Renewables and Buildings – Wind, Solar, Wood, Geothermal

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13 February 2008

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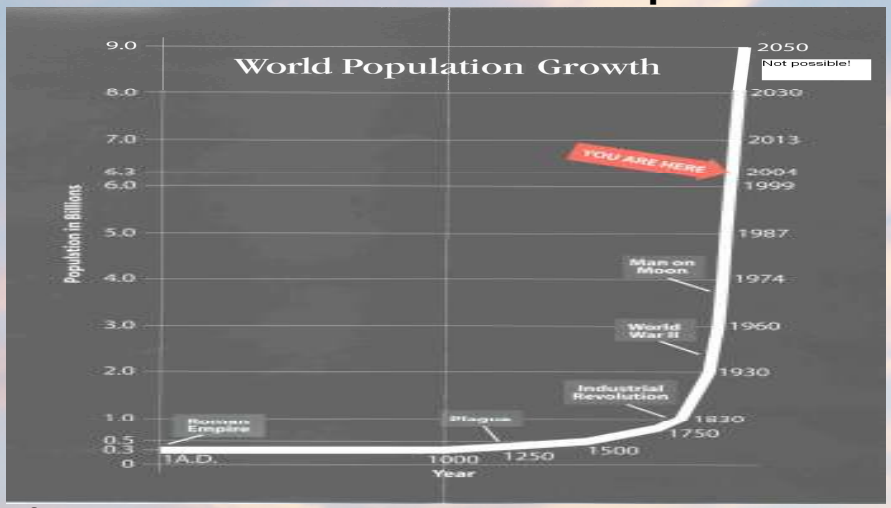
Fossil fuel use has allowed exponential -



- food production which allowed exponential population growth which is using ALL stored fossil fuels in 200 years

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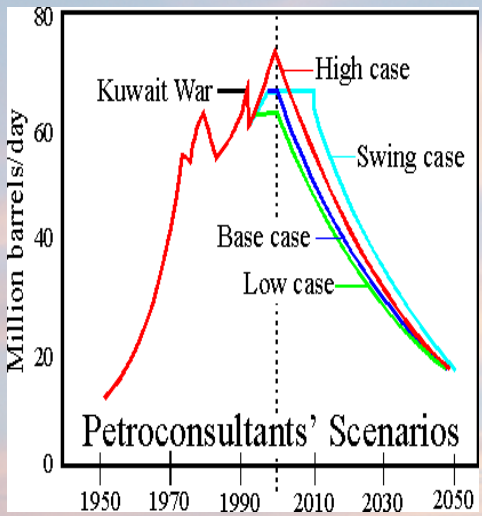
Our huge energy problem



- Fossil fuels are finite, dirty. **Climate change!**
- World oil production peaking in now, after 140+ years of growth.
- Oil is largest (40%)energy source for US and world.
- US now imports almost 70% of the oil we use.
- US **had** the 2nd largest oil resource in the world.

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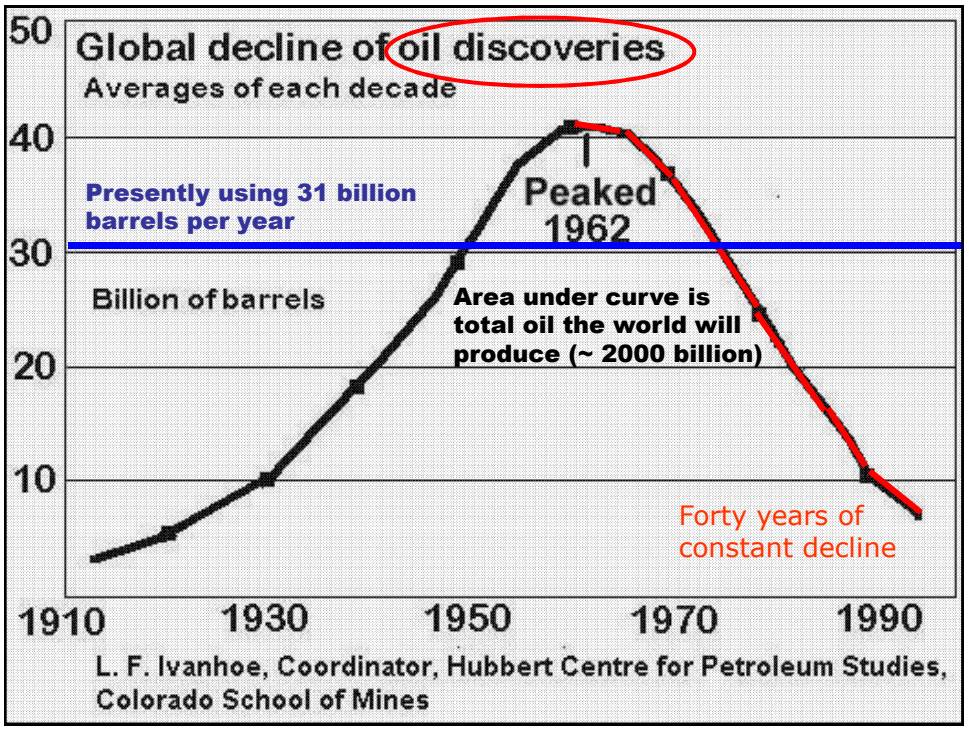
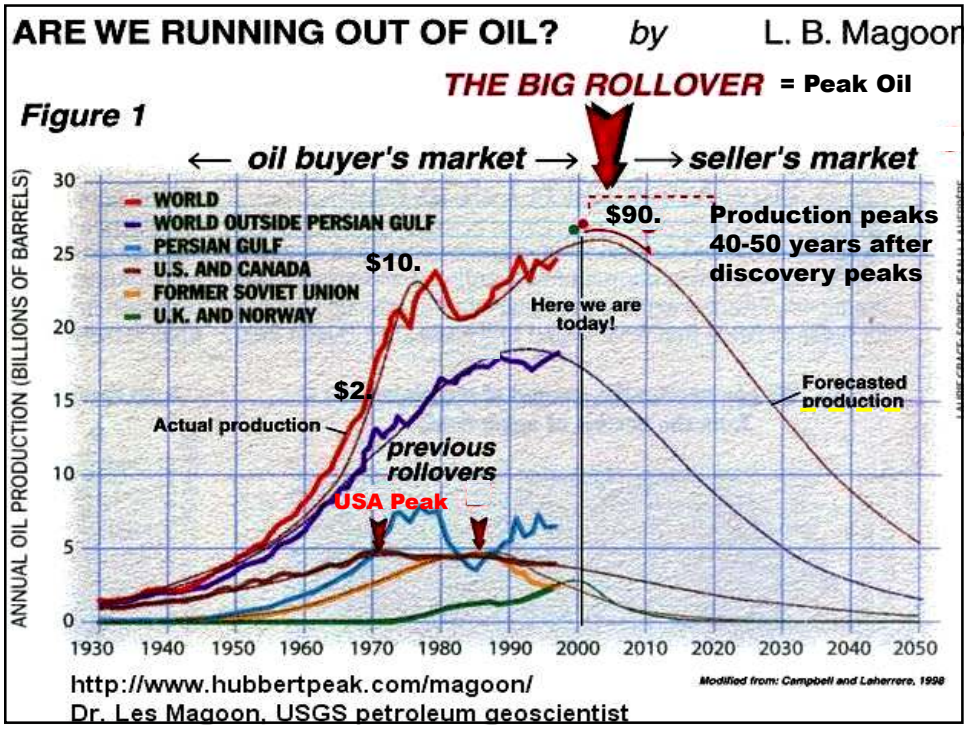
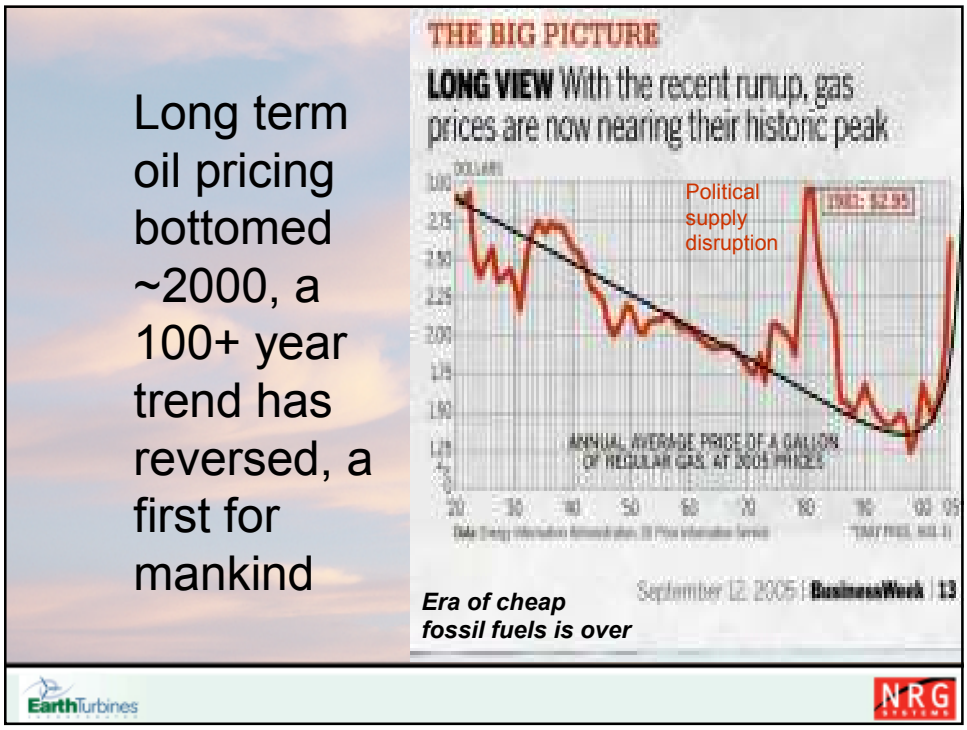



ARE WE RUNNING OUT OF OIL? by L. B. Magoon
THE BIG ROLLOVER = Peak Oil
Figure 1
← oil buyer's market →
→ seller's market
ANNUAL OIL PRODUCTION (BILLIONS OF BARRELS)
WORLD
WORLD OUTSIDE PERSIAN GULF
PERSIAN GULF
U.S. AND CANADA
FORMER SOVIET UNION
U.K. AND NORWAY
$10.
$90.
$2.
Production peaks 40-50 years after discovery peaks
Here we are today!
Forecasted production
Actual production
previous rollovers
USA Peak
30
25
20
15
10
5
0
1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050
http://www.hubbertpeak.com/magoon/
Dr. Les Magoon, USGS petroleum geoscientist
Modified from: Campbell and Laherrere, 1998


Long term oil pricing bottomed ~2000, a 100+ year trend has reversed, a first for mankind
THE BIG PICTURE
LONG VIEW With the recent runup, gas prices are now nearing their historic peak
Political supply disruption
ANNUAL AVERAGE PRICE OF A GALLON OF REGULAR GAS AT 2005 PRICES
Era of cheap fossil fuels is over
September 12, 2005 | BusinessWeek | 13
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Energy Facts

- 1 barrel of oil = 42 gallons or 672 cups (8 oz bottles)
- The world today consumes 85 million barrels/day or 31 billion a year. At $70/barrel = $2.1 trillion/year or 10 cents per cup (Cheaper than water!)
- Energy supply ~40% oil, ~22% natural gas, ~22% coal, ~6% RE, nuclear
- Total world energy bill ~ $8 trillion/year
- Wind power ~ $20 billion/year
- Solar ~ $18 billion/year
- Necessary for food, housing, movement - EVERYTHING
- Energy use in USA is 6 times world average – need 6 earths to support 6.4 billion people with our lifestyle but population is still GROWING
- Peak Oil is a proven theory (Hubbert)
- Denial is a proven theory in human behavior
- Fossil fuels and nuclear are finite, renewables are infinite
- Continued exponential growth in energy is **NOT** possible
- Energy Returned on Energy Invested (ERoEI) – "Energy Profit" critical for making informed future energy decisions – not just on financial returns
- We (American's) are the biggest problem – 30% of world's CO2 emissions, 25% of energy and only 4% of the world's population

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Wind Power






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Small Wind Systems

- Range from 2 to 100 kW
- Displaces energy at retail rates (Net Metering) at point of use
- Requires 8+ mph average wind sites
- Industry tiny but good potential - scalable
- EROI low due to low volumes – markets need to develop
- Federal incentives maybe next year – VT rebates available now

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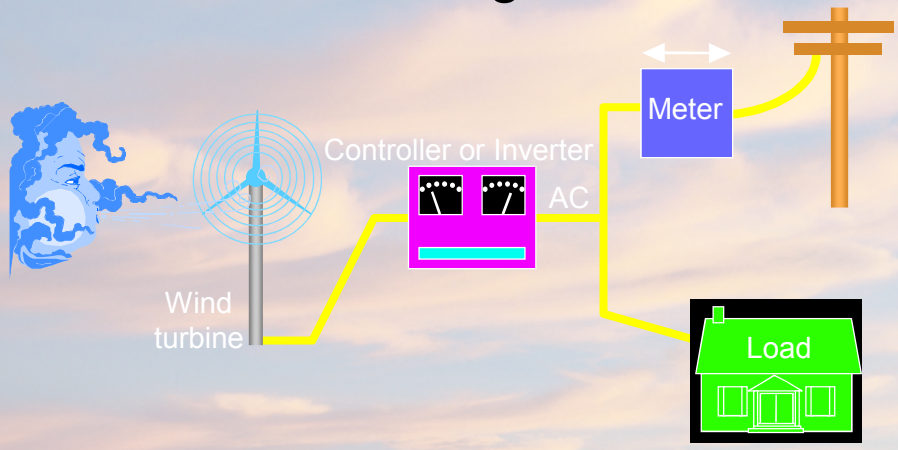
On-Grid Wind System without Storage



Net Metered for AC energy production

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Community Wind

- Group Net metering is coming
- Will allow larger turbines in windy spots to be owned by groups and output shared at retail rates
- Up to 2MW turbines
- Presently OK for select customers/technologies
- Most cost effective wind power for businesses

Vestas V-27 225kw

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Our "Green" Building

Integrated conservation, efficiency & renewables

75kw Solar PV & 5 kw wind =75% of electricity (net-meter)

Day-lighting (solar)

GSHP-30 ton pond geothermal cooling

Radiant floor heating/cooling

Super energy eff. – 1/5 use of typical 46,000 sq ft building

Wood pellet heat & 6 panel solar hot water

$12,000/year energy bill vs $80,000. 90+% renewable

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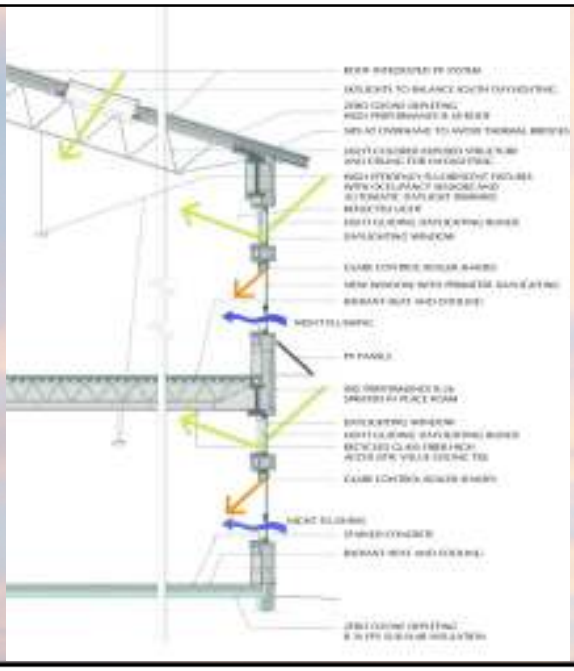

Integrated building design around solar and efficiency

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Day lighting

- Auto dimming fluorescents
- Big windows
- Light paint colors
- Occupancy sensors
- Increases productivity

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Office space

Wood pellet heating

- Gravity fed TARM boilers on 1st floor (2 x 146,000 BTU/hr)
- 30 ton storage silo on 2nd floor – truck filled in summer
- Over 1 year of storage in 12' diameter x 25' tall silo

High Efficiency-Lower Equipment Cost

- Electrical – 75 KVA 208/3 phase, 200 A (not 300 KVA, 480 V)
- Five – 6 ton water/water Heat Pumps with best COP for cooling with pond loop
- Two 146,000 BTU/hr TARM wood pellet boilers (90% eff.)
- Net metered RE is 80% of electrical supply – Rate 6 vs 63
- 12,000 kwh/month average load –RE supplies 9,000 kwh

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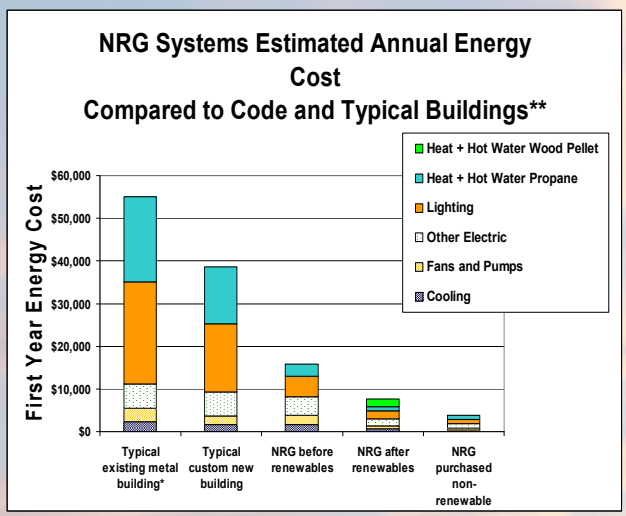
The Numbers (2004)



- $6.50/watt for PV and $8000. for solar hot water
- $519,000. for all solar & wind
- 5 times more efficient – lower capital equipment cost
- 46,000 sq.ft.
- $7.8 million cost ($168./sq.ft.)
- LEED & RE added less than 9% to cost

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Renewables Work!

- We save $7300./year on utility service alone– purchased power less than 7600 kwh/month – no demand/TOD charges
- $49,000 federal tax credit for solar (10% cost) 30% 2006-08
- 5 year accelerated deprecation on solar/wind
- VT state rebate on first 5kw PV = $12,500.
- We have prepaid most of our energy bills for 30+ years, worth $2-5 million
- Year 2004 tax savings was over $170,000 - Higher today – about $270,000 with 30% solar tax credit
- RE works best with HIGH efficiency – if possible, don't do one without the other
- Construction costs are rising due to energy costs – build now!

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Taking care of our future

- A great workspace increases productivity and employee health – big add to profitability.
- Need quality space to handle our 40+%/year growth.
- We've prepaid / hedged most of our energy bills.
- We are ready for a changing energy world.

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New Earth Turbines/NRG Building

- Once-thru well water radiant cooling vs. pond
- 31,000 sq.ft.
- Cost is 35% higher than in 2004 due to higher commodity prices for material
- Higher insulation
- Same size and brands of pellet, solar hot water and PV systems

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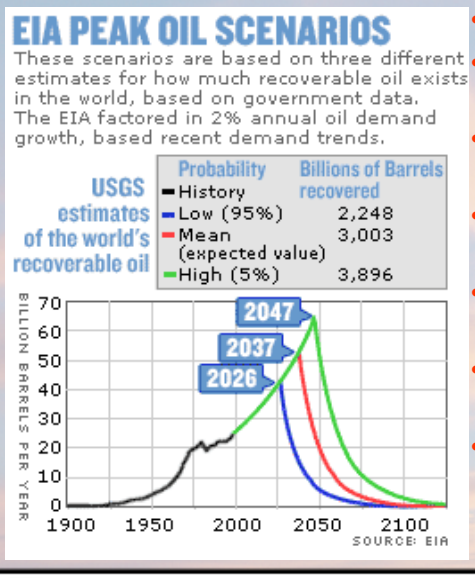
Renewables are our only hope



- Fossil fuels are **finite**, dirty
- Global warming requires 80% cut in CO2 emissions
- The era of **CHEAP** fossil fuels is over
- Oil is largest energy source for US and world
- US uses 25% of world's energy but is 4% pop.
- US **had** the 2nd largest oil resource in the world
- **EIA is wrong**, oil will peak soon & total recovered oil will be around 2,300 billions barrels.

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What we should do now

Conservation – Very large opportunity in USA – need to change habits
Efficiency – Huge gains with present technology – we waste too much
We can and must reduce energy use by ¾ (to **1/4** of use)
Renewables (all are needed but not enough to replace fossil fuels):

- *Wind*: works, cost effective & huge potential (Home, Community & Large)
- *Solar*: works, costs coming down, huge potential
- *Biomass*: food vs. energy & topsoil issues, some pollution, CO2 neutral
- *Geothermal*: part of solution – ground source heat pumping
- *Hydropower* – mature in USA, some added run-of-river available

80% cuts in CO2 by 2050 = **5% reduction** every year for 43 years(+2% now)
Finite fossil fuels should only be used to back-up renewables
Must build new buildings to be super efficient and with integrated renewables
Electricity to become 50% or more of energy supply, up from 20-25%
Must move to electrified mass transit and drop the auto-centric model

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Information Sources

www.awea.org American Wind Energy Association

www.REVermont.org Renewable Energy Vermont

www.windpower.org Danish Windpower

www.simmonsco-intl.com Mathew Simmons' speeches – see "The Energy Crisis Has Arrived"

www.NRGSystems.com Wind Measurement & Green Building

www.EndOfSuburbia.com Peak Oil & the Automobile

www.energybulletin.net/primer.php Primer on Peak Oil

www.kunstler.com The Long Emergency – New living arrangements

www.earthturbines.com Home wind turbines

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