

Future Energy Technologies

# Alternative Energy Technology

Brian Toren and Hank Lederer

# Energy Sources



Hydro

Coal

Oil

Natural Gas

Hydrogen

Biomass

Solar



- Mirrors land space

- PV land space

- Thermal

- Solar Wind

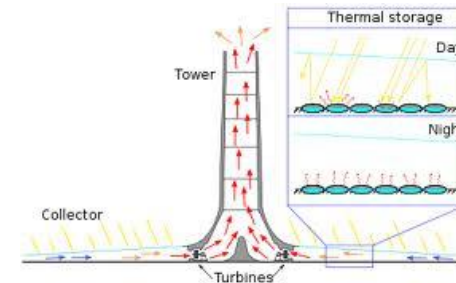
Kinetics

Gravity

Wind

Thermal

Geothermal



# The Oil Crisis

Substituting a dependency on oil for a dependency on rare metals – good idea?

Two scenarios: Moderate Global Collapse Some Consequences

A rise in cost of food

Transportation costs increase

Cost of goods

Unemployment

Economy destabilized

Loss of confidence in markets

The public becomes aware

Money devalued

Globally

# The Decline of Cheap Energy

Many experts say that high-quality fossil fuels that are cheap to extract are dwindling, forcing the world to turn to energy sources that are more costly to produce. This situation is revealed by calculating EROI—the energy obtained per unit of energy spent to obtain it. Conventional oil has a much more favorable EROI than

other sources of liquid fuel ①, but its score is declining steadily ②. Conventional sources of electricity also have high EROIs ③, which can pay off handsomely when used for transportation ④. “The age of cheap energy is over,” said Nobuo Tanaka in 2011, when he was the International Energy Agency’s executive director.

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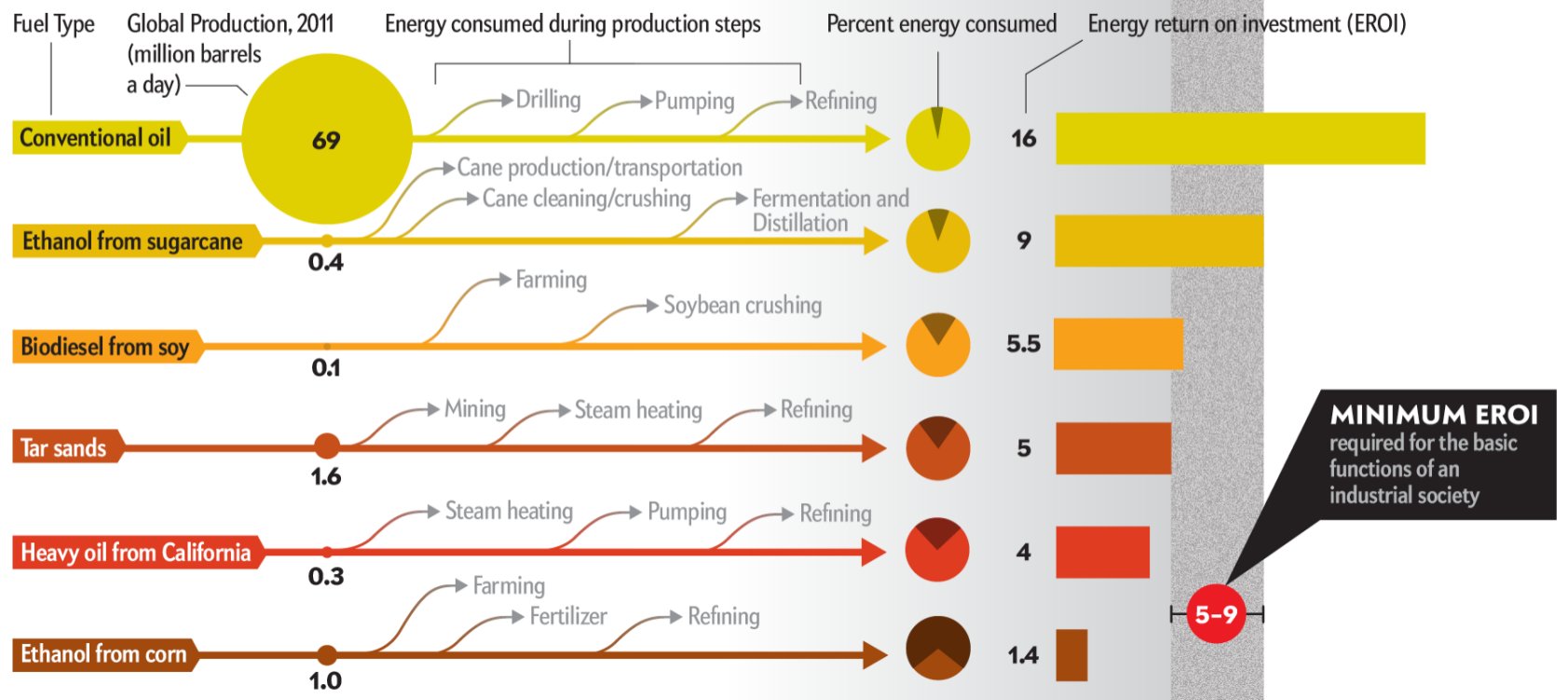
① Liquid Fuels

② Oil’s Advantage Drops

③ Electric Power

④ Mileage Return on Investment

**Crude Oil Gives the Best Energy Return—Today** Each raw material has to be extracted—from oil reservoirs or vegetation—and refined into gasoline or other fuels. Each step lowers the EROI. Values are recent industry averages or from typical installations.



Graphic by Jen Christiansen

DATA SOURCES: INTERNATIONAL ENERGY AGENCY; U.S. ENERGY INFORMATION ADMINISTRATION; U.S. DEPARTMENT OF AGRICULTURE; STUDIES BY CHARLES A. S. HALL ET AL. AND BY OTHER RESEARCHERS (complete list of sources online at [ScientificAmerican.com/apr2013/eroi](http://ScientificAmerican.com/apr2013/eroi))

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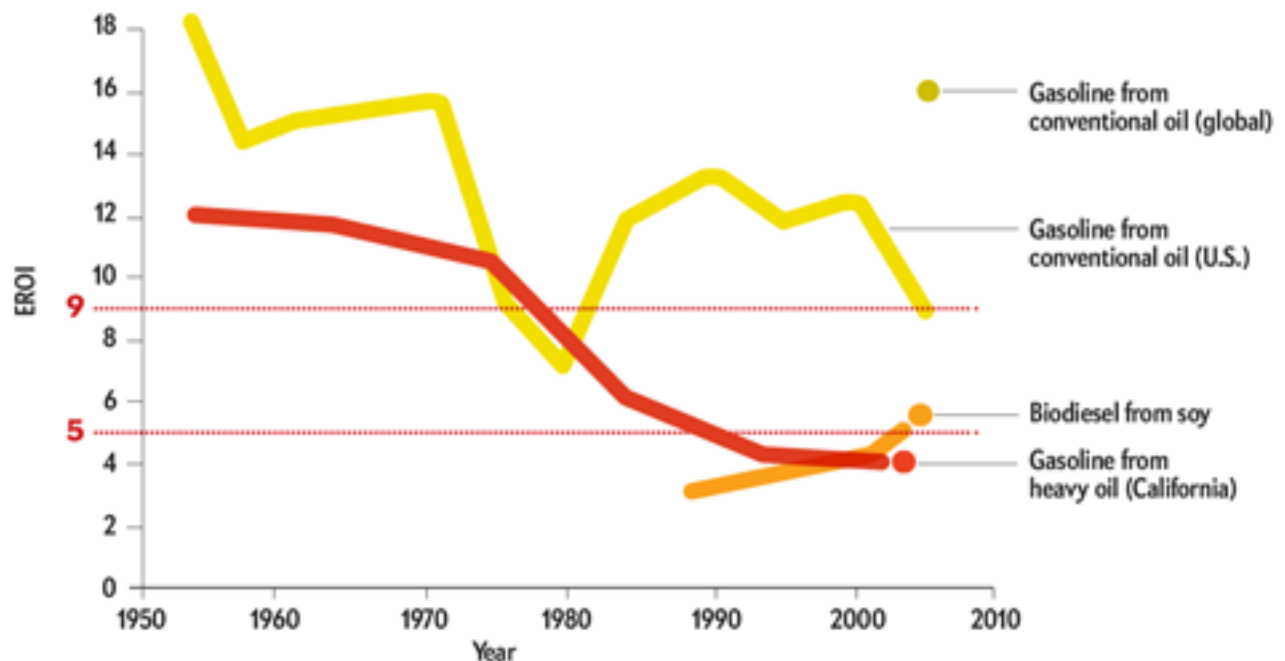
① Liquid Fuels

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A modern economy requires fuels that have an EROI of at least five. For decades oil from conventional deposits soared above that threshold, but it is now dropping. Substitute sources such as heavy oil (thicker petroleum composed of longer hydrocarbon molecules) are more energy-intensive to produce, so they have lower EROIs. But alternative fuels, such as diesel made from soybeans, offer some hope.



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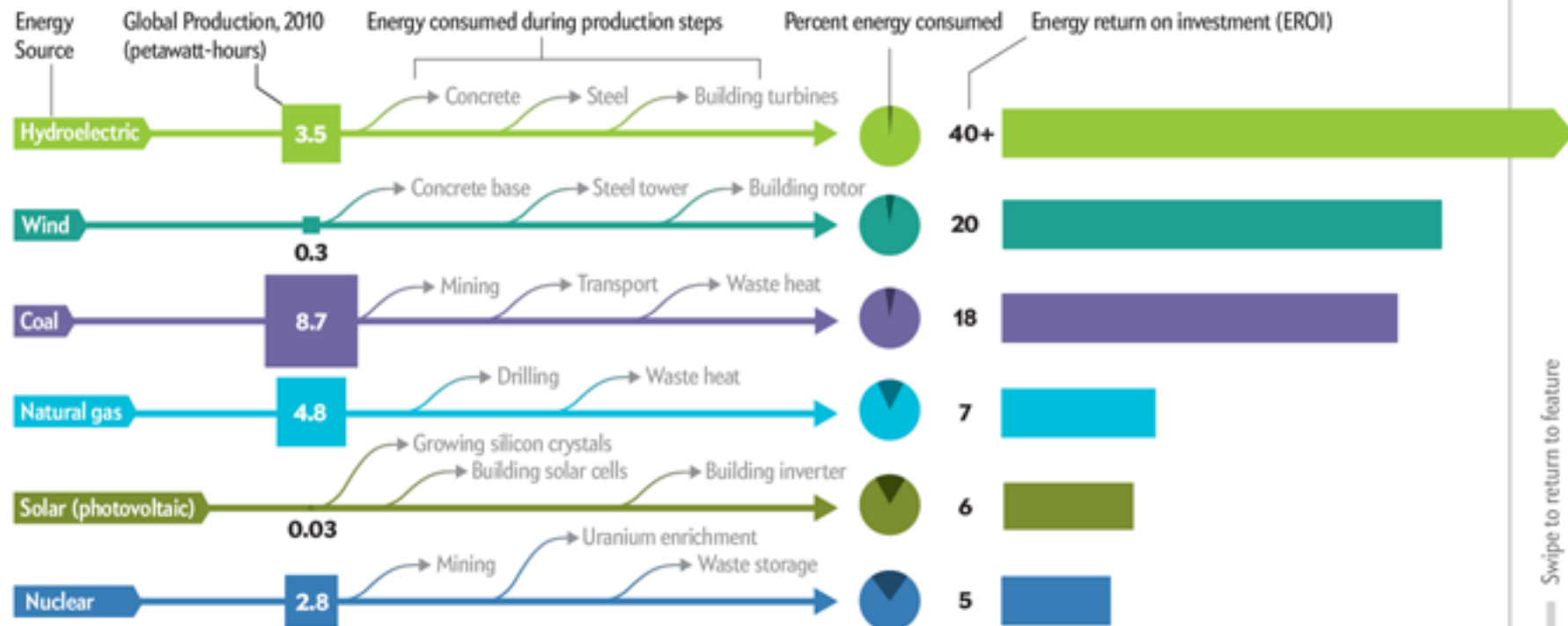
**1** Liquid Fuels

**2** Oil’s Advantage Drops

**3** Electric Power

**4** Mileage Return on Investment

**Renewables Are Competitive with Fossil Fuels** Sources of electricity span a wide range of EROIs. Values are recent industry averages or from typical installations. Renewables do not include energy storage.



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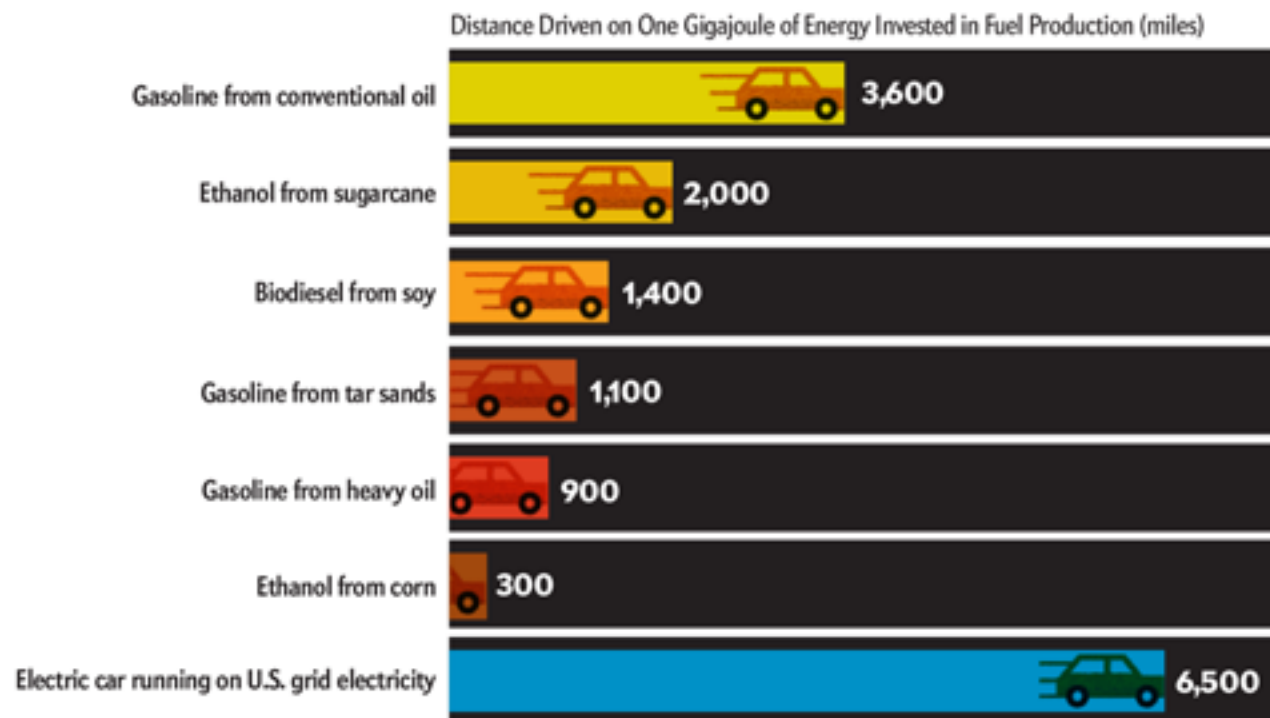
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**1** Liquid Fuels

**2** Oil’s Advantage Drops

**3** Electric Power

**4** Mileage Return on Investment



## Electricity Wins

Transportation fuels are not created equal. A car will go farthest on energy invested in generating electricity, then on conventional gasoline, followed by ethanol made from sugarcane. The miles traveled are based on the energy required to make each fuel, as well as its energy density (for example, ethanol’s energy density is roughly 67 percent of gasoline’s). For electric cars, this value does include electricity transmission, but not manufacturing batteries.

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**Estimated Levelized Cost of New Generation Resources, 2017<sup>[10]</sup>**

		U.S. Average Levelized Cost for Plants Entering Service in 2017 (2010 USD/MWh)				
Plant Type	Capacity Factor (%)	Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Conventional Coal	85	65.8	4.0	28.6	1.2	99.6
Advanced Coal	85	75.2	6.6	29.2	1.2	112.2
Advanced Coal with CCS	85	93.3	9.3	36.8	1.2	140.7
Natural Gas Fired						
Conventional Combined Cycle	87	17.5	1.9	48.0	1.2	68.6
Advanced Combined Cycle	87	17.9	1.9	44.4	1.2	65.5
Advanced CC with CCS	87	34.9	4.0	52.7	1.2	92.8
Conventional Combustion Turbine	30	46.0	2.7	79.9	3.6	132.0
Advanced Combustion Turbine	30	31.7	2.6	67.5	3.6	105.3
Advanced Nuclear	90	88.8	11.3	11.6	1.1	112.7
Geothermal	92	76.6	11.9	9.6	1.5	99.6
Biomass	83	56.8	13.8	48.3	1.3	120.2
Wind <sup>1</sup>	34	83.3	9.7	0.0	3.7	96.8
Solar PV <sup>1,2</sup>	25	144.9	7.7	0.0	4.2	156.9
Solar Thermal <sup>1</sup>	20	204.7	40.1	0.0	6.2	251.0
Hydro <sup>1</sup>	53	76.9	4.0	6.0	2.1	89.9



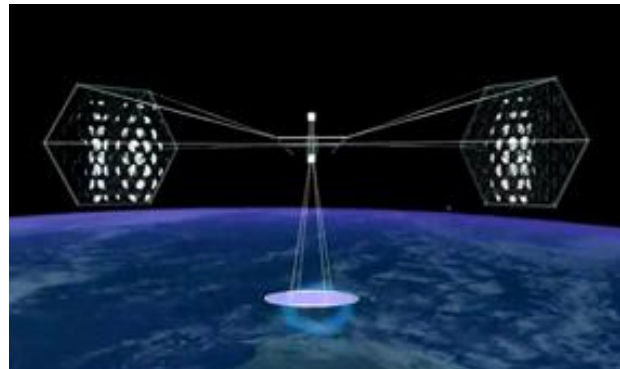
# Solar Energy March 2013

In March of 2013 all 44 megawatts of new electric generation that utilities in the U.S. added to the grid consisted of solar power



Why? It's simply much quicker and cheaper to install thousands of solar panels or erect wind turbines than build a complicated and capital-intensive natural gas power plant.

## Space Based Solar Power





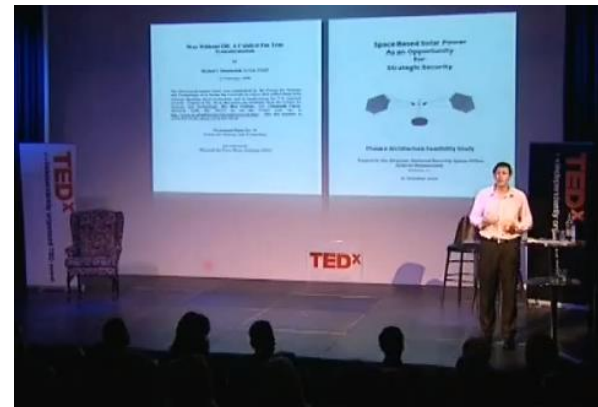
# Solar Energy



First a word from our sponsors

Peter Sage Part 1

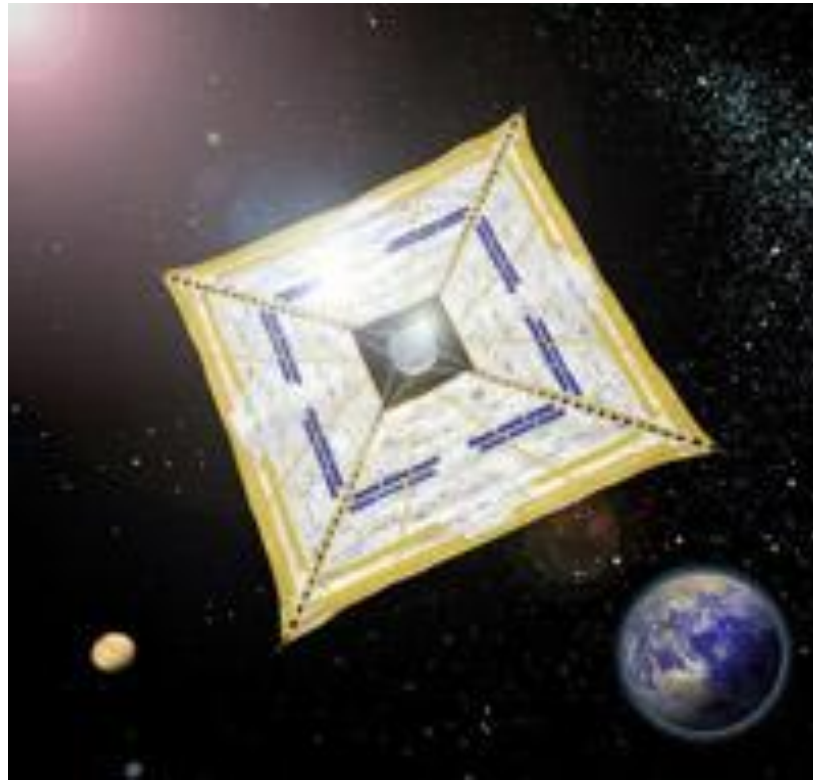
Peter Sage Part 2



# Solar Wind Power

## Solar Wind Power

- How does it work
- Size
- Disadvantages



Solar Wind Power: Generating Power In The Future

# Solar Power Breakthroughs

## Cheaper Solar Panels with Nano Wire



Rendering courtesy of Paul Takizawa



low-cost-high-efficiency-solar-power-

previously-unused-energy-source

# Land Based Solar Power

## Solar Power in the SW



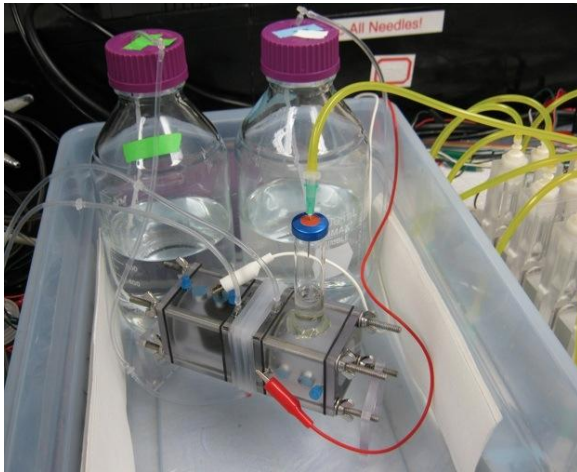
## Concentrated Solar Power



## Solar Power Revolution

# Hydrogen

## Hydrogen fuel from bacteria



## Hydrogen Gas Production Doubled with New Super Bacterium

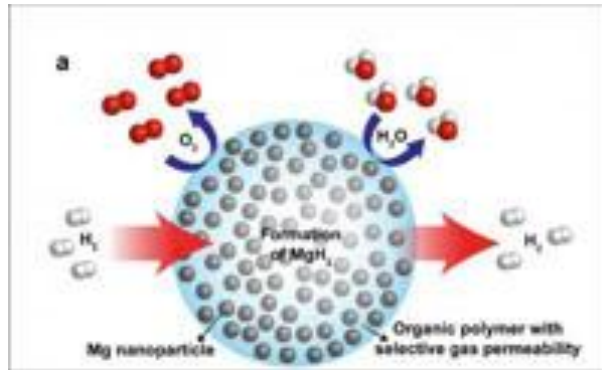
## Artificial Leaf



## Hydrogen car availability

# Hydrogen

## Generation & Storage with Nano- Technology



The East Coast is  
About to Become the  
Hydrogen Highway

New Advances in Hydrogen Fuel Catalysts  
Hydrogen Fuel From Non-food Sources

# Nuclear Fission USA

## America's Nuclear Energy Future

- High temperature, fast gas reactors
- Molten salt reactors
- Small modular reactors
- Integral fast reactor – GE's PRISM
- Thorium
- Other Countries Progress



# Nuclear Fission – World Nuclear Association

## Third-generation reactors

- Improved designs of nuclear power reactors are currently being developed in several countries.
- The first so-called 3rd generation advanced reactors have been operating in Japan since 1996.
- Newer advanced reactors now being built have simpler designs which reduce capital cost. They are more fuel efficient and are inherently safer.

## Fourth-generation reactors

- Concept stage

# Nuclear Fusion

## 1 Magnetic confinement

Magnetic confinement fusion is an approach to generating fusion power that uses magnetic fields to confine the hot fusion fuel in the form of a plasma.

## 2 Inertial confinement

Inertial confinement fusion (ICF) is a process where nuclear fusion reactions are initiated by heating and compressing a fuel target, typically in the form of a pellet that most often contains a mixture of deuterium and tritium.

## 3 Inertial electrostatic confinement

a concept for retaining a plasma using an electrostatic field. The field accelerates charged particles (either ions or electrons) radially inward, usually in a spherical but sometimes in a cylindrical geometry. Ions can be confined with IEC in order to achieve controlled nuclear fusion

Somewhere a big breakthrough is required

# Energy Storage

Gravity

Batteries

Heat Storage

Flywheels

# Fuel Cells

[Ramanathan's Work on Solid-Oxide Fuel Cells](#)

[More Efficient Palladium Fuel Cell Catalysts](#)

[New Process to Boost Hydrogen Fuel Cell Usage](#)

[New Solid Oxide Fuel Cell Technology](#)

# Biofuels

[Common Algae for Biofuel Butanol Production](#)

[New Design Strategy for the Artificial Leaf](#)

[Biofuel as a Jet Fuel Alternative?](#)

[Hydrogen Gas Production Doubled with New Super Bacterium](#)

[Biofuels from Engineered Tobacco Plants?](#)

[New Way to Convert CO<sub>2</sub> into Methanol](#)

[Bacteria Could Power the Future](#)

[Biotechonomy: Can We Grow Energy?](#)

# Wind

[Flying Wind Farms: Future Power Harvesters](#)

[Solar Wind Power: Generating Power In The Future](#)

[Kite-like Turbines Could Capture Wind Above New York](#)

[Small, Low Speed Wind Turbine](#)

[Harnessing High Winds With Giant Kites](#)

[Wind Powered Rotating Skyscraper](#)

# Mechanics

Power from Two Energy Sources?

Hydrokinetic Power Barges

Adding Lithium to Hydrogen Could Improve Production

Tiny Generators Produce Electricity from Ambient Vibrations

Energy Harvesting 'Piezo-tree' Concept

Forget Solar Power, Human Power is the Future Energy Harvesting 'Piezo-tree' Concept

# NanoTechnology

[Hydrogen Generation & Storage Made Easy with Nano-Technology](#)

[Using Carbon Nanotubes to Produce Electricity](#)

[More Power to Electronics Thanks to Nano-scale Wires](#)

[Nanosolar: Solar Power at a Lower Cost](#)

[Nanotechnology Lights Up Batteries and Clothing](#)

[Enhancing Nanocrystal Electrical Conductance with Gold](#)

[Light-driven Nanomotor](#)

[New Nanogenerator for Ipods and Cellphones](#)

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# Transportation

Future Air Travel will have Less Noise, Less Exhaust

[MiraQua: A Tiny Miracle](#)

[Mira EV Travels 1000km on Single Charge](#)

[NASA's Puffin: The Personal Electric Air Vehicle](#)

[Cars of Tomorrow With Energy-Saving Technology](#)

[Low-emission Engines for Future Hybrids Pod Transportation Concept](#)

[Tesla Roadster and the Electric Car Future](#)

[Future Hydrogen Fuel Cell Cars](#)

# Misc

[Power from Two Energy Sources?](#)

[Car Fuel from Carbon Dioxide?](#)

[Advantages of Renewable Energy at Macro and Micro Level](#)

[MIT Breakthrough: Thermo-Chemical Solar Power](#)

[Converting Waste Heat to Electricity](#)

[Converting Carbon Dioxide into Liquid Fuel with Bacteri](#)

[Converting Water and CO2 into Fuel](#)

[Green Heating and Cooling Technology from Carbon](#)

[Harvesting Ambient Energy from Nature](#)

[Sustainable Eco City Concept in Germany](#)

[Electricity and Desalination from Wastewater](#)

[New Advances in Hydrogen Fuel Catalysts](#)

[Converting waste into a renewable energy sources](#)

[Power from Trees Artificial Trees to Produce Alternative Energy](#)

[Waste as a Renewable Energy Source](#)

[Innovative Transportation technologies Matix](#)

[Turning Airborne Carbon Into Fuel](#)

[Cradle to Cradle: Rethinking Sustainability](#)

[Invest in Renewable Energy in China](#)

[Ambient Energy Generator Technology](#)

[Green Steam Energy](#)

# Misc 2

Energy from Pollution

# Ongoing Projects

[Ontario Solar Power could match US Nuclear Power](#)

[Morocco's new Solar Project to Generate 2000MWs](#)

[SunEdison to Build Europe's Largest Solar Power Plant](#)

[World's Largest Solar Power Project Planned](#)

[Los Angeles to Stop Using Coal by 2020](#)

[Google and Microsoft Building Smart Power Grids](#)

[First Hybrid Solar Power Station](#)

[Molten Salt Solar Plant](#)

[Solar Energy "Power Towers" for California](#)

# Environment

**Will Robots Clean Up Future Oil Spills?**

**Future Air Travel will have Less Noise, Less Exhaust**

# Hydroelectric

[America's Premiere Wave Power Farm Sets Sail](#)

[Aquamarine Power Makes Riding the Waves More Interesting](#)

[2 New & Innovative Ocean Wave Energy Devices](#)

[Renewable Energy From Slow Water Currents](#)

[Tidal Energy Industry Boom](#)

[Pelamis Offshore Wave Energy in Portugal](#)

[Ocean and Offshore Renewable Energy Policy](#)

[Renewable Ocean Energy: Tides, Currents, and Waves](#)

# Nuclear & The Big Three

[Is Nuclear Energy a Viable Solution](#)

[The Future of Nuclear Power?](#)

[The Future of oil](#)

[The Future of Natural Gas](#)

[The Future of Coal](#)

# Solar

[Why Solar is the Best Energy Solution](#)

[Laser 'Scribing' to Increase Solar Cell Efficiency](#)

[Making the Best Use of Polymer Solar Cells](#)

[Solar Wind Power: Generating Power In The Future](#)

[The Future is Now with Light-Powered Circuitry](#)

[New Solar Pond Distillation System](#)

[Floating Geodesic Solar Molecules](#)

[Cheap Energy with New Solar Device](#)

[The Solar Flower Tower](#)

[Powering Up The Nation's Largest Solar Power Plant](#)

[A Step Closer to Solar Power in Space](#)

[First Instant Solar\(TM\) PV System](#)

[New Generation of Solar Devices with Trapped Sunlight](#)

[Solar Roadways](#)



# Solar Power Videos

<http://www.youtube.com/watch?v=BoxXlF9mepU>.

<http://m.youtube.com/watch?v=sYIo-0qo9FA&feature=related>

SP in the SW. <http://m.youtube.com/watch?v=ysDXwvNGHeM>

SP panel farm. <http://m.youtube.com/watch?v=ysDXwvNGHeM>

SPbreakthrough [http://m.youtube.com/watch?v=J\\_zzE8xMdZc](http://m.youtube.com/watch?v=J_zzE8xMdZc)

SP Break even breakthrough for <http://m.youtube.com/watch?v=t1tuzvT1hck>

SP Parabolic <http://m.youtube.com/watch?v=t1tuzvT1hck>

Sterling engine <http://m.youtube.com/watch?v=t1tuzvT1hck>

How SE works. <http://m.youtube.com/watch?v=DVOJ-SAOqJQ&feature=related>

SP Popcorn. <http://m.youtube.com/watch?feature=fvwrel&v=hUIjYYLLXhs>

SP revolution <http://m.youtube.com/watch?v=qurqDSMF-nk>

# Solar 2

[Nanosolar: Solar Power at a Lower Cost](#)

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[Boosting Solar Cell Power](#)

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