

A presentation from the 2009 Topical Symposium:

Energy Security: A Global Challenge

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INSS



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How Can We Zero Out America's **Need to** Import Oil at the Soonest Possible Time?

Dr. Paul J. Werbos

personal, **not official**, views

Sources: IEEE-USA (Edison story), IEEE, NSF, US Senate, UN State of the Future; 1979-89: EIA/DOE lead analyst for long-term energy futures.

Click on energy at www.werbos.com

Why This Issue Calls Out for More Action

- **National Security/Vulnerability** -- It is ‘way too risky to assume “best case” or “base case” in an uncertain world
 - Gulf Institute Plans (2003)
 - Tight Link From Supply and Demand to Price
 - Big flow of money to OPEC funding threats to US
- **Likelihood of double dip recession if we do not act soon to limit oil price increases**
 - 3.6 billion barrels per year *150 == \$540b/year import bill; * \$250 = \$900b/year, >> China’s \$2t Treasury bonds
- **Big near-Term Savings possible with more open markets – methanol, natural gas, electricity**
- **Possibility of Market-Friendly Action** which opens the door to new fuels and limits price rises through greater competition, **but does not discriminate against actual use of oil.**



FUTURES OF THE PERSIAN - ARABIAN GULF REGION

Presented by

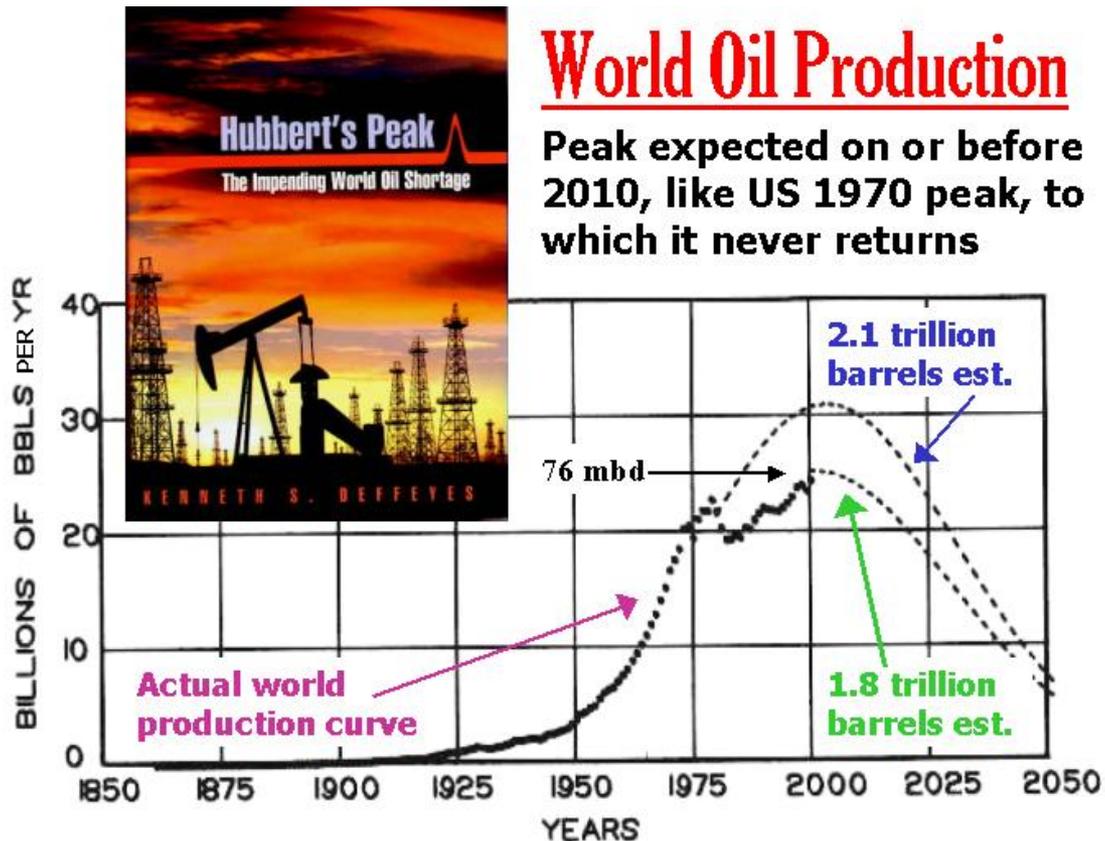
Dr. Ismail AlShatti

President

Gulf Institute for Futures and Strategic Studies

2. CHARACTERISTICS OF THIS REGION

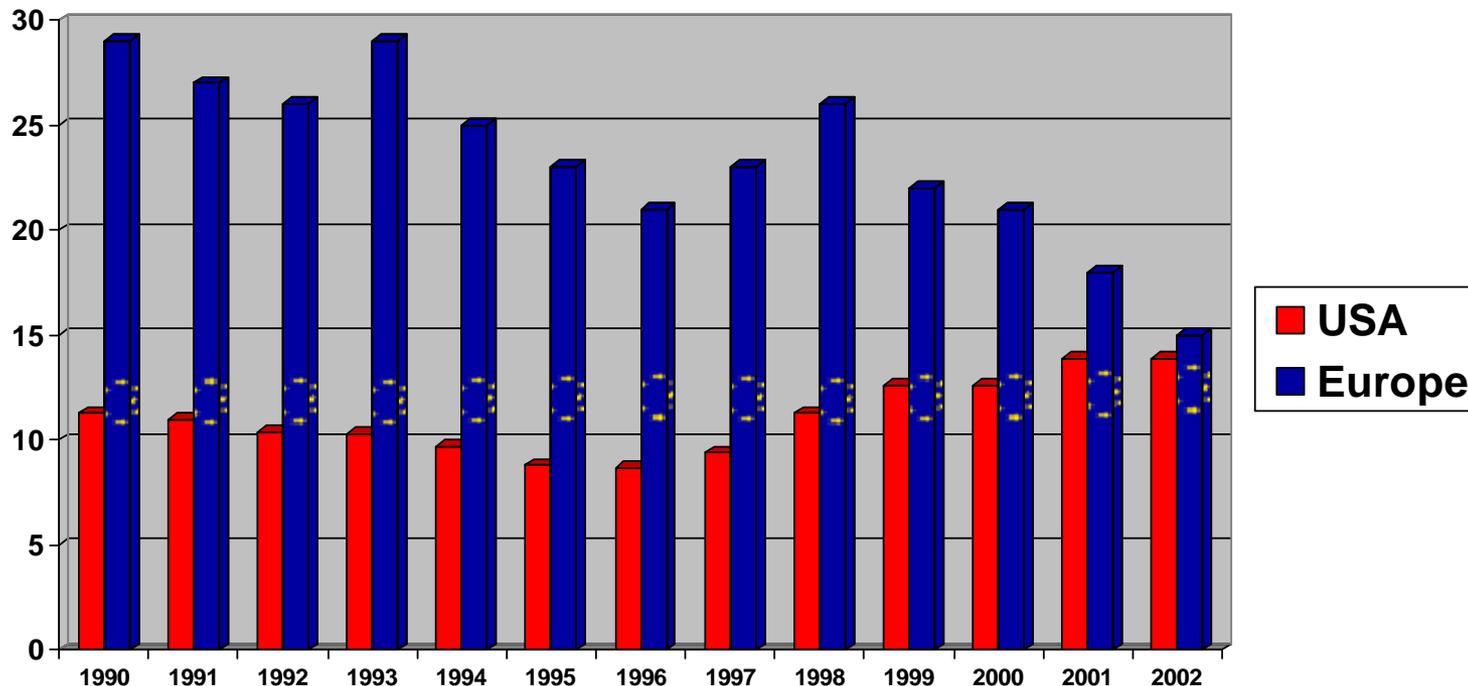
2.3 Potential Influential Power



This century seems to witness era of oil scarcity. Most forecasts and estimates of geologists tell that world oil production will peak before 2010, and then decline triggering energy price and global economic disturbance.

2. CHARACTERISTICS OF THIS REGION

2.3 Potential Influential Power



During last decade exporting oil from the region to USA is increasing whereas exporting to Europe is decreasing. Energy Information Administration has reported that industrial countries will import 72% of their demand from the region and it will be 76% in 2020.

3. SCENARIOS OF THE PERSIAN ARABIAN GULF

3.2 Scenarios of Security and Peace

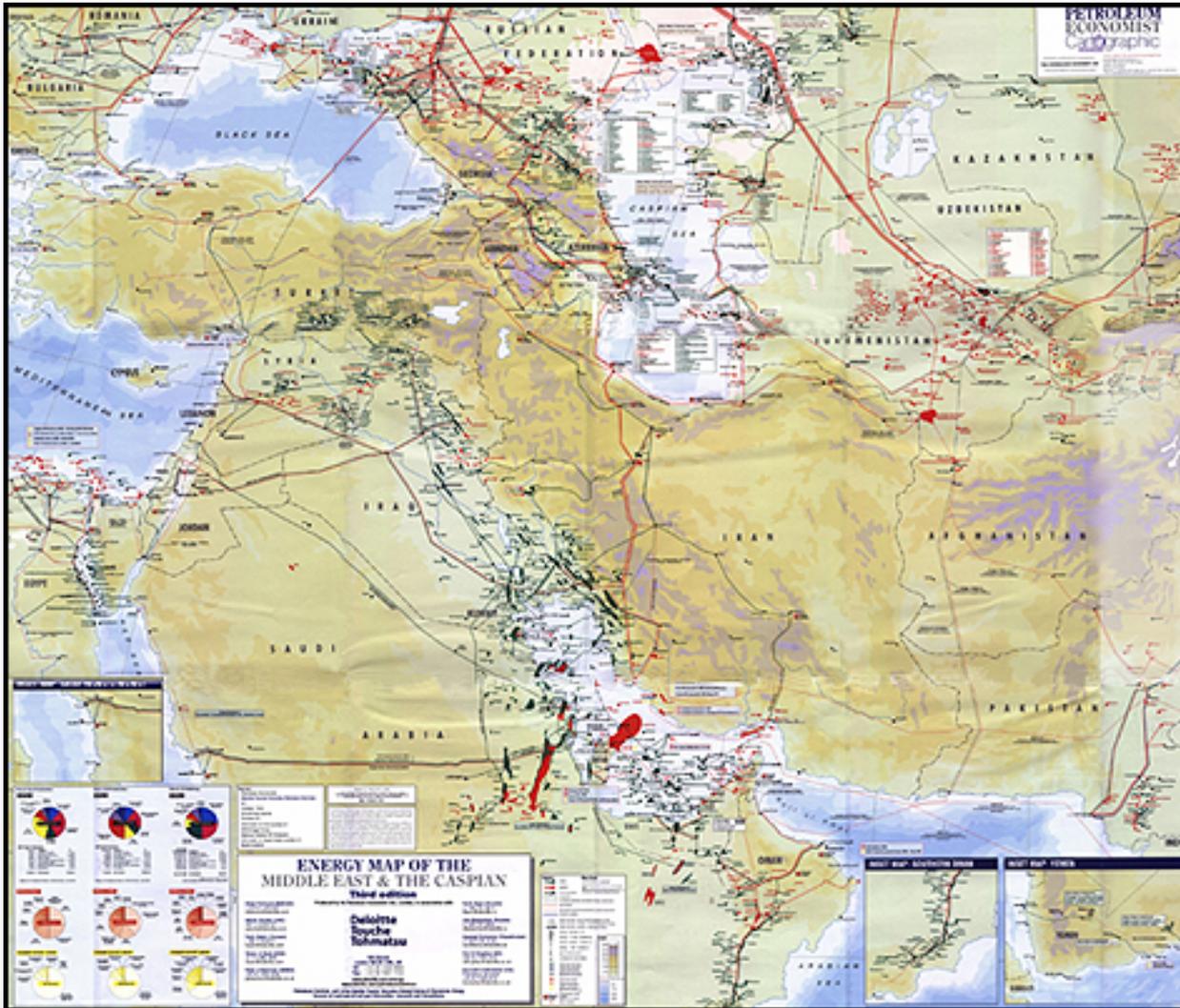
Escalating the importance of the region for western civilization



The use of oil as a weapon in confrontation between Western and Muslim societies is the main concern of the strategic decision makers in the west. This use will make the military power useless without fuel. It will remain pile of metal scrap.

3. SCENARIOS OF THE PERSIAN ARABIAN GULF

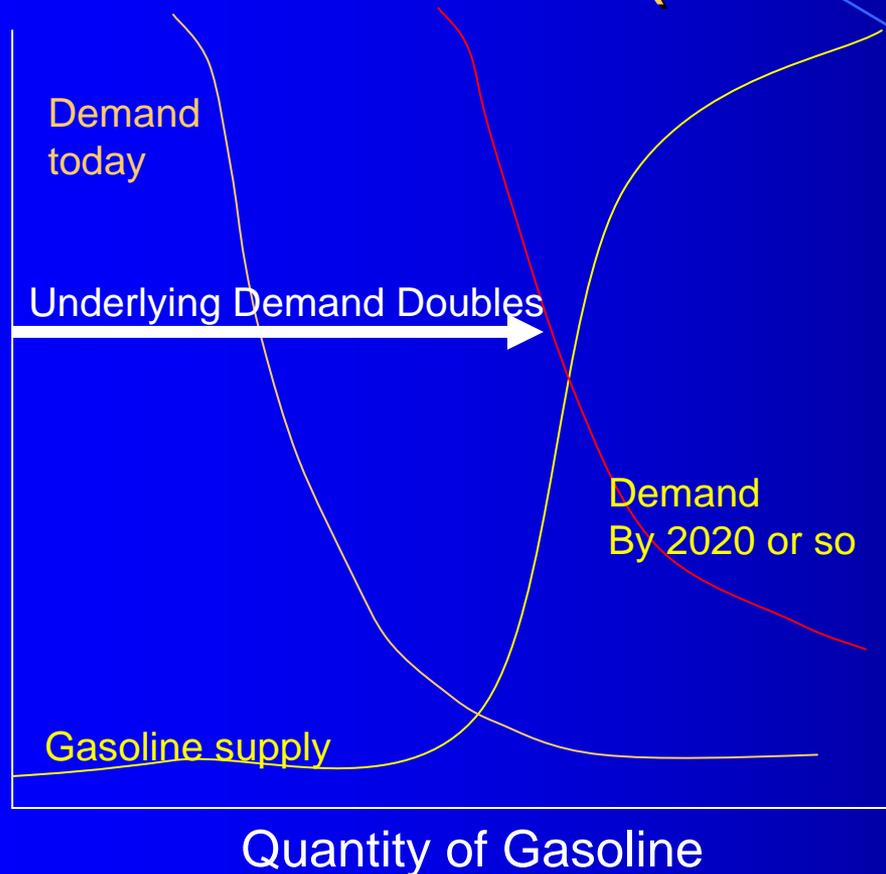
3.2 Scenarios of Security and Peace >> a. Oil Security Track



Where should be the military existence achieved?

This map shows the Oil & Gas field location In Persian Arabian Gulf region and Caspian sea region. The green spots indicates oil field and the red spots indicates gas field. The Green line indicates the oil pipelines and the red lines indicates the gas pipelines. This map gives an idea where the western military existence should be achieved to protect oil field.

How will you cut your gasoline use by 50% or more? (Gulf or hurricane...)



- If output falls, free market raises prices enough to **force** you cut your use in half or more.
- The only question: how? Lower income? Small car? Or market-friendly new technology?
- Antimarket tricks like price caps, hi interest rates, pressures on Arab states only lead to worse outcomes (Nash)

Long-term price elasticity of driving = -0.2 ; price doubling of GASOLINE only gives 14% reduction. Bigger reduction only as cars turn over, 15 years!

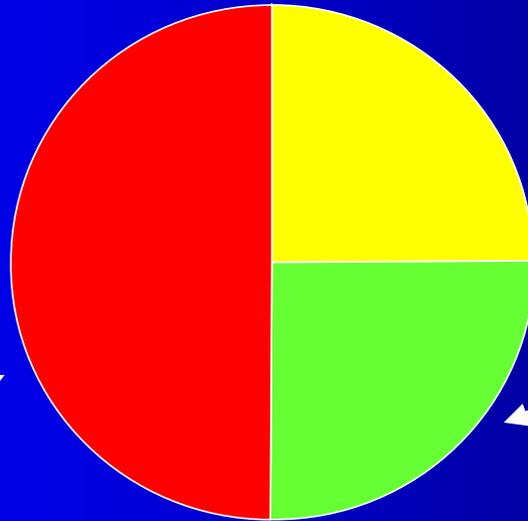
For example, from 2007 to 2008, average price from \$68 to \$93 (EIA), demand from 3.66b to 3.58. Peak price of \$150 was half due to high marginal cost (supply/demand), half legitimate foresight.

Rough but Unbiased Estimate of Potential Savings With Methanol (Just One of the Main Options We Should Grow)

- What would we save if used **methanol** in cars, if US wholesale price of \$220/tonne? (Strong 2004 price)
- 216 b. gallons/yr of gasoline \equiv 418 b. gal. methanol
- EIA Primer on Gasoline Prices: \$1.56 in '03, 14% distribution, 15% refining&profits, 27% all tax
- To \$220/tonne, add same distribution cost cost per physical gallon, same profit and tax per Btu
- At **pre-Katrina** \$2.50/gallon-gasoline, using methanol would have cost **\$324b, versus \$540b!**
- New methanol costs well under \$220/tonne! (Google on “Canaccord methanol”)

How To Zero Out Gasoline Dependency: Best Near-Term Hope for 100% Renewable Zero- Net-CO2 cars & **Total Security** for Car Fuel

Highest mpg
Hybrids Cut
Gas per Mile
By 50%

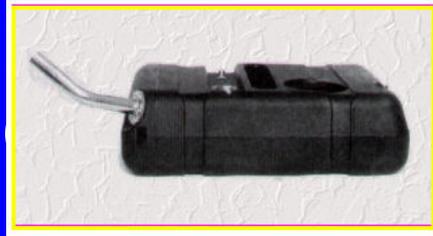


With **GEM fuel-flexible** cars,
biofuels might supply $\frac{1}{4}$
of present liquid fuel
demand trends

Plug-in Hybrids
with 10kwh batteries
get half their energy
from electricity

GEM fuel-flexible plug-ins offer a 100% solution based on near-term technology! www.ieeeusa.org/policy/positions/PHEV0607.pdf

Grand Strategy for Total Energy Security



Maximize Fuel-Flexible Plug-in Hybrid Cars



Open door to US natural gas (e.g. to trucks) while it lasts

R&D for more efficient use of diverse fuels

R&D for batteries for affordable electric cars



Minimize cost and then maximize supply of renewable electricity

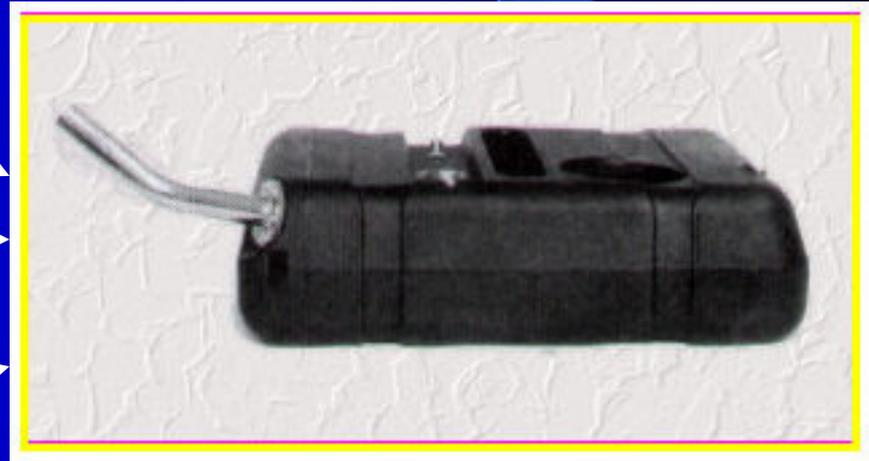
Maximize supply of Alternate liquid fuels
– Not oil
– Incentives, standards and R&D

GEM Flexibly Fuel Vehicles (FFV) One Tank To Hold Them All

G: Gasoline

E: Ethanol

M: Methanol



With an FFV, you choose each day which to buy
At \$100-200/car, a more open competition, level playing field,
better unleash the power of the free market
GEM flexibility \Rightarrow use of any corrosive fuel, adaptive engine
control

Plug-in Hybrids (PHEV) : A Large-Scale Opportunity Here and Now

- Hybrids cut liquid fuel use 50% already. Plug-ins cut **50% of that**.
 - “Researchers have shown .. (PHEV) offering.. electric range of 32 km will yield... 50% reduction..” (IEEE Spectrum, July/05). Shown in working Prius.



- Battery **breakthroughs in China**: from 10/07, 10kwh batteries (larger than) cost **\$2,000**. www.thunder-sky.com. Thus an extra \$2,000 per car can cut gas dependence in half.
- **Gives economic security in case of sudden gasoline cutoff.**
- **Does not strain grid – actually strengthens it, if done right**

IEEE Computational Intelligence Society – Alternate Energy Task Force

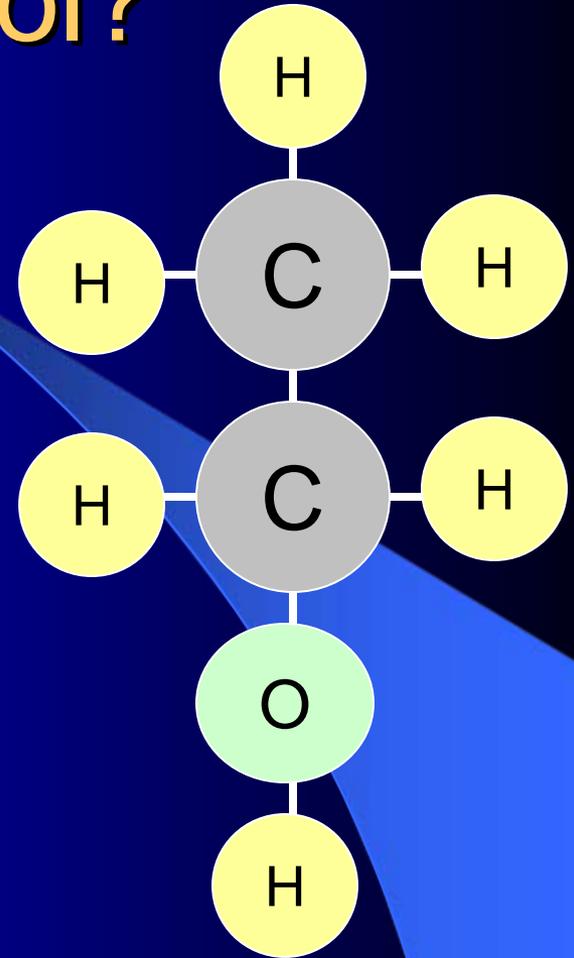
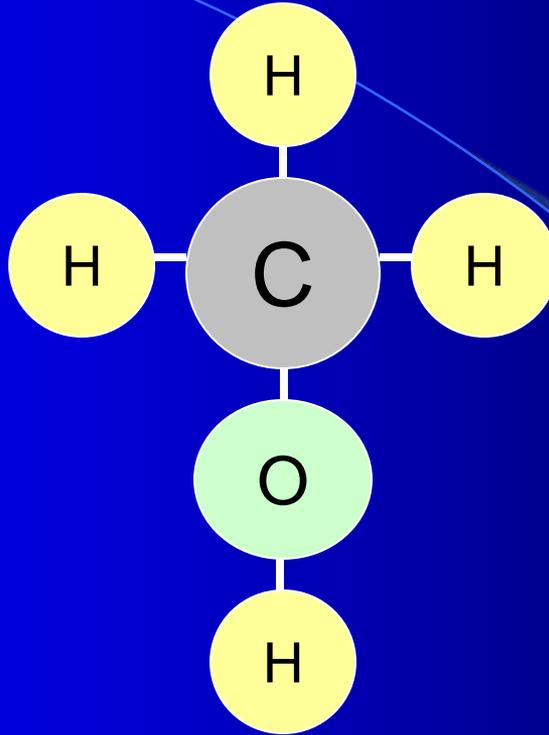
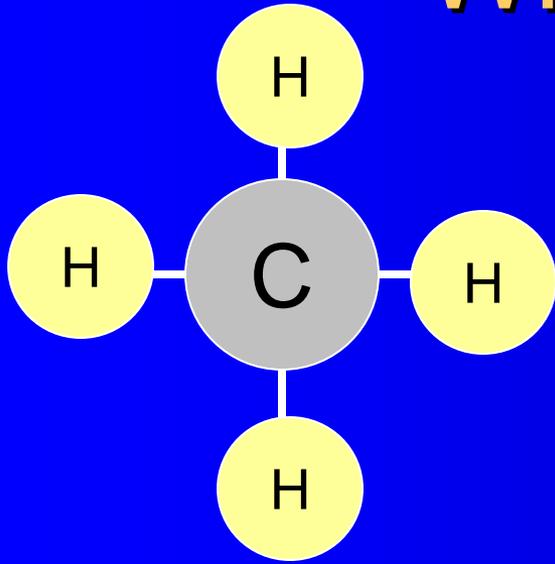
<http://iee-cis.org/isa/alternative/>

- Rajashakeera, Rolls-Royce
(former Delphi hybrid leader)
 - Prokhorov, Toyota
 - Anya Getman, Caterpillar
 - Marko, Bosch
 - Feldkamp, Ford
 - Javaherian, GM
 - Bonissone, GE
 - Zimmerman, Siemens
 - Fei-Yue Wang, Chinese Academy of Science
 - Chair: Werbos
 - Estevez
 - Fukuda
 - Sarangapani
 - Venayagamoorthy
 - Liu
- Research for Honda, Caterpillar, ABB, Others
- Some serious reshuffling since auto bankruptcies, endangering clean air

New Legislation Is Also Essential, To Move As Fast as We Can & Should:

- Thanks to Senate Legislative Counsel: bill & explanations posted at last paragraph of www.werbos.com/energy.htm. All 4 together to escape “who goes first”:
- For vehicles:
 - Extend tax incentives for **all** fuel-flexible and hybrid vehicles (including plug-ins and even fuel cells) until most cars sold are “futuristic cars.” Need the extension **now** to allow new investments aimed at future. (Pryor/Inhofe.)
 - Require GEM flexibility in liquid fuel systems (open fuel standard, Brownback).
- For refueling stations (recharging or gas stations):
 - Extend tax incentives, include retrofit and public access electric recharging.
- For actual fuel use and production:
 - Modification of Waxman/Markey “Low Carbon Fuel Standards,” with penalty for oil shale removed, credit for natural gas and electricity required, and faster encouragement of new technology/fuel/combinations
 - Support prices for alternative liquid and gaseous fuels
- Aggressive new R&D:
 - \$60 million for **well-focused** new R&D living up to unmet opportunities here, through ARPA-E/NSF partnerships open to all universities, small business, etc.

What IS Methanol?



Methane

Natural Gas
Scarce as Oil
Needs Special
Tank

Methanol

Good H Carrier
Can Be Bioliquid
Or From Coal, Gas

Ethanol

e.g From Corn
Drinkable

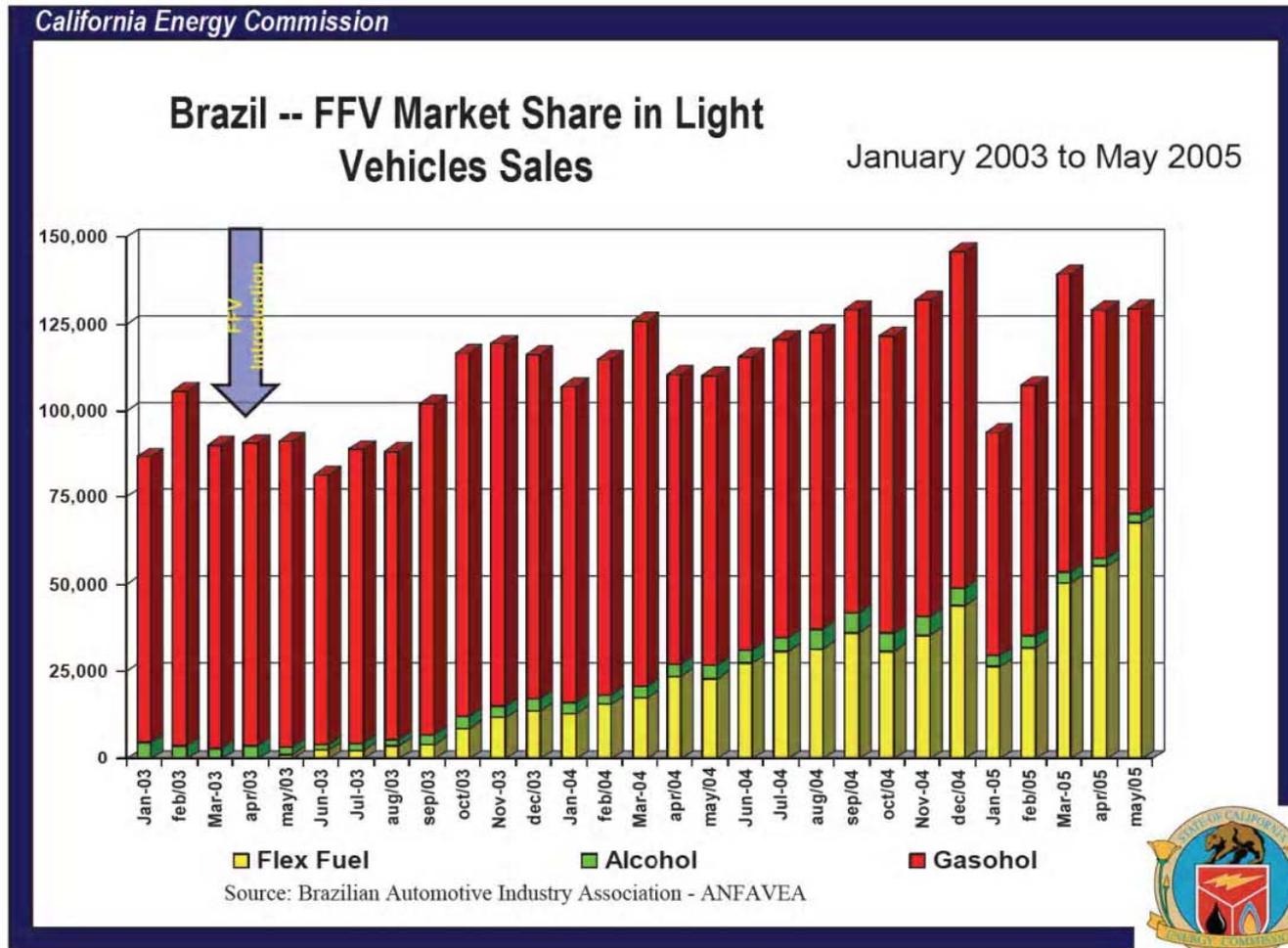
Nonfood biofuels could supply half our fuel needs using old technology – if we stop demanding purity in our ethanol/alcohol!



We need to give this guy permission to compete with Saudi Arabia and Iran for the car fuel market! He doesn't need a subsidy – only more freedom and an open door! Just give him a chance, and within 15 years...

(Also, try a google on “forest industry” methanol.)

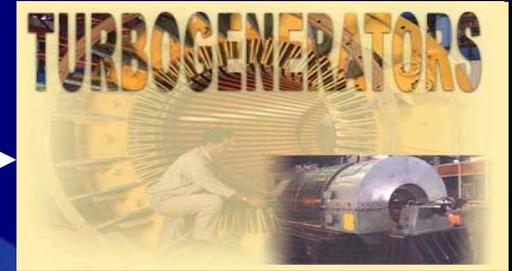
Fuel flexibility can be brought online very quickly, much faster than hybrids merely doubling every year!



All major manufacturers which sell in US have sold such cars in Brazil!!

Limits of 3 Paths from Natural Gas to Cars

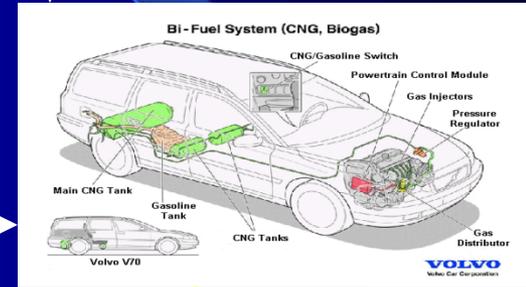
US
gas



Not enough



Liquefy, transport
and import (LNG)



\$6200 more per car

Make methanol, transport
and import (\$160/ton or new
high efficiency GTL)



**GEM-flexible car: <\$200
more per car**

BUT US gas supply has grown a lot lately, deserves level playing field, and can help a lot with trucks in next few difficult decades!!

China, US, Japan and Korea: Who Will Win the Race towards Plug-In Cars?

Dr. Paul J. Werbos

-- personal, **not official**, views
IEEE-USA, IEEE, NSF,
UN State of the Future
1979-89: EIA/DOE lead analyst
for long-term energy futures



www.werbos.com/energy.htm

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The view from Morgan-Stanley

March 11, 2008

- “We see lithium-ion PHEVs today as akin to MP3 players in 1998. They are likely to revolutionize the automobile as we know it, but it still unclear who will develop the equivalent of the iPod”
- Projected battery costs: \$4,025 for 7kwh (20 miles all-electric) , \$5,585 for 14kwh (GM Volt)
- www.vvcars.com/pdf/PHEV_MorganStanley.pdf

World's First Mass Market PHEV

2nd half of 2008: BYD Motors F6DM



- 20 kwh battery, 65 miles all-electric driving range
- Made in Shenzhen, China
- Follow-on in 2009: F3DM, 100 miles all-electric
- www.byd.com
- \$21,000 sales price, to be imported (deal with Buffet)

Other contenders

- GM Volt, 14kwh, 40 miles: planned for late 2010, using A123 or LG Chem advanced lithium battery. **Enough for 90% of US to get to work** in case of total gasoline embargo, if employer parking lots have recharge stations.
- Hyundai: US mass-market hybrid 2009, no comment on plug-in, deal with LG Chem and massive new Korean battery program www.eetimes.eu/power/196600822
- Toyota: 2010 PHEVs to fleet owners only, a test, using **proprietary** advanced lithium-ion battery and power electronics technology GM cannot buy. Plans to keep doubling hybrid output every year.
- Chery (China) says by 2010: half of its million cars per year will be hybrids, half of them on alternate liquid fuels. 40% will be for export.
- Dongfeng Electric Car Company, and Chang' An

What limits rate of deployment of hybrids & plug-ins? Cost, cost, cost...

- Hybrid Prius vs. regular Prius: cost penalty = **\$3000** (2006 data Car & Driver, Financial Times) about enough to pay off at \$3-4/gallon without interest
- About **\$2000** of the \$3000 is for small fast battery, currently nickel hydride less than 1kwh.
- **\$1,000-\$2,000 tax incentive** per car, for the first million hybrids from each manufacturer, essential to speed of development, becoming cheaper, **in US**
- **Outside the US**, higher gas price bigger market now, but subsidized gasoline prices in China cheaper than US

What would accelerate plug-ins most?



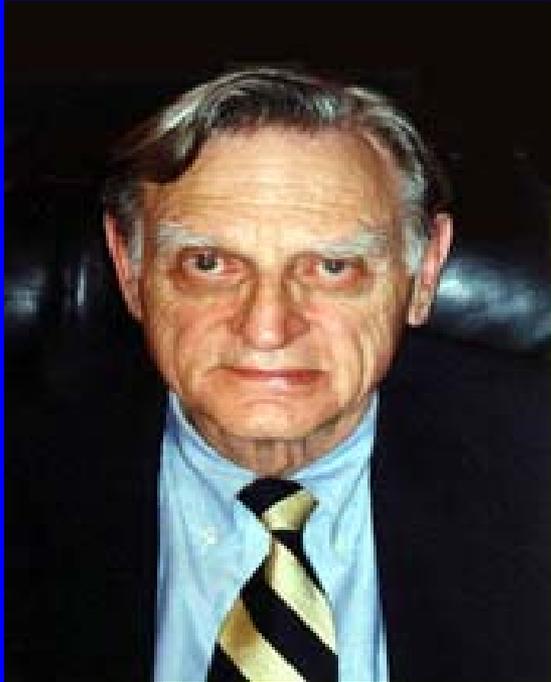
Dr. Abe, leads all of
Toyota hybrid, plug-in
& electric car
development

Me

Prof. Toshio Fukuda

- Toyota response December 4, 2008:
 - **Permanent** tax incentives (not just 4 years)
 - Promote **recharge posts everywhere** (cuts fuel use in half again, energy security, attracts consumer)
 - **Standards** for recharge posts – quicker recharge, compatibility, eventually V2G

Lithium Iron Phosphate Batteries: The One Proven Key to Breaking the Cost Barrier

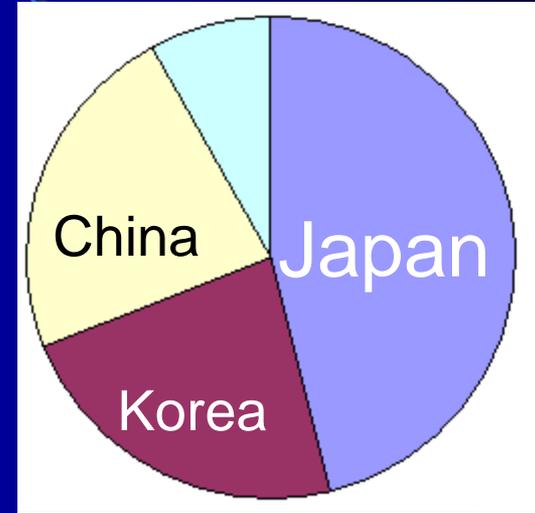


- Invented in 1997 by NSF grantee Prof. John Goodenough, U. Texas
- Winner of the Japan Prize
[www.japanprize.jp/e_2001\(17th\).htm](http://www.japanprize.jp/e_2001(17th).htm)
- Recent huge surge in production at:
 - A123, to manufacture in China
 - LG Chem
 - BYD (Shenzhen), claims to be world's #2 producer of rechargeable batteries
 - Thunder Sky (Shenzhen), safety add-on

How incentives/markets are changing the game: Better batteries are coming



Thunder Sky, China, 10kwh now \$2000
(Werbos in-depth visit June 2007)



World Li Battery Output

Toyota says it will go to Li batteries next year or so, that its new joint venture with Mitsubishi is far ahead of everyone else. But Korea's new thrust aims to beat Japan in rechargeable sales by 2012, by focusing on next generation technology.

New US-China Opportunity?

Some highlights from Shenzhen...

- Plan to get to \$1000 for 14kwh battery is in place.
- Thunder Sky says zero water runoff in manufacturing. Shenzhen says electronics, clothing, batteries, leather industries about equal as sources of pollution overall. Recycling of batteries needed, but global PHEV use would maybe double the (limited, sustainable) issue we have already from lead-acid batteries. Safety > Toyota.
- Ready now: mass production in 2007 of amazing 150-mile electric motorcycles in China. High performance!
- Can REPLACE today's hybrid batteries: power surges are easier when the battery itself is bigger.
- For GM use, need: (1) intelligent 300-volt battery management system (computational intelligence can do it!); (2) neutral US-funded battery & system testing facility, credible to GM etc.



China Government Plan

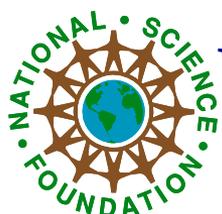
China Daily, posted in chinaview 10/27/7

- Wan Gang, new Minister of Science and Technology & “sea turtle”, strongly supports New Energy Vehicle Key Project of the National Hi-Tech R&D Program.
- Zhen Zijian, Deputy Director:



“(this is) the priority for China’s auto industry, which is expected to become the world’s largest in 10-15 years.”

- Ouyang Minggao (Tsinghua):”.. an innovative union of private companies, research bodies & universities.. along 3 paths – hybrid, clean fuel and electric vehicles.” Also google Caijing magazine.
- Chery says the A5 hybrid 4-door sedan will be \$1,400-\$2,900 higher than conventional version which starts at \$9,975.



Workshop on “Drug Discovery Approach to Breakthroughs in Batteries” Sept 8-9 at MIT

- | Focus: How could new crossdisciplinary research maximize the probability of breakthrough battery designs, suitable for new plug-in hybrid cars but costing only half as much or less as what is coming already?
- | Motivation: IEEE white paper argues that fuel-flexible plug-in cars offer our best near-term hope for independence from oil imports, but the high cost of batteries for new cars like the GM Volt is the main obstacle.
- | Sponsors: ECCS. Participation from DOE, DARPA, GM. Strong encouragement from OSTP. <http://web.mit.edu/dsadoway/www/nsfworkshopMain.htm>
- | Key findings:
 - » The “design space” is huge, and poorly explored due to cutbacks in US electrochemical engineering (other than fuel cells), and the slow speed of traditional Edisonian “shake and bake” methods.
 - » Systematic exploration, using computational approaches (quantum modeling, learning from data, stochastic search) as now used in the pharmaceutical industry show great promise. Sang-Tae Kim, former OCI Director, helped build new partnerships here.
 - » The uncertainties are great, but somewhere between 2X and 10X improvements are likely to be possible, **if** we follow up on this opportunity. No one else is doing it yet in the US.
 - » A new EFRI topic in this area would have huge workforce benefits for the US in this key area even in the worst case where GM imports batteries from China, whose industry is now well ahead of the US industry in this area.
 - » In addition to battery design, new lifetime analysis, catastrophic safety analysis and open-source models for battery management systems are all badly needed.