Terrestrial Renewable Energy And Biofuels

Alfred J. Cavallo
US DHS EML
201 Varick St, 5th Floor
New York, NY 10014

PROPOSAL:

A Modern Industrial Society
Can Be Fully Powered
Using
Terrestrial Renewable Resources

Renewable Resource Base

- Immense: for example
- US Wind resource equivalent to 5-10x current average electric consumption
- US agricultural land sufficient to yield liquid fuels to power fuel-efficient transportation fleet
- Solar thermal/PV resource large

Most Promising Renewables

- Wind
  - Excellent technology; 30 GW Installed
  - Moving Offshore in Europe
- Solar Thermal
  - Luz Parabolic Concentrators Proven
- Biofuels
  - Brazilian Ethanol Program

Renewable Energy Not Taken Seriously:
By Utilities, By Oil Companies
By Renewable energy advocates

Challenges:

Technical (Transmission, Storage)

Externalities do not count

Relative Profits (liquid fuels especially)

APPROACH

Renewable Energy (electricity, fuel)

MUST be:

- Affordable (not necessarily cheap)
- Technically equivalent to other competitors
- Profitable for manufacturers, utilities

(Necessary but not sufficient)

BIOFUELS

- Ethanol from corn (US farm subsidy)
- Biomass to Syngas to fuels

  Biomass+O_2 -> CO+nH_2+heat

  CO+mH_2 ->(catalyst, FT process) Fuels

  (similar to GTL process for monetizing stranded natural gas)
- Ethanol and Methanol from non-corn crops

  (energy crops, agricultural waste)

Example: Brazil

- Successful program to produce ethanol from sugarcane
- Cost is the same as gasoline (boe)

BUT:

Production flat over past decade

Petroleum Consumption up 40%

Production x2

WHY??

NEWS FLASH

- London, June 26 - The **Beyond Petroleum Company (aka BP)** today signed a formal agreement to invest $6.15 billion in a joint venture to produce biofuels in Russia.
- The political importance of the deal was underscored by the appearance of Prime Minister Tony Blair and President Putin at a biofuels conference here today.

UNDERSTAND THE MARKETS

How profitable is this business?

"Non-OPEC finding and development costs dropped from $22/bbl in 1981 to $6/bbl in 2001 (2001$)."

E. Baird, President and CEO, Schlumberger Ltd.

Fossil Fuels, The Key to Sustainable Development,

World Energy, 2003, Vol 6, 1, 34-41.

Wind Turbine Technology

- 30,000 MW Installed ($30 Billion)
- Produced on assembly lines in large factories
- Highly competitive
- European private enterprise R&D
- Excellent reliability
- 4.5 MW machines under development

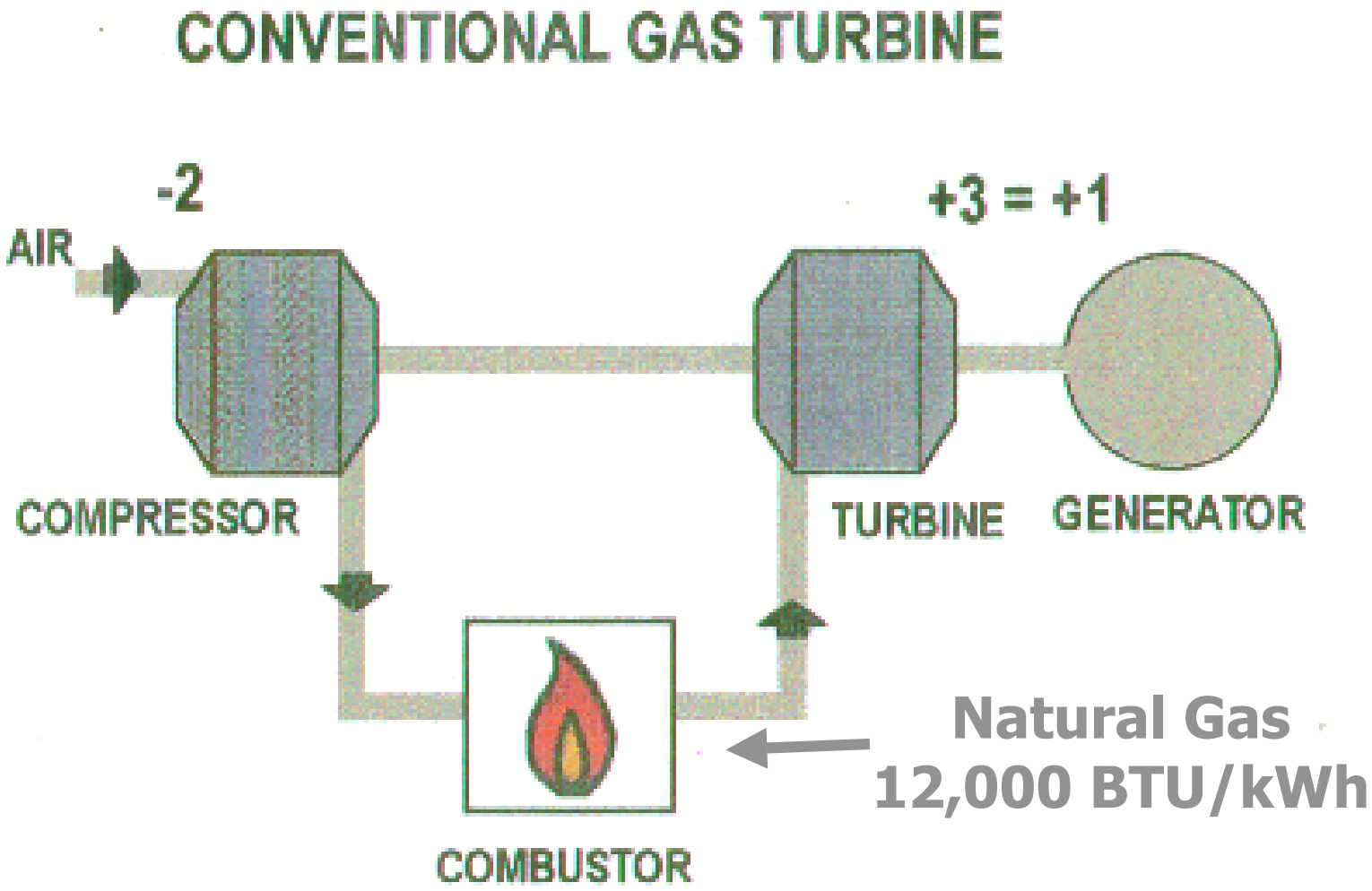
Compressed Air Energy Storage (CAES)

- Proven technology; existing plants
- Gas Turbine (simple, inexpensive)
- Underground Storage (invisible)
- 3D Seismography
- Porous rock, solution mined caverns
- Suitable geology widely available
- Seasonal Storage economical

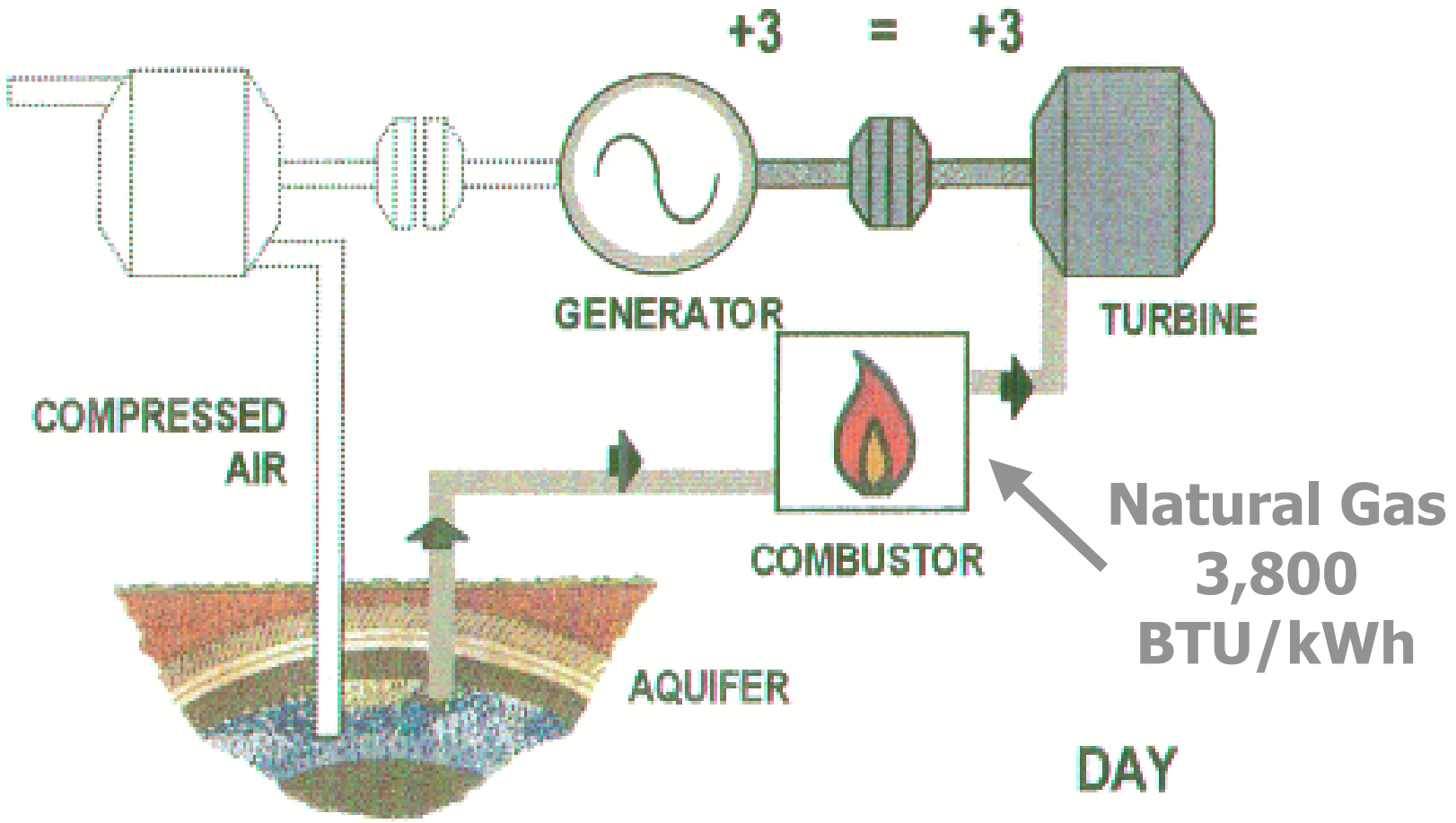
CAES

- About 65% of gas turbine output used to compress air at inlet to combustor
- Compressed air stored underground, eliminating need to compress air.
- World's best kept secret energy storage technology.

Mechanics of CAES – background



Mechanics of CAES – generation



Utility Wind/CAES Systems

- Wind generated electricity most economical renewable energy.
- Capacity factor designed to produce lowest local cost of electricity (0.3).
- Capacity factor can be (0.5) for 10% increase in local COE.
- Baseload Wind/CAES with transmission for 10-15% increase in delivered COE.

Iowa Wind/CAES Project

- Project Template
  - Demonstration Project
  - Public private partnership
  - Special appropriation (earmark) outside of normal channels through Congressional Delegation

IOWA WIND/CAES Plant

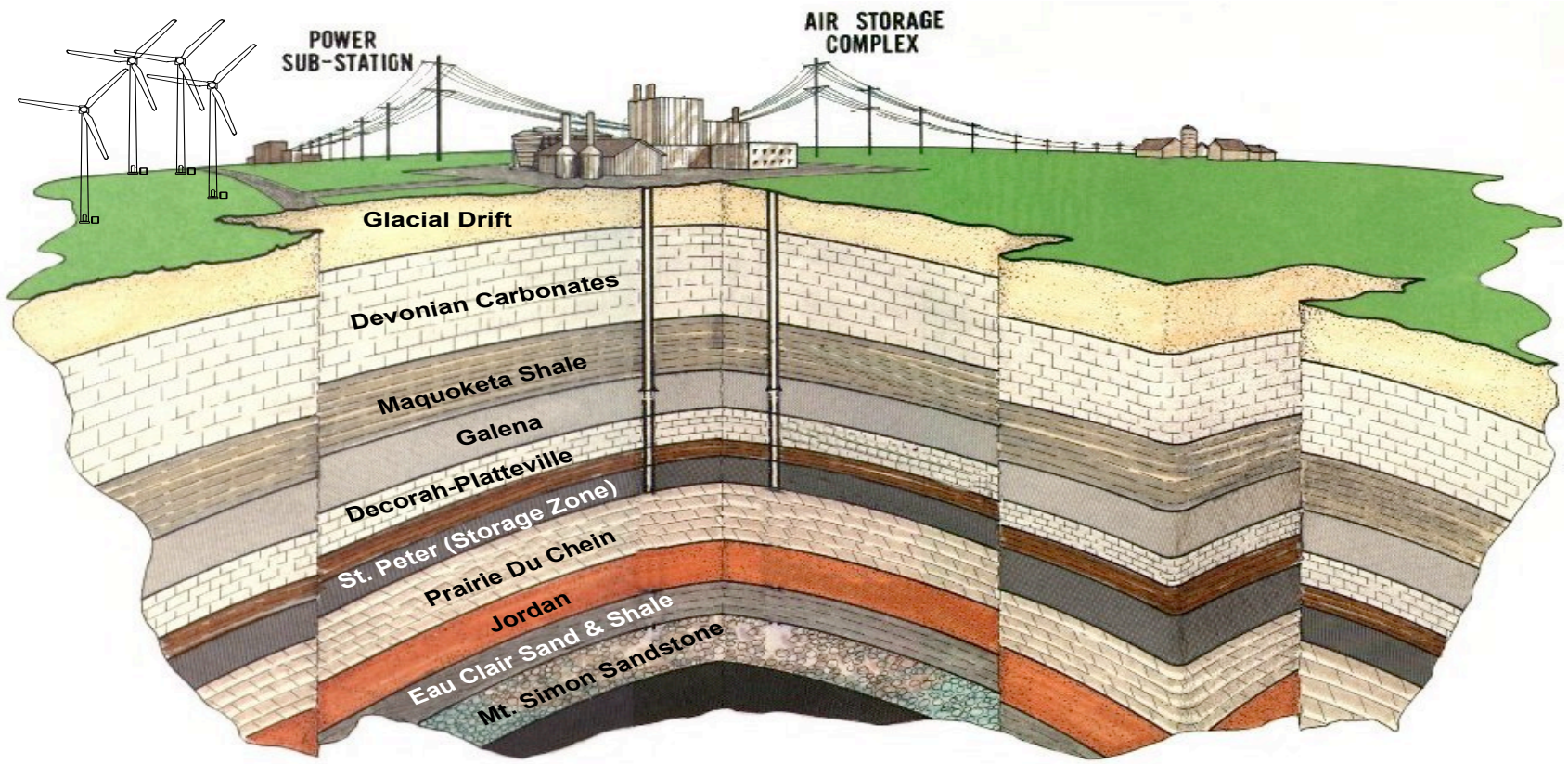
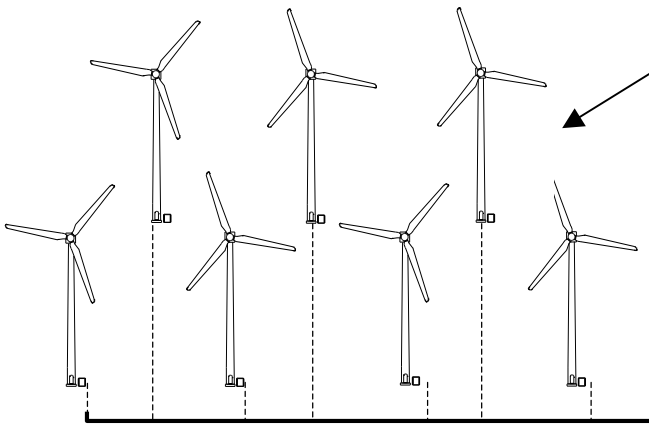


Diagram of Proposed Wind – CAES Power Plant Near Fort Dodge, Iowa



25 - 400 MW Wind Generation

Underground and overhead 24 kV collection circuits for delivering wind power directly to CAES substation

100-200 MW CAES Power Plant

Electric Power Substation at CAES Power Plant

161 kV Transmission Line to Webster Substation for Delivery of Power to Utility Grid

Ground Level

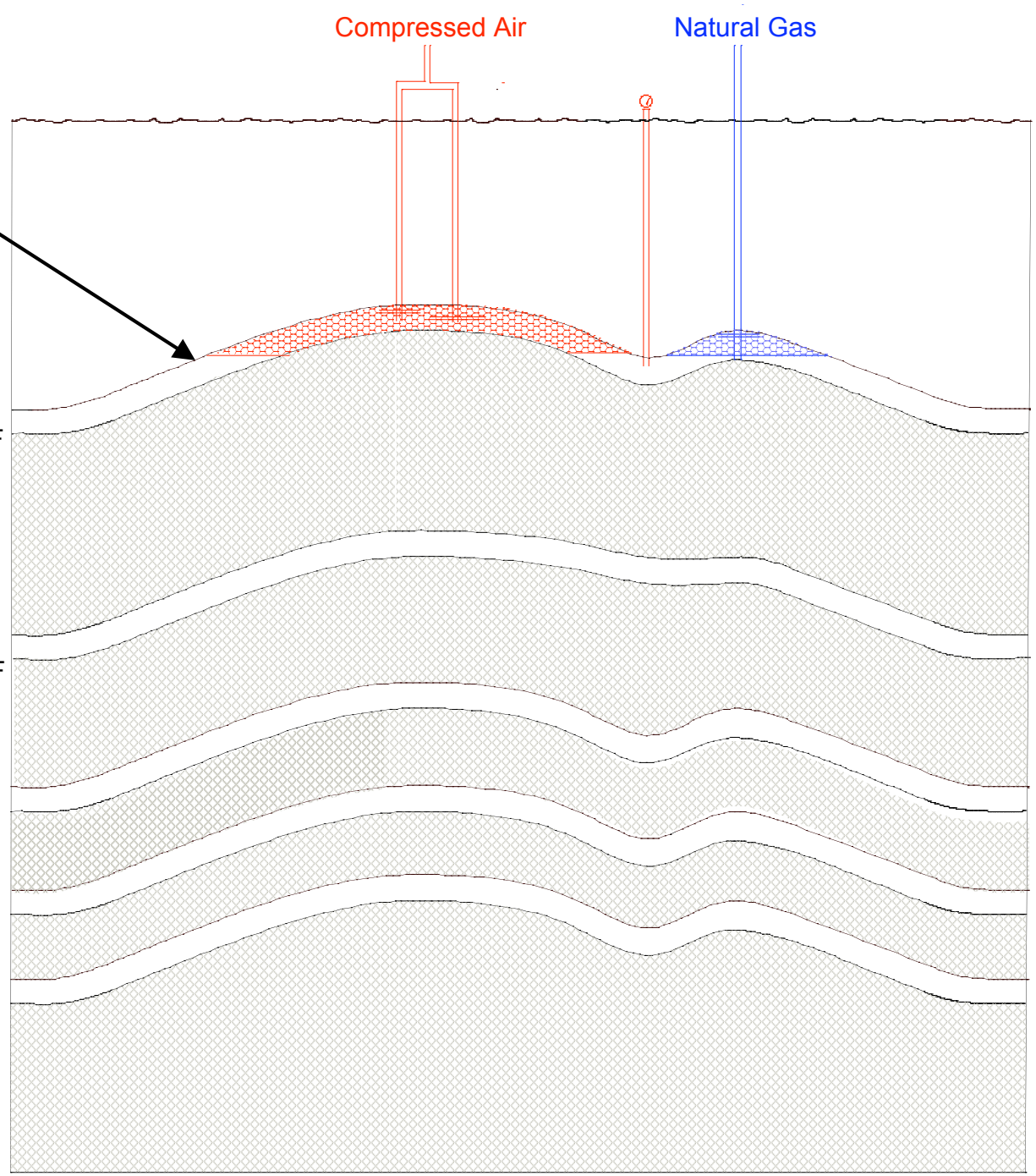
Injection wells to aquifer strata Compressed air bubble

Compressed Natural Gas bubble

Natural Gas Pipeline to Pressure Regulation Equipment & Pipeline

TAW 12 / 3 / 2002

The St. Peter Aquifer can be used for storing both compressed air and natural gas. Due to the shape of the aquifer, about 8 BCF of compressed air and 2 BCF of natural gas could be stored in the same aquifer.



Comparison of Installation and Operation Cost				
	Installation Cost $ / kW	Operating Cost		Delivered Cost of Energy $ / Mwh
		Fixed Costs $/kW-Yr	Dispatch Costs $ / Mwh	
200 MW CAES Plant, No Wind	$625	$22	$27.5	$57 at 28% C.F.
200 MW Simple Cycle Combustion Turbine	$400	$10	$55.0	$76 at 28% C.F.
250 MW Combined Cycle Plant	$575	$20	$29.0	$57 at 28% C.F.
New Coal Unit Operated at Intermediate CF	$1,700	$15	$10.0	$68 at 28% CF
200 MW CAES + 400 MW Wind Plant	$2,200	Levelized Cost =		$38 at 75% CF
New Coal Unit at Base Load CF	$1,700	Levelized Cost =		$34 at 75% CF
New Coal Unit at Base Load CF with Climate Change	$1,700	Levelized Cost =		$43 at 75% CF
Based on $4.00 per MMBTU Gas Price, $12.5/Mwh off-peak energy for charging CAES, climate change adder is $15/ton of CO2, Green tag revenue of $5/Mwh				

Other revenue offsets

- Ancillary service revenue potential (examples)
  - Regulation = ± 2.50/MWH (Cal. ISO 9/98 – 9/99)
  - Spinning reserves = $6.23/MWH (Cal. ISO 9/98 – 9/99)
- Green tag value ± $5/MWH

Status of Iowa Project

- Iowa Association of Municipal Utilities has raised internally and spent over $600k to investigate the concept.
- 3D Seismology of Storage Structures complete.
- Decision to proceed in August.

Conclusions

- Renewable resources (intermittent and biomass) can provide electricity and fuels that are:
  - Affordable
  - Technically competitive
  - Profitable

Significant barriers remain:

Cannot hope to match profitability of competing systems