# The Real Cost of Alternative Energy Generation

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## hy Are We Talking About Alternative Energies a

- nan nature to talk about better ways to satisfy human needs and wants.
- tically correct/popular thing to do
- need to expand our knowledge base to solve energy problems
- ironmental costs of old technology energies are unacceptable
- rgy is a major cost factor in everything we do
- ng 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**

Billons 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 Germany USA	194.27 148.71 66.98	276.76 338.75 118.83	1.42 2.28 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 Iow
  - Wind turbines/solar PV high
  - Solar thermal, wave & Title, Waste very high
- Fuel Costs
  - Fossil fuels, Biomass high
  - Nuclear Iow
  - -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

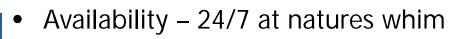
Increases need for distribution infrastructure



#### **Solar Cell Installation**

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

# Wind Power Usage Factors



- Energy Collection complex electrical generators in remo 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
- Administrational 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