# CLEAN ENERGY: Alternatives to the Dinosaur

## Facts & Footnotes

By Howard Silverman, with Ed Hunt and Seth Zuckerman
howard@ecotrust.org

### What's the real price of a gallon of gas?

**F** Studies show that if you include all the hidden costs, the price of gas could double.

A 2001 paper by Doug Koplow and John Dernbach and published by Annual Reviews identifies ten reports since 1978 that have evaluated domestic subsidies to fossil fuels. Subsidies are categorized into five areas: fiscal and tax provisions, transport infrastructure, energy security, externalities, and state and local programs. Only three of the ten reports attempt to quantify subsidies in at least three of the five areas. Though some of the ten reports look at all fossil fuels, each of these three focus on oil alone. These three reports are:

Hwang, R. (1995). "Money Down the Pipeline: Uncovering the Hidden Subsidies to the Oil Industry." Union of Concerned Scientists. http://www.ucsusa.org/clean_vehicles/archive/page.cfm?pageID=817
Wahl, J. (1996). "Oil Slickers: How Petroleum Benefits at the Taxpayer's Expense." Institute for Local Self Reliance. http://www.ilsr.org/carbo/costs/truecosttoc.html
International Center for Technology Assessment (1998). "The Real Price of Gas." International Center for Technology Assessment. http://www.icta.org/projects/trans/realpricegas.pdf

Their findings are as follows:

| | Hwang | Wahl | ICTA |
|---|---|---|---|
| Net Oil Subsidies (Billions 1999$) | 103-343 | 58-367 (Did not assess transport or state and local subsidies) | 574-1,736 |

Total 1999 U.S. petroleum consumption across all sectors was roughly 19 million barrels/day or 291 billion gallons/year (http://www.eia.doe.gov/emeu/aer/txt/ptb0512c.html). The subsidies tabulated by these reports would thus add from 20¢ to $5.96 to the price of a gallon of gasoline, as well as to the price per gallon of other products of the refining process: jet fuel, asphalt, etc.

— **Koplow, D. and J. Dernbach (2001). "Federal Fossil Fuel Subsidies and Greenhouse Gas Emissions: A Case Study of Increasing Transparency for Fiscal Policy." Annual Review of Energy and the Environment, V. 26, p. 361-389.** http://www.mindfully.org/Energy/Fossil-Fuel-Subsidies.htm

Our statement that "the price of gas could double" is for conceptual purposes only. Note the precaution advised by Mark Delucchi:

"One should resist the temptation to add up all of the unpriced costs, and express the total per gallon of gasoline, as if the optimal strategy to remedy every inefficiency were simply to raise the gasoline tax."

— **Delucchi, M. (1998). "The Annualized Social Cost of Motor-Vehicle Use in the U.S., 1990-1991: Summary of Theory, Methods, Data, and Results." Institute of Transportation Studies, p. 26.** http://its.ucdavis.edu/publications/1996/RR-96-03%20(01).pdf

These calculations can serve, however, to highlight the extent to which subsidies undermine the functioning of the market and thus of goals such as energy security. Subsidies, say Koplow and Dernbach, function like regulations and thus could be subject to the same procedural limits:

"[Subsidies] transfer rights and responsibilities across groups and can affect the markets for particular goods or services, often tilting the competitive 'playing field' against other participants. Subsidies are also as capable as environmental regulation of producing particular policy outcomes…

"The development and continued implementation of subsidy programs by administrative agencies could be subject to the same kinds of procedural limits as administrative regulations. This analysis would be similar to the kinds of analysis required for administrative rulemaking but tailored more particularly to subsidies. Those proposing a new subsidy or the continuation of an existing subsidy listed on the registry would be obliged to prepare an analysis of the need for the subsidy, the fiscal impact of the subsidy, an analysis of whether the subsidy is still needed, and, if so, an analysis of whether there are any less costly or more effective alternatives to achieving the purpose of the subsidy…

"Congress could require that subsidies on the registry be subject to an environmental impact analysis that includes a detailed examination of their environmental effects or externalities."

— **Koplow, D. and J. Dernbach (2001). "Federal Fossil Fuel Subsidies and Greenhouse Gas Emissions: A Case Study of Increasing Transparency for Fiscal Policy." Annual Review of Energy and the Environment, V. 26, p. 384-386.** http://www.mindfully.org/Energy/Fossil-Fuel-Subsidies.htm

F Artificially low prices for oil and other fossil fuels have kept us dependent on dirty energy for decades.

"The overall [subsidy] supports are large enough to affect the marketplace viability of substitute fuels."

— **Koplow, D. and J. Dernbach (2001). "Federal Fossil Fuel Subsidies and Greenhouse Gas Emissions: A Case Study of Increasing Transparency for Fiscal Policy." Annual Review of Energy and the Environment, V. 26, p. 370.** http://www.mindfully.org/Energy/Fossil-Fuel-Subsidies.htm

## Think clean energy is decades away?

F In the last two years, venture capitalists have doubled the share of their investments that they're steering to clean energy.

"Clean energy now accounts for 2.3% of total VC activity, compared with 0.7% just three years ago [and 1.2% two years ago]."

— **Makower, J., R. Pernick, and C. Wilder (2003). "Clean Energy Trends 2003." Clean Edge, p. 3.** http://www.cleanedge.com/reports/index.php?report=trends2003

F Worldwide, the clean energy market is projected to reach $180 billion a year by 2020.

"Worldwide, the market for the seven clean energy technologies examined [wind, geothermal, biomass, small hydro, solar, fuel cells, and systems and efficiency technologies] over the next 20 years is expected to be $180 billion a year."

— **Climate Solutions (2001). "Poised for Profit: How Clean Energy Can Power the Next High-Tech Job Surge in the Northwest." Climate Solutions, p. 5.** http://www.climatesolutions.org/pubs/pdfs/CleanEnergyReport.pdf

F Meanwhile, studies around the country show that clean energy creates more jobs and generates more local income than fossil fuel-based energy production. The New York State Energy Office concluded that, for each unit of electricity generated, wind power creates 27% more jobs than coal and 66% more than natural gas.

"A UCS analysis for Wisconsin found that, over a 30-year period, an 800-megawatt mix of new renewables would create about 22,000 more job-years than new natural gas and coal plants would. A New York State Energy Office study concluded that wind energy would create 27 percent more jobs than coal and 66 percent more than a natural gas plant per kilowatt hour generated. A study of energy efficiency and renewable energy as an economic development strategy in Colorado by Economic Research Associates found an energy bill savings of $1.2 billion for Colorado ratepayers by 2010 with a net gain of 8,400 jobs."

— **Nogee, A., S. Clemmer, B. Paulos, and B. Haddad (1999). "Powerful Solutions: 7 Ways to Switch America to Renewable Electricity." Union of Concerned Scientists, p. 11.** http://www.ucsusa.org/publication.cfm?publicationID=54

## Hybrids

F The same tricks that help a small car get 68 miles per gallon can also help a sports car accelerate 0-60 in three seconds. The only reason you never hear about hybrids winning Formula One races is that the sanctioning body banned them as having an unfair advantage on the track.

> "The highbred hybrid's roots date to 1998, when Don Panoz's Le Mans racing team discovered that shoehorning a 195-horsepower electric motor and a 300-volt nickel-metal-hydride battery alongside the gasoline engine would give the team's car an edge. It successfully competed in a race, but the team didn't have enough time or money to develop the car as its primary racer. Several Formula One teams, though, got wind of the idea and started pursuing hybrids of their own. Their plan was to use a car's alternator the mini generator in every vehicle that keeps the battery charged as an electric-assist motor that could contribute small boosts of power. This prompted the Formula One sanctioning body to ban the technology before it ever got to the track. 'They had to,' says John Wallace of Ford's electric-centric Think division. 'Teams without it would have had their behinds waxed.'"
>
> "The hybrid configuration Dodge is using in the Durango and Ram is similar to the Dualnote's - an electric motor powers the front wheels, a gas engine the rear wheels. A Viper with this setup would get 10 percent better gas mileage and 20 percent more torque, says Larry Oswald, DaimlerChrysler's vice president of hybrid engineering. 'That would take another second or two off its 0-to-60 time,' he says. In other words, it'd get to 60 mph in less than 3 seconds."
>
> — **Carney, D. (2002). "Hybrids Get Hot."** ***Popular Science.*** http://www.popsci.com/popsci/auto/article/0,12543,220824,00.html

F The Army plans to purchase 30,000 hybrid trucks by the end of the decade.

> "The Army will evaluate the prototype before establishing performance and procurement criteria and opening the bid process. The Army is expected to want 30,000 hybrids by the end of the decade."
>
> — **General Motors website (2003). "GM Reveals Fuel-Efficient Military Truck To Army." General Motors.** http://www.gm.com/company/gmability/environment/road_to_future/adv_tech_vehicles/tomorrows_hybrids/army_010903.html

## Biodiesel

F Just one-fifth of the used restaurant grease in New York City would be enough to power its transit system.

> "New York City alone could produce 53 million gallons of biodiesel annually from its waste greases, Dr. Tyson estimated. That is about five times the annual diesel fuel consumption of the city public transit system."
>
> — **Baard, E. (2002). "Biodiesel: A Fuel That Starts Low on the Food Chain."** ***New York Times*****, 12 May.**

F Releasing far less CO2 and a fraction of the air pollutants of regular diesel fuel, biodiesel is a great solution for the thousands of soot-spewing trucks and buses on the road today.

> 100% biodiesel reduces emissions of carbon monoxide by 43.2% and particulates by 55.4%.
>
> — **Center for Transportation Technologies and Systems (2002). "Beyond Diesel – Renewable Diesel." National Renewable Energy Laboratory, U.S. Department of Energy, 1 August.** http://www.afdc.doe.gov/pdfs/6668.pdf
>
> "Biodiesel reduces net emissions of CO2 by 78.45% compared to petroleum diesel."
>
> — **Sheehan, J., V, Camobreco, J. Duffield, M. Graboski, and H. Shapouri (1998). "Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus." National Renewable Energy Laboratory, U.S. Department of Energy.** http://www.nrel.gov/docs/legosti/fy98/24089.pdf
>
> Note: The authors of the above report admit, "Conducting life cycle inventories is fraught with difficulties. Incomplete data is the rule rather than the exception. There are varying degrees of confidence in the results that we

present in this report. The most reliable conclusions of this study are for overall energy balance and carbon dioxide emissions." Still, their finding of a 78% reduction in life cycle CO2 emissions has been criticized as not accurately accounting for emissions from agricultural operations. Biodiesel produced from waste vegetable oils, on the other hand, is not subject to the same life cycle considerations, and its use would clearly reduce overall CO2 emissions. The National Renewable Energy Laboratory compares the production of biodiesel from various sources here:

"Half of U.S. biodiesel production capacity is designed for soybean oil, and half for recycled restaurant cooking oil, earning biodiesel a reputation for having a pleasant french-fry smell. [In Europe most biodiesel is made from rapeseed (canola) oil.] Because of incentives from a U.S. Department of Agriculture program supporting commodity purchases for increased biofuel production, 2001 U.S. biodiesel production was predominantly from soybean oil, but once the effect of the commodity program is over, the two main sources will likely again roughly balance. Both soybean oil and recycled restaurant cooking oil are currently in surplus and biodiesel production uses only a small portion of each, so there is no resource constraint."

— **National Renewable Energy Laboratory (2001). "Biofuels for Your State." National Renewable Energy Laboratory, U.S. Department of Energy.** http://www.ott.doe.gov/biofuels/pdfs/biofuels_for_your_state.pdf

## Biomass Gasification

**F** Studies at the Oak Ridge National Laboratory indicate that "power crops" for gasification, such as switchgrass, could be produced cost-competitively without eroding soils or competing with food crops.

"Perennial prairie grasses offer many advantages to the developing biofuels industry. High yielding varieties of native prairie grasses such as switchgrass, which combine lower levels of nutrient demand, diverse geographical growing range, high net energy yields and high soil and water conservation potential indicate that these grasses could and should supplement annual row crops such as corn in developing alternative fuels markets. Favorable net energy returns, increased soil erosion prevention, and a geographically diverse land base that can incorporate energy grasses into conventional farm practices will provide direct benefits to local and regional farm economies and lead to accelerated commercialization of conversion technologies."

— **Downing, M., S. McLaughlin, and M. Walsh (1995). "Energy, Economic, and Environmental Implications of Production of Grasses as Biomass Feedstocks," in *Proceedings, Second Biomass Conference of the Americas: Energy, Environment, Agriculture, and Industry.* National Renewable Energy Laboratory: Golden, Colorado, p. 288-297.** http://bioenergy.ornl.gov/papers/bioam95/downing1.html

"Switchgrass and wood raised on 54 million acres of land and used in biomass gasification/gas turbine systems could produce 630 billion kWh, for about 4.5¢/kWh. This is equal to a fifth of total US electricity production."

— **Nogee, A., S. Clemmer, B. Paulos, and B. Haddad (1999). "Powerful Solutions: 7 Ways to Switch America to Renewable Electricity." Union of Concerned Scientists, p. A-7.** http://www.ucsusa.org/publication.cfm?publicationID=54

— **Graham R., E. Lichtenberg, V. Roningen, H. Shapouri, and M. Walsh (1995). "The Economics of Biomass Production in the United States," in *Proceedings, Second Biomass Conference of the Americas: Energy, Environment, Agriculture, and Industry.* National Renewable Energy Laboratory: Golden, Colorado.** http://bioenergy.ornl.gov/papers/bioam95/graham3.html

**F** Burlington, Vermont is home to the largest biomass gasification plant in the country, a facility with the capacity to power 6,000 homes.

"On August 12, 2000, Future Energy Resources Corporation (FERCO) successfully completed 24 hours of continuous operation of its commercial scale demonstration plant in Burlington, Vermont. FERCO designed and built the gasifier, the largest U.S. biomass gasification facility, in partnership with the U.S. Department of Energy, who provided technical assistance and funding for facility construction and testing, and the Burlington Electric Department. Over the period of testing, the facility converted more than 285 tons of wood chips into SilvaGas, a medium Btu gas that is substitutable for natural gas. The SilvaGas was piped directly to Burlington Electric Department's McNeil Generating Plant, where it produced more than 140 MWh of electric power [enough for 6000 homes]."

— **Biomass Research and Development Initiative (2000). "Technology Feature: Successful**

**Gasification Testing at Burlington, VT." National Biomass Coordination Office, U.S. Department of Energy, July-August.** http://www.bioproducts-bioenergy.gov/0800.html

F A village in the Philippines uses the stand-alone BioMax gasifier to power a hundred homes on coconut shells.

"A small biomass power system that converts raw coconut shells to both electrical and thermal energy has won a prestigious Asian Innovation Award given annually by the *Far Eastern Economic Review*. Called the BioMax, the system is the core of a pioneering project in the village of Alaminos, Madalag, Aklan, where its productive uses are harnessed to create coconut-based livelihood opportunities. The BioMax was designed and built by Community Power Corporation (CPC), a Colorado, USA-based company, with support from the National Renewable Energy Laboratory of the U.S. Department of Energy and Shell Solar B. V. of Amsterdam, Netherlands."

— **Community Power Corporation (2001). "Far Eastern Economic Review Awards CPC Asian Innovation Award." Community Power Corporation, 31 October.** http://www.gocpc.com/press/FEER Award Press Release.doc

"In 2000, Browne [of CPC] spent four weeks in the Philippines installing a machine that ran on coconut shells and produced enough juice to electrify 100 homes in a small village."

— **Parks, B. (2003). "Splinter Technology." *Outside Magazine*, January.** http://outsideonline.com/outside/news/200301/200301_disp_tech.html

## Hydrogen Fuel Cells

F *The Economist* says that hydrogen's reputation as dangerous is "undeserved," and that estimates of $100 billion for a nation-wide distribution system are "outlandish."

"Hydrogen is often perceived as dangerous, but that reputation is largely undeserved. It is true that hydrogen is inflammable. But methanol is corrosive and extremely toxic, and petrol is both a carcinogen and easily ignited. A related factor is that hydrogen is a gas at room temperature and disperses rapidly, unlike methanol and petrol. With public education and garage-style handling, hydrogen can be at least as safe as today's fuels."

"Phasing in hydrogen infrastructure is thus the first part of the puzzle. The oft-cited estimates of $100 billion or more for that are outlandish. That is because duplicating today's petrol infrastructure, from day one, is simply not necessary. Experience with the introduction of diesel in America and unleaded petrol in Germany shows that even if only 15% of forecourts offer it, a new fuel can become widely accepted."

— **The Economist Technology Quarterly (2001). "The Fuel Cell's Bumpy Ride." *The Economist*, 24 March, p. 39-41.**

F Hydrogen buses from Ballard have been on the streets of Chicago and Vancouver since 1998.

"Three local buses in Chicago, USA and three local buses in Vancouver, Canada using Ballard® fuel cell engines proved their efficiency in everyday operation during two separate two-year test programs. Collectively, these six buses traveled over 118,000 kilometers (73,000 miles) in revenue service and over 200,000 passengers had an opportunity to experience the benefits of fuel cell technology."

— **Ballard website (2003). "Fuel Cell Technology: Transit Buses." Ballard Power Systems.** http://www.ballard.com/tD.asp?pgid=26&dbid=0

F Hundreds of fuel cells have already been installed in buildings that value their clean, silent and dependable operation as well as their capacity for "dual-generation" of both heat and electricity.

"UTC Fuel Cells has been producing a commercial fuel cell power plant since 1991. UTC Fuel Cells' PC25™ fuel cell power plant produces 200 kW of electricity and 900,000 BTUs of usable heat. UTC Fuel Cells has delivered more than 250 PC25 systems and has installed units in 19 countries on five continents. PC25 systems provide clean, reliable power at a range of locations from a New York City police station to a major postal facility in Alaska to a credit card processing system facility in Nebraska to a science center in Japan."

— **UTC Fuel Cells website (2003). "Our Company." UTC Fuel Cells.** http://www.utcfuelcells.com/whoweare/ourcompany.shtml

## Geothermal

F Energy from the heat of the Earth already accounts for 6% of the electricity generated in California.

Removing California's electricity imports of 15% from the mix, geothermal accounted for 6% of in-state generation in 2001.

— **California Energy Commission webpage (2002). "California Gross System Electricity Production for 2001." California Energy Commission.** http://www.energy.ca.gov/electricity/gross_system_power.html

F Now technological developments are allowing companies like ORMAT to offer smaller facilities that tap geothermal resources at lower temperatures, in the 200-250ºF range.

"The first production unit from ORMAT's new 250 Series production line has started delivering electricity to the Hundertwasser's Rogner Hotel in Bad Blumau, Austria, utilizing as its energy source 110°C hot water from a local geothermal well.

"The geothermal power plant consists of one standard containerized ORMAT Energy Converter (OEC) CHP module, generating 250 kW electricity and 2,500 kW heat energy.

"ORMAT designed, manufactured and delivered the OEC. The maximal prefabrication of the unit enabled on-site installation by owner's local team within only 5 days."

— **ORMAT Press Release and website (2001). "First ORMAT 250 Series Power Plant in Commercial Operation in Austria." ORMAT, 5 September.** http://www.ormat.com/news_024.htm and http://www.ormat.com/projects_507.htm

## Solar

F Photovoltaic (PV) cells - which convert sunlight into electricity with no moving parts - have dropped tenfold in price in the last 25 years.

"PV cells have dropped tenfold in price since 1975."

— **The Energy Foundation (1997). "Annual Report 1997: Technology, the Environment, and the Human Dilemma." The Energy Foundation.** http://www.energyfoundation.org/documents/1997_Essay.DOC

F One promising development at Lawrence Berkeley National Laboratory would utilize the full spectrum of sunlight to nearly double the efficiency of the conversion process.

"A team led by Wladek Walukiewicz... has discovered that, contrary to earlier reports, the band gaps of the In1-xGaxN ternary alloy system extend over a very wide energy range (0.7 eV to 3.4 eV) and thus provide a near-perfect match to the solar energy spectrum. This creates the opportunity to design and fabricate new multijunction solar cells that will have greatly improved efficiencies, possibly reaching the theoretically predicted ultimate efficiencies."

— **Walukiewicz, W. (2002). "Full Solar Spectrum Photovoltaic Materials Identified." Materials Sciences Division, Lawrence Berkeley National Laboratory.** http://www.lbl.gov/msd/PIs/Walukiewicz/02/02_8_Full_Solar_Spectrum.html

## Wind

F "The fastest growing game in the power business," according to *Business Week* magazine, wind energy is now price competitive with both coal and natural gas.

> "In May, 2001, General Electric Co. scooped the assets of Enron Corp.'s wind-power division out of bankruptcy for $285 million. ...Nearly two years later, it's clear that GE grabbed a cheap ticket into the fastest-growing game in the power business. Global wind capacity has nearly quadrupled in the past five years... [and] new, well-sited wind towers can compete with coal- or gas-fired plants, charging 3 cents to 6 cents per kilowatt hour, versus around 4 cents for coal or gas."
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> — **Aston, A. (2003). "A Strong Tailwind for Wind Power."** ***Business Week*****, 3 March.** http://www.businessweek.com/magazine/content/03_09/b3822094_mz022.htm

F Oregon could generate more electricity from wind than it currently consumes.

> Oregon wind electricity generation potential: 70 million MWh/yr.
>
> — **The Land and Water Fund of the Rockies, Northwest Sustainable Energy for Economic Development, GreenInfo Network (2002).** ***Renewable Energy Atlas of the West: A Guide to the Region's Resource Potential.*** **Hewlett Foundation and The Energy Foundation, p.56.** http://www.energyatlas.org/
>
> State electric utility total sales in 2000: 50 million MWh/yr.
>
> — **Energy Information Administration (2002). "Electric Sales and Revenue 2000." Energy Information Administration, table 17.** http://www.eia.doe.gov/cneaf/electricity/esr/esrt17p16.html#or

## Net Metering

F By supplementing large electric plants with power from smaller and more diverse sources, our electricity supply will be cleaner, more reliable, more secure, and more efficient as well.

> 207 Benefits of Distributed Resources are listed on the website for the book, Small Is Profitable.
>
> — **Lovins, A., E. Datta, T. Feiler, K. Rábago, J. Swisher, A. Lehmann, and K. Wicker (2002).** ***Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size.*** **Rocky Mountain Institute: Snowmass, Colorado.** http://www.smallisprofitable.org/207Benefits.html

F The U.S. Department of Energy says that policy changes should aim to remove barriers to such distributed energy generation nationwide.

> "Much more must be done in order to create a regulatory, policy, and business environment which does not create artificial market barriers to distributed generation...In the present regulatory environment, utilities have little or no incentive to encourage distributed power... Current tariffs and rate design as a rule do not price distribution services to account for system benefits that could be provided by distributed generation."
>
> — **Alderfer, R., M. Eldridge, and T. Starrs (2000). "Making Connections: Case Studies of Interconnection Barriers and their Impact on Distributed Power Projects." National Renewable Energy Laboratory, U.S. Department of Energy, p. iv.** http://www.nrel.gov/docs/fy00osti/28053.pdf

F Many European countries, for example, require utilities to purchase solar or wind energy from customers at near-retail rates.

> "Government-mandated feed-in or buy-back rates and competitive-market bidding are the two most widely used mechanisms by E.U. member countries to stimulate deployment of renewable-electric generation." Countries that have mandated feed-in rates include Germany, Denmark, Italy, Spain, Portugal, Greece, Austria, and Sweden. Germany has a buy-back rate of 90% of the government-set electricity price for wind; Denmark, 85% of the consumer electricity price for wind; Italy, $0.10/kWh for wind and $0.15/kWh for PV or biomass; Spain, 80-90% the average electricity price for all renewables; etc.

— **Goldstein, L., J. Mortensen, and D. Trickett (1999). "Grid-Connected Renewable-Electric Policies in the European Union." National Renewable Energy Laboratory, U.S. Department of Energy, p.6.** http://www.nrel.gov/analysis/emaa/eu_599_lg.pdf

## Tidal Power

**F** The first of the new generation of tidal power stations went online in Norway at the end of 2002.

"In a novel use of clean energy, the world's most northerly town will soon be the first to get electricity from a sub-sea power station run on tidal currents tugged by the moon."

— **Doyle, A. (2002). "Arctic town to get offbeat tidal energy." Environmental News Network (Reuters), 7 Nov.** http://www.enn.com/news/wire-stories/2002/11/11072002/reu_48896.asp

**F** The four hundred million gallons entering and exiting through the Golden Gate twice daily make it one of the best tidal power locations in the world.

"Environmental scientists have long suspected that San Francisco's unique geography could help it become energy independent. The Bay is one of the top 10 prospects in the world for tide-based hydropower, energy experts say. Twice a day, 400 million gallons of water enter and exit through the Golden Gate. Peter O'Donnell, a senior energy specialist with the Department of the Environment, compared that underwater energy to the force of two hurricanes."

— **Stoll, M. (2002). "Harnessing the ocean waves."** ***San Francisco Examiner*** **(Reprinted on S.F. Department of the Environment website), 20 Nov.** http://www.ci.sf.ca.us/sfenvironment/articles_pr/2002/article/112002.htm

**F** According to the S.F. Department of the Environment, HydroVenturi has pledged $4 million to the launch of a demo project.

Conversation with Peter O'Donnell, Senior Energy Specialist, San Francisco Department of the Environment.

## Dollars in Your Pocket

**F** With bonds or money market accounts, the best you can hope for is about a 5% return. Putting that same money into the purchase of an Energy Star refrigerator could pay you back five times that much.

"Replacing your refrigerator with a new unit will significantly reduce your refrigerator electricity bill, and ENERGY STAR-labeled models are available that can save an additional 20-30% compared to a standard new unit." Return on investment: 27%.

— **Home Energy Saver (1999). "Estimated Annual Energy Bill for Average House." Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory.** http://www.homeenergysaver.lbl.gov/

**F** In fact, the typical home energy efficiency upgrade pays better than the Dow Jones Industrials did during the 1990s.

Savings of energy efficient house over typical house for S. F. Bay Area: 42%, for Portland area: 37%. Return on investment: fluorescent bulbs, 41%; duct sealing, 41%; Energy Star washer, 37%; water tank wrap, 28%; etc.

— **Home Energy Saver (1999). "Estimated Annual Energy Bill for Average House." Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory.** http://www.homeenergysaver.lbl.gov/

The Dow Jones Industrials rose from 2,810 at the beginning of the decade to 11,497 at the end. The average yearly gain was 15.9%.

— **Dow Jones Indexes (2003). "Dow Jones Industrial Average Historical Performance." Dow Jones Indexes.** http://www.djindexes.com/downloads/xlspages/DJIA_Hist_Perf.xls

## A Breath of Fresh Air

F One study for the Los Angeles area published in *Science* estimates its annual air pollution-related health costs to be almost $10 billion.

> "An assessment of health effects due to ozone and particulate matter ($PM_{10}$) suggests that each of the 12 million residents of the South Coast Air Basin of California experiences ozone-related symptoms on an average of up to 17 days each year and faces an increased risk of death in any year of 1/10,000 as a result of elevated $PM_{10}$ exposure. The estimated annual economic value of avoiding these effects is nearly $10 billion."
>
> — **Hall, J., A. Winer, M. Kleinman, F. Lurmann, V. Brajer, and S. Colome (1992). "Valuing the Helath Benefits of Clean Air." *Science*, vol. 255, 14 Feb.**

## Real Energy Security

F Pretty much everyone agrees that importing 55% of our energy puts our nation in a tough position. But relying on oil or gas that's piped thousands of miles across the country holds dangers as well.

> "The U.S. imports more than 11 million bbl. a day--55% of our total consumption."
>
> — **Carey, J. (2003). "Taming the Oil Beast." *Business Week*, 24 Feb.** http://www.businessweek.com/magazine/content/03_08/b3821001.htm

> "[Our] continuous electrical supply now depends on many large and precise machines, rotating in exact synchrony across half a continent, and strung together by an easily severed network of aerial arteries whose failure is instantly disruptive... The size, complexity, pattern, and control structure of these electrical machines make them inherently vulnerable to large-scale failures: a vulnerability which government policies are systematically increasing. The same is true of the technologies that deliver oil, gas; and coal to run our vehicles, buildings, and industries... America's energy vulnerability is an unintended side effect of the nature and organization of highly centralized technologies. Complex energy devices were built and linked together one by one without considering how vulnerable a system this process was creating. Through such incremental ad-hocracy, our nation has drifted haphazardly from one kind of energy vulnerability to another."
>
> — **Lovins, A. and L. Lovins (1982). *Brittle Power: Energy Strategy for National Security*. Brick House Publishing: Andover, Massachusetts, p. 1-2.** http://www.rmi.org/sitepages/art7095.php

F For every federal tax dollar of ours spent on research into clean energy sources, four dollars have been spent on oil, gas, coal and nuclear.

> The breakdown for Department of Energy research and development spending, 1948-1998, is as follows: nuclear power, $66 billion; fossil fuels, $26 billion; renewables, $12 billion; and energy efficiency, $8 billion. The total of the first two is more than four times greater than that of the latter two.
>
> — **Green Scissors Report 2002 (2002). "Running On Empty: How Environmentally Harmful Energy Subsidies Siphon Billions from Taxpayers." Friends of the Earth, Taxpayers for Common Sense, U.S. Public Interest Research Group Education Fund.** http://www.greenscissors.org/publications/runningonempty.pdf

## A More Stable Climate

F "There are policy options that would slow climate change without harming American living standards," says a joint statement endorsed by over 2,500 economists.

> "This statement was endorsed by over 2500 economists including eight Nobel Laureates: '…Economic studies have found that there are many potential policies to reduce greenhouse-gas emissions for which the total benefits outweigh the total costs. For the United States in particular, sound economic analysis shows that there are policy

options that would slow climate change without harming American living standards, and these measures may in fact improve U.S. productivity in the longer run.'"

— **(Statement drafted by) Arrow, K., D. Jorgenson, P. Krugman, W. Nordhaus, and R. Solow (1997). "The Economists' Statement on Climate Change." Redefining Progress.**
http://www.rprogress.org/publications/econstatement.html

## Fix the Market for Fossil Fuels

F "Many scientists consider [global warming] the greatest economic threat of this century," says *Business Week* magazine.

"Based on interviews with dozens of economists, oil analysts, environmentalists, and other energy experts, *BusinessWeek* has crafted guidelines for a sensible and achievable energy policy… The plan has the added benefit of tackling global warming, which many scientists consider the greatest economic threat of this century."

— **Carey, J. (2003). "Taming the Oil Beast." *Business Week*, 24 Feb.**
http://www.businessweek.com/magazine/content/03_08/b3821001.htm

## Build a Market for Clean Energy

F A national [Renewable Electricity Standard] law would create jobs, improve energy security, and actually reduce our nation's total energy bill.

"The EIA [Energy Information Administration] report, using high estimates of renewable energy costs, shows that under a 20% RPS [Renewable Portfolio Standard – another term for a Renewable Electricity Standard], total consumer energy bills (other than for transportation) would be roughly the same as business as usual through 2006 and only $2.8 billion or 0.7% higher in 2010. By 2020, total bills would be $580 million (0.1%) *lower* with an RPS."

— **Union of Concerned Scientists (2001). "EIA Study: National Renewable Energy Standard of 20% is Easily Affordable." Union of Concerned Scientists.**
http://www.ucsusa.org/publication.cfm?publicationID=79

— **Energy Information Administration (2000). "Analysis of Strategies for Reducing Multiple Emissions from Power Plants: Sulfur Dioxide, Nitrogen Oxides, and Carbon Dioxide." Energy Information Administration, U.S. Department of Energy, p. 163-164.**
http://www.eia.doe.gov/oiaf/servicerpt/powerplants/pdf/sroiaf(2000)05.pdf

## What's the Big Idea?

F "I'd put my money on solar energy… I hope we don't have to wait til oil and coal run out before we tackle that."
-Thomas Edison, in conversation with Henry Ford and Harvey Firestone, March 1931

"After they'd been discussing problems at home and abroad, the old man [Edison] said suddenly, 'We are like tenant farmers, chopping down the fence around our house for fuel, when we should be using nature's inexhaustible sources of energy – sun, wind and tide.'
"Firestone responded that the oil and coal and wood couldn't last forever. They'd been tackling rubber. He wondered how much research was going into harnessing the wind, for example. Windmills hadn't changed much in a thousand years.
"Ford said there were enormously powerful tides – for example, the Bay of Gundy. Scientists had only been playing with the question so far.
"Edison said, 'I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait till oil and coal run out before we tackle that. I wish I had more years left!'"

— **Newton, J. (1987) *Uncommon Friends: Life with Thomas Edison, Henry Ford, Harvey Firestone, Alexis Carrel, & Charles Lindbergh.* Harcourt: San Diego, California, p. 31.**