\$1k)
 - Indonesia 2.3
 - Thailand 1.8
 - Malaysia 1.7
 - Philippines 1.1
- Subsidies lower intensity
 - GDP Impact – Increases project payback times
 - Distort market place prices
- Energy Demand / Capital .9 MTOE (ASEAN)

Solar Power Usage Factors

Availability – Limited to daylight hours and mostly clear sky

Energy collection –

- Photo voltaic cells – large mount footprint for major users
- Direct – for heat, may be easily concentrated for hybrid systems
- Favorable operations and maintenance costs

Political Correctness high and improving.

Good source of jobs and low environmental impacts

Increases need for distribution infrastructure



Solar Cell Installation

- Crystalline- Old Technology
- Poly Crystalline-12V- \$1.50-\$2.00 per watt
- Mono Crystalline - 12V- \$1.30 per watt
- Large System – 3-6,000 w –about \$1 per watt

Wind Power Usage Factors



- Availability – 24/7 at nature's whim
- Energy Collection – complex electrical generators in remote locations
 - Wild life impacts
 - Some direct usage for pumping water
 - Climate impacts in some places
- Political correctness quite high.
- Great source of jobs for manufacturing and installation
- Distribution infrastructure a problem in some areas
- Visual pollution concerns near urban areas
- Typical Installation

Offshore Wind Energy

- Abundant Availability 70% US Electricity -28 coastal
- Shallow water has a big potential 43% of Atlantic < 100' Deep
- Easier to transport large components – Larger Generators
- Use Floating Generator in Deep Water
- Under sea cable carry electricity to shore for distribution
- Offshore winds are stronger during the day when energy is needed

Storage of Electricity

- Grid operational Systems provide reserves
- Spinning Synchronized reserved – rapid response
- Other reserves > 10" responses
- Pumped storage – water, compressed Air and Fly Wheels
- Required to supplement solar, wind and water
- User level demands for emergency and non-emergency
 - Gas Power Generation, Battery packs
 - Rechargeable personal electronics
 - Fuel cells
- Economics drive amount of storage available
- DOE 2013 electrical storage handbook is online

Grid Integration Costs

- Infrastructure Additions
 - Transmission Lines
 - Current merging hardware
- Administrative costs
 - Internal
 - Governmental
- Power Quality Issues
- Economics – who pays the bill
- Renewable replace traditional

Electricity Access 2011

- Humanitarian / Political problem in some ASEAN countries
- 134 million people or 22% have no access
- Philippines 30%, Myanmar 51%, Cambodia 66%, Indonesia 27% and Lao PDR 22%
- Distribution infrastructure is major cost consideration