

TRANSITIONING FROM PETROLEUM-BASED TRANSPORTATION FUEL: A MIRACLE OR A HOAX?

NH₃

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By:
Matthew R. Simmons, Founder
Ocean Energy Institute

Petroleum Invented Modern Transportation

- Before oil was cracked into motor gasoline, diesel and aviation fuel, travel was laborious.
- Before the era of steam-ships and steam operated trains, man's travel ability unchanged for millennium:
 - Walking
 - Sailing
 - Horse riding



Pre-Oil Travel Was A Dirty Business

- Trees were destroyed to create fuel for steam engines.
- Wind for sail power was most advanced form of transportation for many centuries.
- Diseases were rampant from horse dung and dead horses:
 - At the turn of the nineteenth century, New York City's infrastructure relied upon disease-creating entities such as the horse. Between 100,000 and 200,000 horses lived in the city at any given time and about 15,000 dead horses were removed from the streets of New York each year. Each one of those horses gave off 24 pounds of manure and several quarts of urine daily.



A Lot Began To Change By 1900

(Ladies' Home Journal December 1900)

- 20th century miracles seemed far-fetched in December 1900.
- Every miracle finally materialized thanks to petroleum, internal combustion engines, electricity, Ford's horseless buggy and Wright Brothers' plane experiment.

8 THE LADIES' HOME JOURNAL

WHAT MAY HAPPEN IN THE NEXT HUNDRED YEARS

By JOHN ELFRETH WATKINS, JR.



Trains One Hundred and Fifty Miles an Hour. Trains will run two miles a minute, normally; express trains one hundred and fifty miles an hour. To go from New York to San Francisco will take a day and a night by fast express. There will be cigar-shaped electric locomotives hauling long trains of cars. Cars will, like houses, be artificially cooled. Along the railroads there will be no smoke, no cinders, because coal will neither be carried nor burned. There will be no stops for water. Passengers will travel through hot or dusty country regions with windows down.

To England in Two Days. Fast electric ships, crossing the ocean at more than a mile a minute, will go from New York to Liverpool in two days. The bodies of these ships will be built above the waves. They will be supported upon runners, somewhat like those of the sleigh. These runners will be very buoyant. Upon their under sides will be apertures expelling jets of air. In this way a film of air will be kept between them and the water's surface. This film, together with the small surface of the runners, will reduce friction against the waves to the smallest possible degree. Propellers turned by electricity will screw themselves through both the water beneath and the air above. Ships with cabins artificially cooled will be entirely fire-proof. In storm they will dive below the water and there await fair weather.

Telephones Around the World. Wireless telephone and telegraph circuits will span the world. A husband in the middle of the Atlantic will be able to converse with his wife sitting in her boudoir in Chicago. We will be able to telephone to China quite as readily as we now talk from New York to Brooklyn. By an automatic signal they will connect with any circuit in their locality without the intervention of a "hello girl."

Man will See Around the World. Persons and things of all kinds will be brought within focus of cameras connected electrically with screens at opposite ends of circuits, thousands of miles at a span. American audiences in their theatres will view upon huge curtains before them the coronations of kings in Europe or the progress of battles in the Orient. The instrument bringing these distant scenes to the very doors of people will be connected with a giant telephone apparatus transmitting each incidental sound in its appropriate place. Thus the guns of a distant battle will be heard to boom when seen to blaze, and thus the lips of a remote actor or singer will be heard to utter words or music when seen to move.

Photographs will be Telegraphed from any distance. If there be a battle in China a hundred years hence snapshots of its most striking events will be published in the newspapers an hour later. Even to-day photographs are being telegraphed over short distances. Photographs will reproduce all of Nature's colors.

Grand Opera will be Telephoned to private homes, and will sound as harmonious as though enjoyed from a theatre box. Automatic instruments reproducing original airs exactly will bring the best music to the families of the untalented. Great musicians gathered in one inclosure in New York will, by manipulating electric keys, produce at the same time music from instruments arranged in theatres or halls in San Francisco or New Orleans, for instance. Thus will great bands and orchestras give long-distance concerts. In great cities there will be public opera-houses whose singers and musicians are paid from funds endowed by philanthropists and by the government. The piano will be capable of changing its tone from cheerful to sad. Many devices will add to the emotional effect of music.

Vegetables Grown by Electricity. Winter will be turned into summer and night into day by the farmer. In cold weather he will place heat-conducting electric wires under the soil of his garden and thus warm his growing plants. He will also grow large gardens under glass. At night his vegetables will be bathed in powerful electric light, serving, like sunlight, to hasten their growth. Electric currents applied to the soil will make valuable plants grow larger and faster, and will kill troublesome weeds. Rays of colored light will hasten the growth of many plants. Electricity applied to garden seeds will make them sprout and develop unusually early.

Few Drugs will be Swallowed or taken into the stomach unless needed for the direct treatment of that organ itself. Drugs needed by the lungs, for instance, will be applied directly to those organs through the skin and flesh. They will be carried with the electric current applied without pain to the outside skin of the body. Microscopes will lay bare the vital organs, through the living flesh, of men and animals. The living body will to all medical purposes be transparent. Not only will it be possible for a physician to actually see a living, throbbing heart inside the chest, but he will be able to magnify and photograph any part of it. This work will be done with rays of invisible light.

Coal will Not be Used for Heating or Cooking. It will be scarce, but not entirely exhausted. The earth's hard coal will last until the year 2050 or 2100; its soft-coal mines until 2200 or 2300. Meanwhile both kinds of coal will have become more and more expensive. Man will have found electricity manufactured by water-power to be much cheaper. Every river or creek with any suitable fall will be equipped with water-motors, turning dynamos, making electricity. Along the seacoast will be numerous reservoirs continually filled by waves and tides washing in. Out of these the water will be constantly falling over revolving wheels. All of our restless waters, fresh and salt, will thus be harnessed to do the work which Niagara is doing to-day: making electricity for heat, light and fuel.

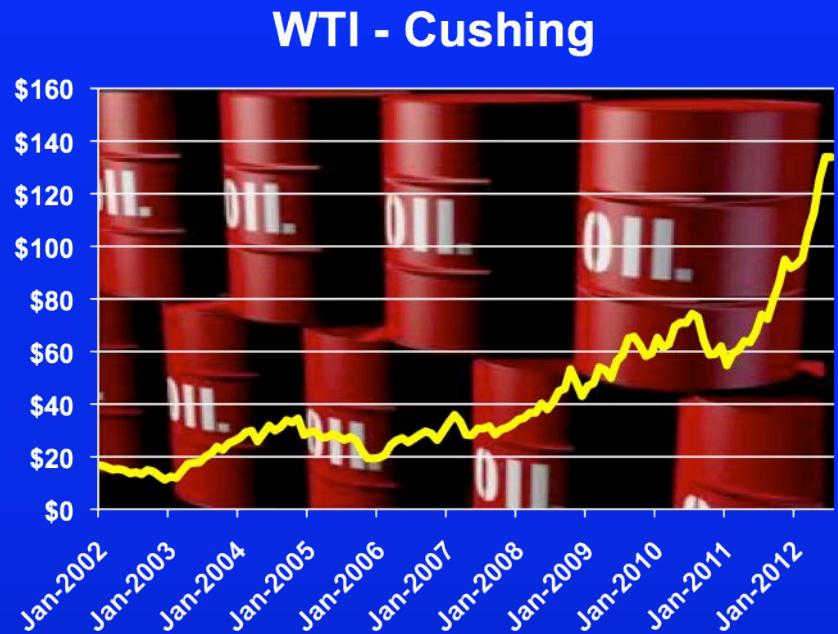
By 2001, World Took All These Miracles For Granted

- Concorde could cross Atlantic in a few hours.
- Consumers could fly San Francisco - Paris round-trip for \$350.
- Americans drove 9,450 miles in a single year and paid very little for this miracle.
- Conventional wisdom believed energy prices would steadily drop, increasing these miracles exponentially.



Trembles Morph Into Earthquakes

- Belief that oil prices would fall and stay low became cruel hoax.
- From late 1998 to early July 2008, oil prices rose 14-fold.
- New supplies were getting scarce and very expensive to turn into usable energy.
- Maturing supplies were all in decline (at accelerating rates).



Decades Of Cheap Oil Took Their Toll

■ While oil consumers enjoyed this cheap oil ride, unforeseen consequence were devastating:

- Few new assets were added
- Few new employees were hired
- Returns on invested energy capital were pathetic



The petroleum system got very rusty and gray while demand continued to soar.

Suddenly, Gasoline Was Not Cheap

- Rising oil prices caused gasoline, diesel and jet fuel to soar.
- By mid-2008, U.S. motorists had “Pain at the Pump” (\$4.00/gallon).
- European motorists had agony at the pump (\$8.00 - \$11.00/gallon).
- Airlines were losing billions due to high cost of jet fuel.
- Trucking companies were losing money.



But, oil prices were still cheap, just not almost free.

How Expensive Was \$140 Oil (Or \$4.00 Gasoline)?

- It still represented remarkable bargain.
- \$140/barrel is \$3.33/gallon or \$0.21/cup.
- A cup of oil costs 1/5 of other consumables:

- Bottled water
- Coke
- Cheap wine



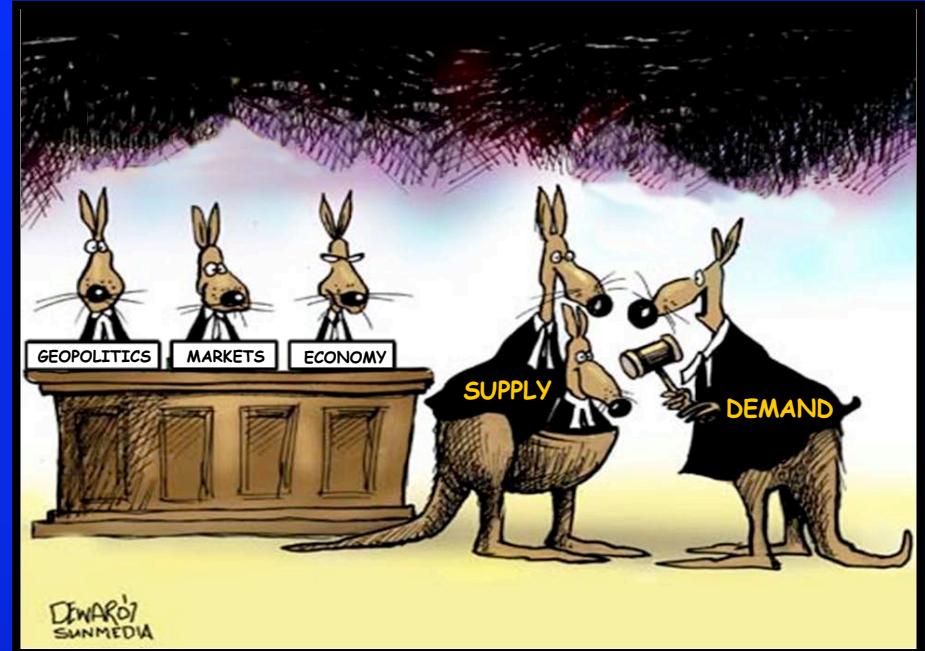
Why Did Oil Prices Soar?

■ Many pundits still blame this nightmare on spectators or market manipulators.

■ The real twin culprits were:

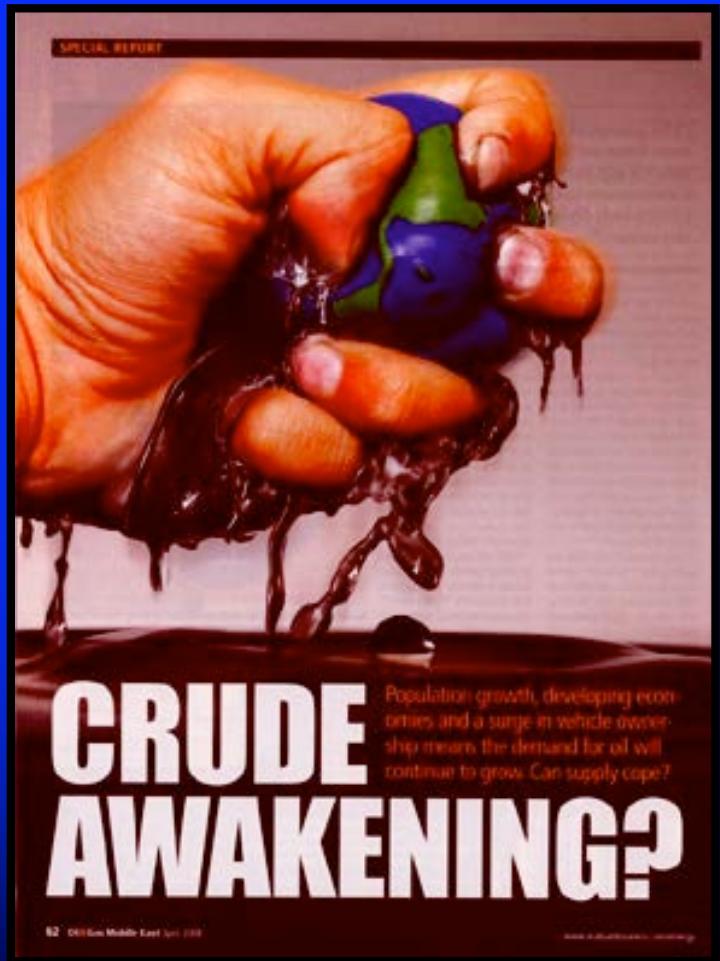
- Demand: It grew too fast
- Supply: It peaked and began into a long decline

■ This was no aberration but beginning of a new post-oil era.



World Still In Denial Of This Change

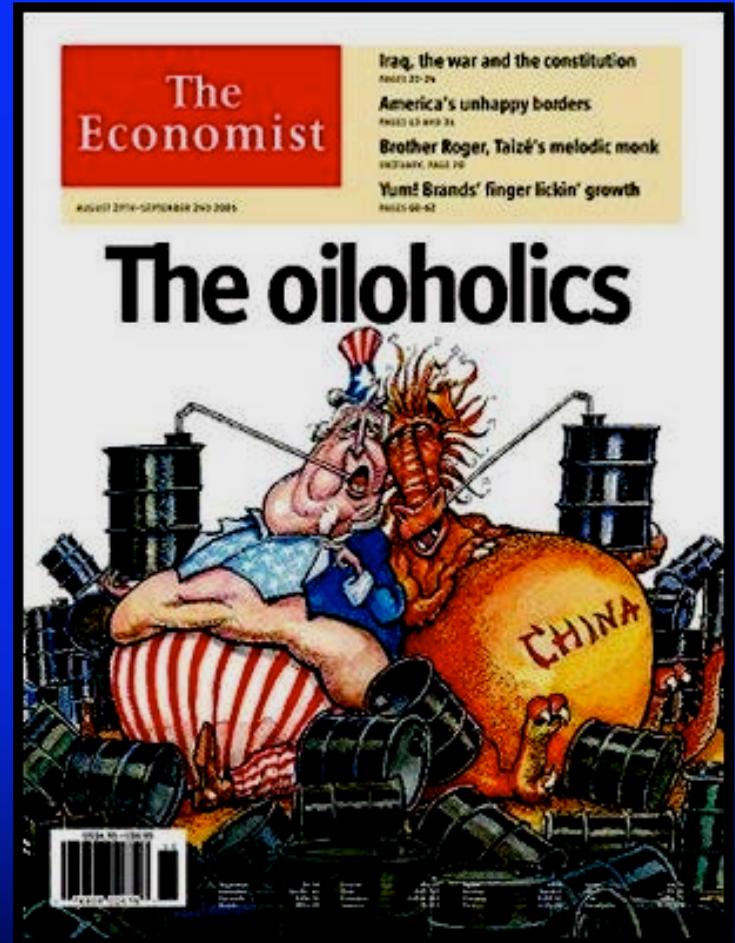
- Transition from a world addicted to oil to world living with less oil will be biggest challenge of 21st century.
- How world reacts to this challenge might determine how long 21st century will be peaceful.
- Stakes to make rapid conversion will not be easy.



Source: Oil & Gas Middle East - April 2008

We All Got Addicted To Oil

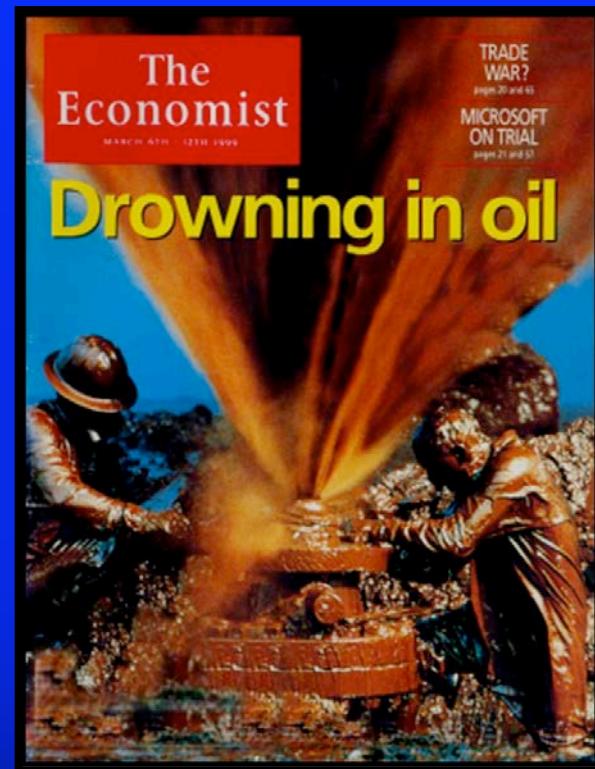
- The oil miracle was such a blessing that the whole world became accidentally addicted.
- America became public enemy #1:
 - With 5% of global population, we now use 25% of world's oil
- Rest of world is now also addicted:
 - China now uses 9 MM B/D of oil
 - India uses 3.5 to 4 MM B/D of oil
- Together they have 16 times more people than USA.



Source: The Economist, August 25, 2005

We Were Hallucinating About Abundant Energy

- Greatest myth was that Middle East oil was limitless in supply and almost free.
- Second myth: “Modern technology” had made finding new oil steadily cheaper.
- Third myth: Demand growth is peaking.



Source: The Economist, March 6, 1999

These three convictions kept encouraging world's addiction to oil-based transportation.

Oil Supplies Will Fall...Demand Will Not

- Odds are high that global oil flow peaked in 2005.
- Each successive year, we need to anticipate less available crude to turn into transportation.
- Meanwhile:
 - America still adds 10 - 13 million cars/year
 - We have 850 cars per 1,000 people
 - China has 18 cars per 1,000 people...and this number is growing steadily

Table 11.1b World Crude Oil Production: Persian Gulf Nations, Non-OPEC, and World (Thousand Barrels per Day)

	Persian Gulf Nations ^a	Selected Non-OPEC ^a Producers								Total Non-OPEC ^a	World
		Canada	China	Egypt	Mexico	Norway	Former U.S.S.R.	Russia	United Kingdom	United States	
1973 Average	20,098	1,798	1,900	165	466	82	8,324	NA	2	9,208	24,888 64,579
1974 Average	18,034	1,430	1,490	285	706	180	8,023	NA	12	8,375	21,992 62,828
1975 Average	17,981	1,436	2,114	694	1,938	489	11,705	NA	1,022	8,697	22,802 62,548
1976 Average	9,638	1,471	2,606	887	2,746	778	11,685	NA	2,630	8,971	37,564 63,964
1977 Average	16,274	1,683	2,774	873	2,648	1,930	10,976	NA	1,820	7,866	36,822 60,492
1978 Average	14,940	1,640	2,500	625	2,766	1,766	10,406	NA	2,048	6,071	34,567 62,152
1979 Average	17,387	1,937	3,121	922	2,865	3,041	—	NA	6,580	2,568	6,495 63,762
1980 Average	18,095	1,922	3,200	866	3,023	3,142	—	NA	6,920	2,518	6,462 37,320 65,744
1981 Average	19,337	1,981	3,185	854	3,070	3,011	—	NA	6,864	2,616	6,262 37,466 65,948
1982 Average	18,687	1,907	3,166	—	2,906	3,019	—	NA	6,079	2,084	6,881 37,569 65,922
1983 Average	19,012	1,927	3,249	782	3,023	3,229	—	NA	6,471	2,271	6,811 38,361 65,881
2001 Average	19,098	2,028	3,309	720	3,127	3,226	—	NA	6,917	2,282	6,801 39,014 65,101
2002 Average	17,704	2,171	3,360	716	3,177	3,179	—	NA	7,408	2,292	6,746 39,919 67,108
2003 Average	19,053	2,306	3,409	713	3,371	3,042	—	NA	8,132	2,094	6,681 40,724 69,448
2004 Average	20,787	2,396	3,486	673	3,388	2,964	—	NA	8,405	1,844	6,419 41,637 72,612
2005 January	21,295	2,330	3,561	658	3,351	2,720	—	NA	8,870	1,705	5,441 41,358 73,231
February	21,355	2,298	3,570	658	3,345	2,809	—	NA	8,922	1,771	5,454 516 73,514
March	21,405	2,172	3,584	662	3,252	2,867	—	NA	8,925	1,802	5,821 511 73,842
April	21,585	2,300	3,584	659	3,405	2,864	—	NA	8,888	1,771	5,655 511 73,168
May	21,445	2,311	3,511	658	3,251	2,859	—	NA	8,903	1,743	5,651 511 73,009
June	21,495	2,330	3,646	656	3,425	2,998	—	NA	9,026	1,643	5,460 41,558 73,588
July	21,695	2,338	3,654	658	3,082	2,715	—	NA	8,993	1,628	5,240 41,143 73,757
August	21,655	2,372	3,668	655	3,414	2,643	—	NA	9,140	1,342	5,218 41,169 73,388
September	21,515	2,262	3,632	659	3,367	2,663	—	NA	9,170	1,358	4,204 40,413 73,389
October	21,525	2,301	3,549	664	3,247	2,777	—	NA	9,123	1,512	4,254 40,737 73,587
November	21,425	2,548	3,621	667	3,311	2,645	—	NA	9,210	1,543	4,837 41,425 73,980
December	21,325	2,648	3,520	647	3,381	2,683	—	NA	9,240	1,648	4,984 41,903 74,268
Average	21,691	2,306	3,609	658	3,334	2,968	—	NA	9,048	1,649	6,178 41,401 73,987
2006 January	21,175	2,595	3,670	654	3,372	2,657	—	NA	9,030	1,707	5,105 41,579 73,759
February	21,375	2,504	3,662	657	3,311	2,620	—	NA	9,042	1,639	5,045 41,412 73,647
March	21,250	2,411	3,710	651	3,350	2,610	—	NA	9,150	1,597	5,045 41,398 73,489
April	21,250	2,531	3,680	653	3,376	2,407	—	NA	9,150	1,590	5,128 41,486 73,591
May	21,305	2,371	3,715	655	3,385	2,535	—	NA	9,150	1,592	5,181 41,496 73,591
June	21,305	2,386	3,700	607	3,287	2,526	—	NA	9,393	1,500	4,979 73,051
July	21,680	2,512	3,716	620	3,232	2,571	—	NA	9,240	1,453	5,102 41,627 74,076
August	21,710	2,543	3,660	638	3,252	2,430	—	NA	9,330	1,203	5,059 41,179 73,754
September	21,360	2,601	3,649	640	3,259	2,338	—	NA	9,350	1,354	5,037 41,242 73,465
October	21,295	2,855	3,650	660	3,177	2,373	—	NA	9,455	1,492	5,106 41,793 73,809
November	21,805	2,588	3,572	615	3,163	2,466	—	NA	9,333	1,504	5,105 41,771 73,809
December	20,695	2,668	3,592	619	2,978	2,508	—	NA	9,420	1,472	5,165 41,664 73,218
Average	21,235	2,626	3,673	639	3,268	2,491	—	NA	9,247	1,400	6,102 41,466 73,639
2007 January	20,475	2,576	3,811	616	3,143	2,431	—	NA	9,420	1,510	5,195 41,867 73,133
February	20,356	2,618	3,739	614	3,148	2,454	—	NA	9,460	1,654	5,147 42,124 73,240
March	20,445	2,594	3,685	612	3,182	2,391	—	NA	9,473	1,554	5,178 41,993 73,240
April	20,494	2,534	3,749	609	3,182	2,427	—	NA	9,369	1,566	5,218 42,067 73,521
May	20,403	2,586	3,626	616	3,152	2,347	—	NA	9,350	1,587	5,247 41,680 72,967
June	20,508	2,572	3,643	679	3,166	2,327	—	NA	9,460	1,436	5,120 41,566 73,154
July	20,508	2,572	3,746	679	2,843	2,195	—	NA	9,393	1,228	4,976 41,003 72,459
August	20,462	2,709	3,746	679	2,843	2,195	—	NA	9,393	1,228	4,976 41,003 72,459
September	21,012	2,570	3,716	679	3,161	2,190	—	NA	9,520	1,381	4,899 41,229 73,318
October	21,158	2,592	3,722	609	2,995	2,273	—	NA	9,603	1,527	5,038 41,614 73,938
November	20,503	2,581	3,727	602	2,927	2,235	—	NA	9,529	1,529	5,038 41,614 73,938
December	21,474	2,516	3,807	609	2,954	2,235	—	NA	9,403	1,436	5,072 41,355 74,202
Average	20,682	2,611	3,729	637	3,082	2,270	—	NA	9,497	1,477	5,103 41,037 73,310

^a Organization of the Petroleum Exporting Countries.
^b The Persian Gulf Nations are Bahrain, Iran, Iraq, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates. Production from the Neutral Zone between Kuwait and Saudi Arabia is included in "Persian Gulf Nations."
^c Revised. ^d Not available. ^e Not applicable. ^f Estimate.
^g Includes: ^h Crude oil, including lease condensate but excludes natural gas plant liquids. ⁱ Monthly data are often preliminary figures and may not average to the annual totals because of rounding or because updates to the preliminary monthly data are not available. ^j Data for countries may not sum to World totals due to independent rounding. ^k U.S. geographic coverage is the 50 States and the District of Columbia.
^l Web Page: See <http://www.eia.doe.gov/emeu/mer/inter.html> for all available data beginning in 1973.
^m Sources: See end of section.

Source: EIA Monthly Energy Report – March 2008

We Face A “Clash” Of Society

- Unless world adopts Plan B to use less oil and creates a source of energy to transport “things”, we face chaos:
 - Global food shortages
 - Economic collapses
 - End of globalization
 - Etc., etc.



We Can Use Less Oil

- Plan B can be implemented quite fast (if we have the will):
 - End long-distance commuting.
Work where you live
 - Grow food locally
 - Travel efficiently (water trumps rail,
rail trumps roads)
 - Produce things close to consumption point
- But, these merely buy time to invent replacement for transportation energy.



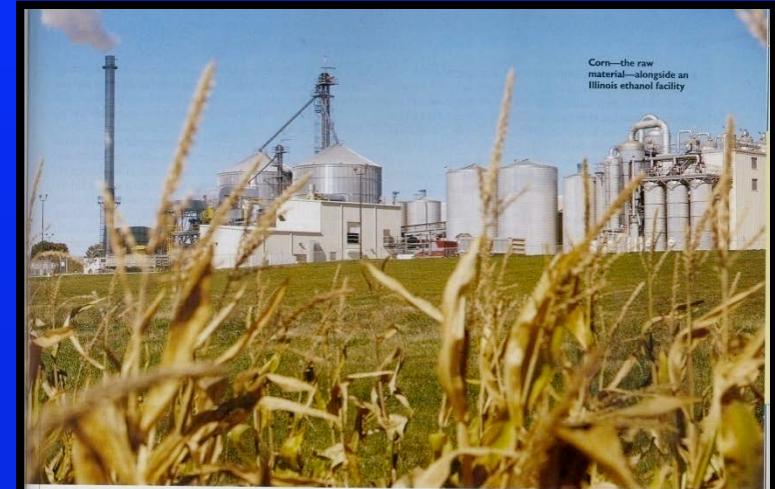
Viable New Fuel Source Needs To Use Current Fleet

■ Assuming we can create non-internal combustion vehicles:

- America has 280 million oil-consuming vehicles
- World has almost 900 million vehicles
- Airplanes will never “plug-in”

■ Early experiments to create biofuels were also dim:

- Corn ethanol became almost a scam
- Cooking oils, bio-mass, manure, etc., creates only tiny amounts of useable fuel



Corn—the raw material—alongside an Illinois ethanol facility

FORUM

The Ethanol Illusion

Can we move beyond an energy policy running on hype and hot air?

by MICHAEL B. McELROY

AMERICANS' annual consumption of gasoline (for both private and commercial transportation) amounts to more than 140 billion gallons—close to 500 gallons for every man, woman, and child in the country. With gasoline prices up by almost a third over the past year, the annualized bill for gasoline (direct and indirect) for a typical U.S. family of four is now more than \$5,000, a burden that falls disproportionately on those least equipped to bear it. Not surprisingly, there has been a political reaction. Leaders of the major oil companies have been summoned to testify in Congress and there are calls for a windfall-profits tax. But the price of gasoline is linked inevitably to the price of oil, and there is little Congress or the oil companies can do about that, at least in the short term. Geopolitical considerations, notably the instability in the Middle East, and international market conditions (increased demand from China and India, political uncertainties in Russia and Venezuela), determine the price of oil, currently at an all-time high of close to \$98 for a 42-gallon barrel of crude.

But there is a solution, some would claim. Why not replace gasoline with ethanol, the stuff that adds zip to your beer and your gin and tonic, a fuel produced from homegrown corn? After all, more than 40 percent of the world's corn is grown in the United States, which can legitimately claim to be the world's most efficient agricultural economy. Corn grows by drawing carbon dioxide from the atmosphere through photosynthesis. Won't that offset concerns about increasing levels of greenhouse gases and consequences for global warming? However, we put up an option that appears to have benefits not only for the farmer and the consumer but also for the environment—and also enhances national security by reducing our dependence on imported oil? Attracted by these visions, subsidies have been lavished on corn-based ethanol, and investors are rushing to boost production.

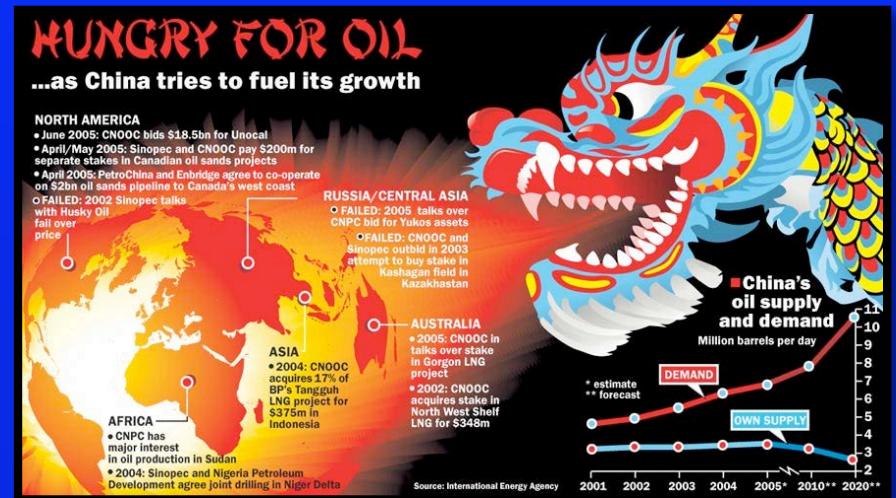
BUT UNFORTUNATELY, the promised benefits prove upon analysis to be largely ephemeral. It is urgent that we understand the realities before proceeding headlong toward corn-

Photograph by Scott Olsen/Getty Images

Source: Harvard Magazine

It Is Daunting To Replace Small Percentage Of Petroleum Fuel

- World currently uses over 25 MM B/D of gasoline, diesel and aviation fuel.
- This amounts to over one billion gallons/day or 42,000 gallons/hour.
- But, 75% is used by 15% of world's population.
- China is second highest car buyer.
- They now have 18 vehicles/1,000 people.
- USA has ≈900 vehicles/1,000 people.



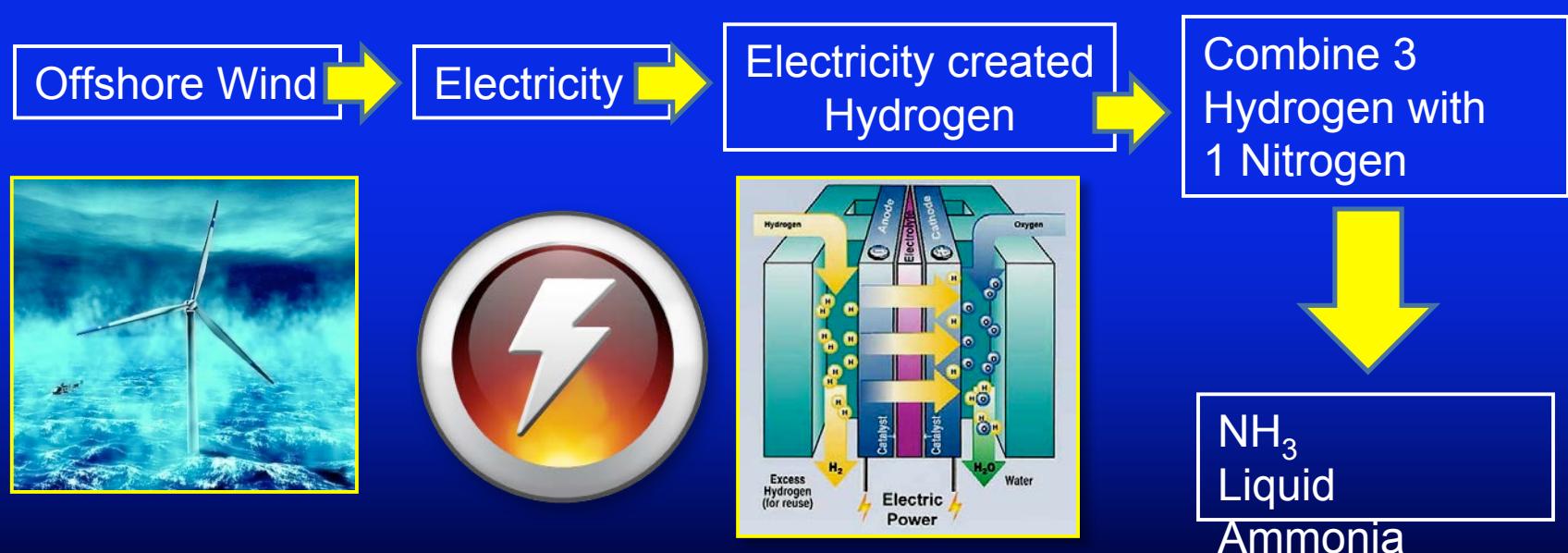
The World Needs New Transportation Energy Source

- Biofuels would destroy our food chain.
- Algae holds promise, but current supply is tiny.
- There are few viable alternate supply sources that can scale to become important.
- Conservation (“Plan B”) can buy time but it is not a permanent solution.



NH_3 (Liquid Ammonia) Is Only Realistic Solution That Makes Sense

- Since NH_3 can be created through offshore wind, its feedstock is abundant.
- Since 60% of world's population live within 50 miles from shorelines, it is available locally.
- The conversion process has been proven:



We Know NH₃ Works

- Air Force and NH₃ pioneers have proven this high density fuel can power cars, boats and planes.
- Offshore winds are abundant.
- The wind quality does vary:
 - May be too mild (Cape Wind)
 - Or, too strong
- We need to capture the sweet spots and begin creating liquid ammonia.



NH_3 Bi-Product Is Not Sooty...It Is Clean

■ Offshore wind conversion process also creates:

- Desalinated water
- High quality salt

■ What is does not create – Carbon emissions!

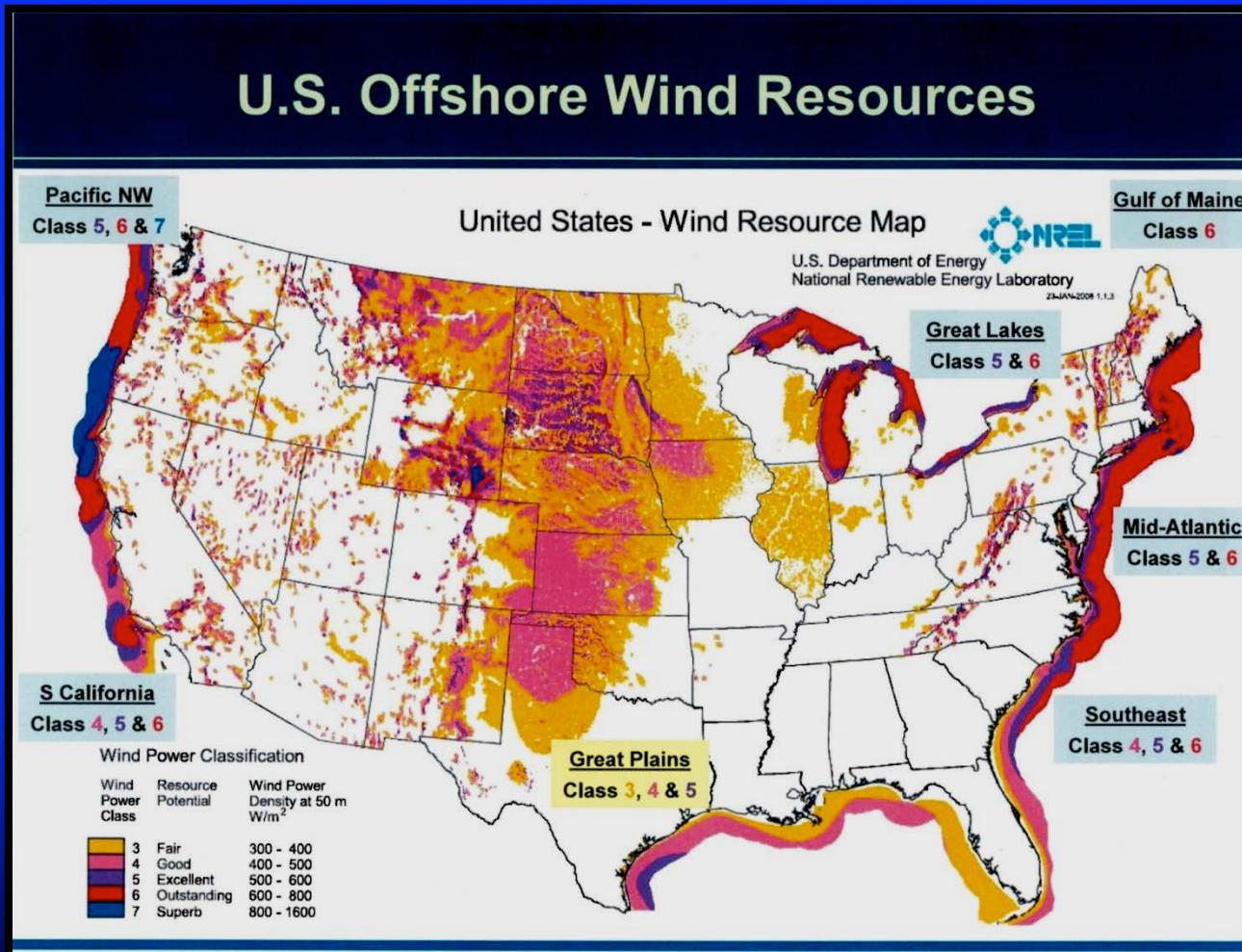


How Much NH₃ Can Offshore Wind Create?

- 100MW plant creates ≈4,800 B/D of NH₃.
- 5 gigawatts of offshore-created electricity can create ≈180,000 B/D of NH₃.
- This is goal of Gulf of Maine Wind Project (during non-winter months).

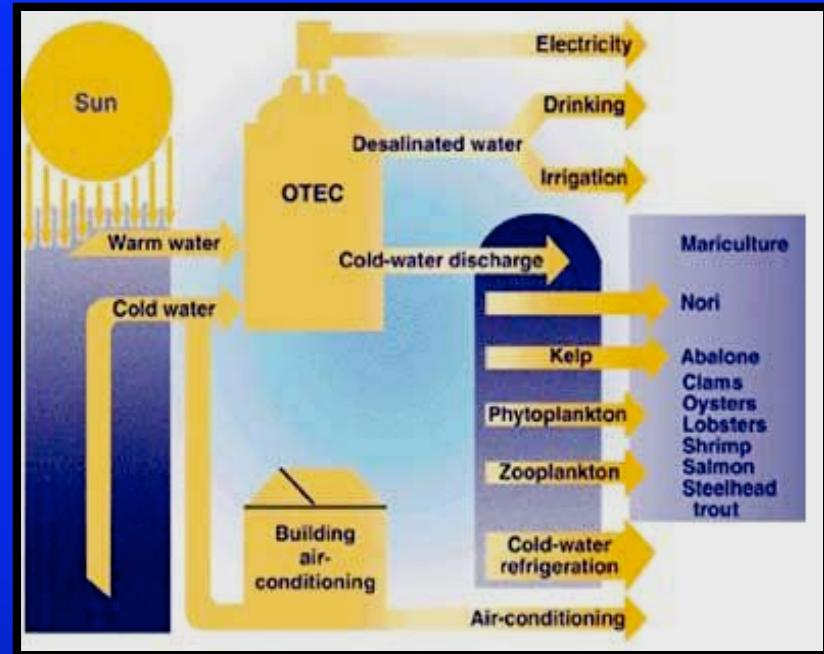


How Much Energy Is In USA's Offshore Winds?



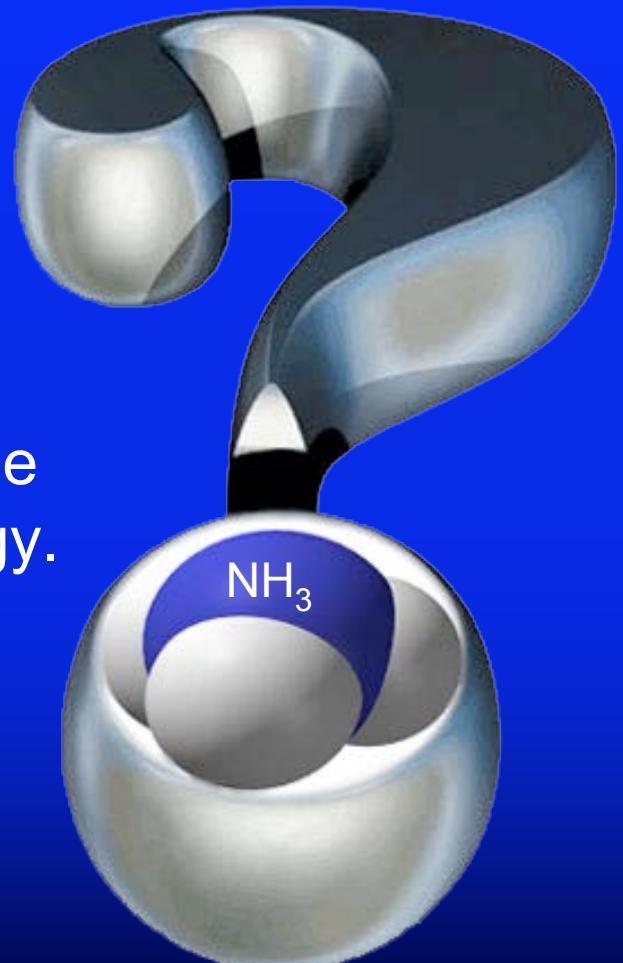
Offshore Wind Can Also Create Potable Water

- All fossil fuel power plants consume enormous volumes of water. Some is recovered, most is lost.
- Offshore winds can produce desalinated, pure water and high quality salt.
- Potable water could soon become our scarcest resource.



How Will 21st Century Work Out?

- We do not have abundance of oil and natural gas.
- We must rapidly create a Plan B.
- We must create a viable and scalable replacement for transportation energy.
- Thus far, only viable solution is NH₃.



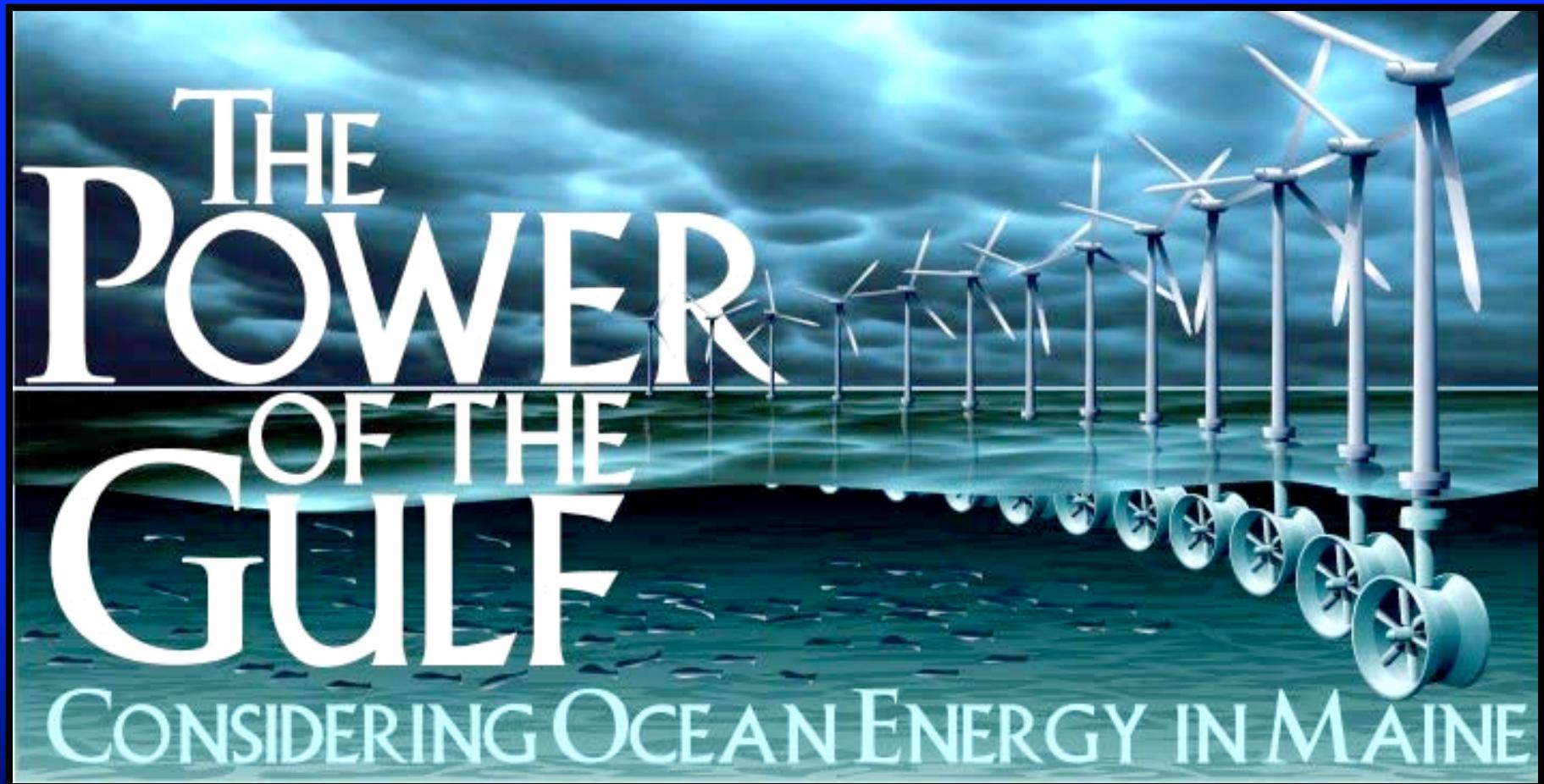
The Solution To A Nightmare Was Before Our Eyes

- Ocean winds can create transportation fuels for 21st century and beyond.
- NH_3 preserves use of internal combustible engines.
- Oceans cover 71% of the globe.
- 60% of world's population live within 60 miles of our coast lines.

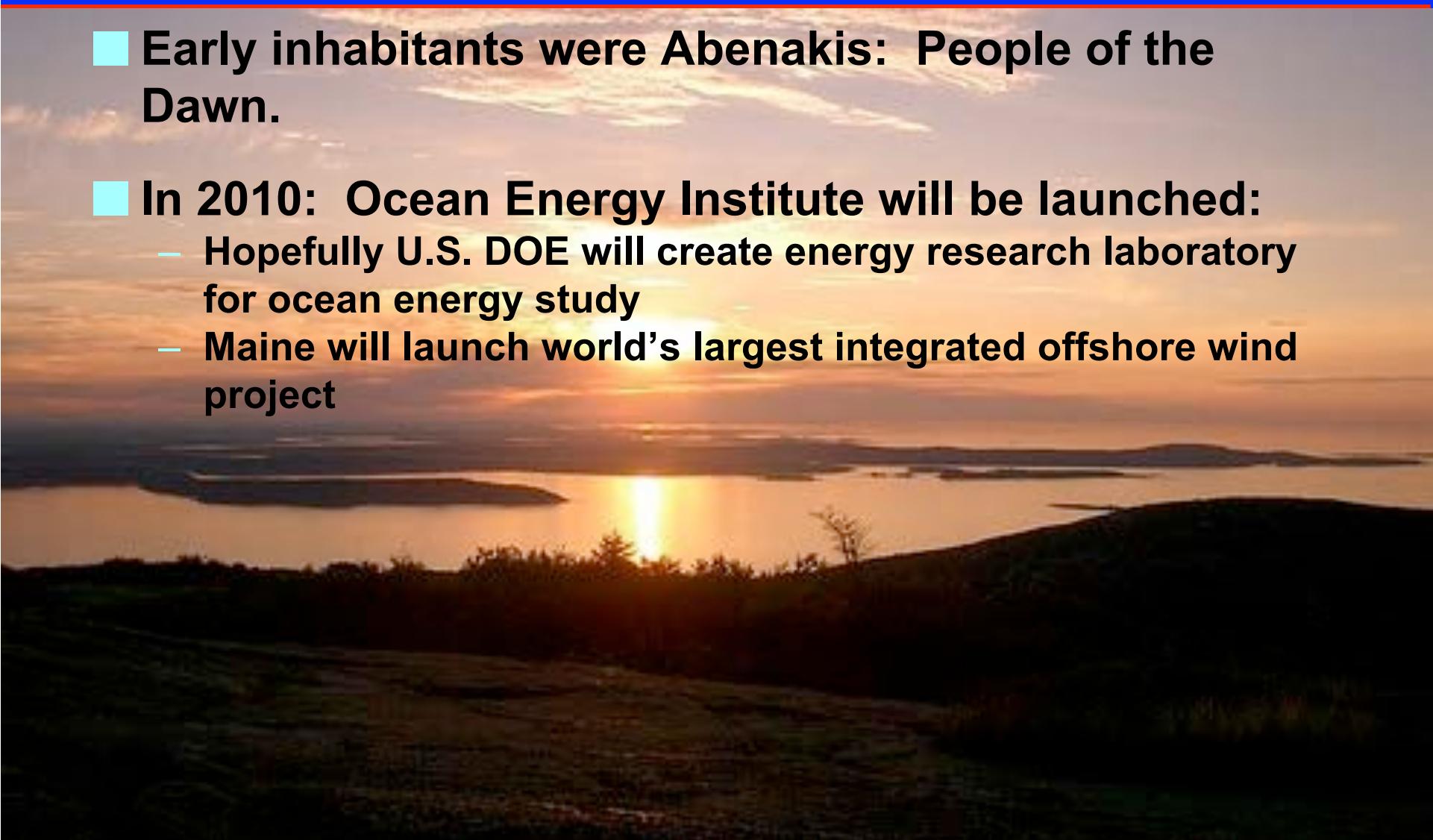


NH_3 can scale to finally replace oil as transportation fuel.

Gulf Of Maine Will Soon Become Test Case For The New Energy Miracles



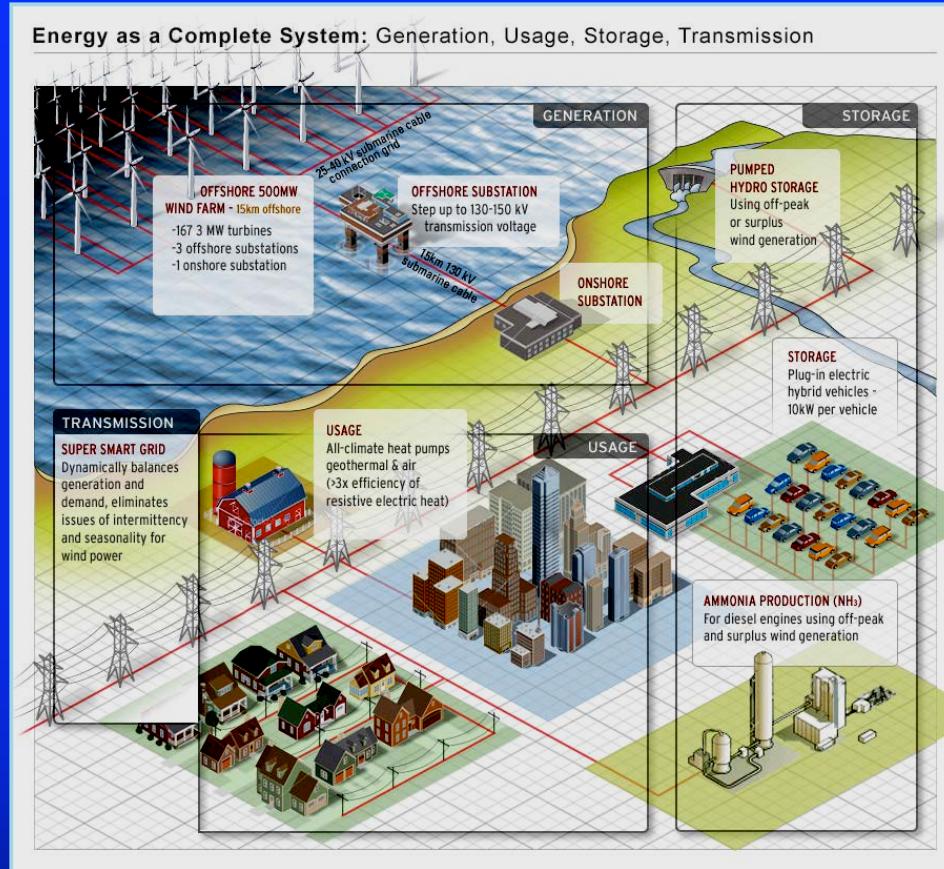
Gulf Of Maine Has America's First Light



- Early inhabitants were Abenakis: People of the Dawn.
- In 2010: Ocean Energy Institute will be launched:
 - Hopefully U.S. DOE will create energy research laboratory for ocean energy study
 - Maine will launch world's largest integrated offshore wind project



Ocean Energy Institute



Making Ocean Energy A Reality...

For information and/or copies regarding this presentation, please contact Laura Russell at 713-546-7211.