

## Summary of Selected Technology Advances

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### 1. National Renewable Energy Laboratory (NREL)

The National Renewable Energy Laboratory is an interesting place if you have an interest in renewable energy. The lab is located on the west side of Denver, Colorado, and if you are in the area it definitely is a place to visit. If you can't visit directly, then visit their web site at <http://www.nrel.gov/overview/>. The following is an overview from their web site.



“The National Renewable Energy Laboratory (NREL) is the nation's primary laboratory for renewable energy and energy efficiency research and development (R&D).

NREL's mission and strategy are focused on advancing the U.S. Department of Energy's and our nation's energy goals. The laboratory's scientists and researchers support critical market objectives to accelerate research from scientific innovations to market-viable alternative energy solutions. At the core of this strategic direction are NREL's **research and technology development areas**. These areas span from understanding renewable resources for energy, to the conversion of these resources to renewable electricity and fuels, and ultimately to the use of renewable electricity and fuels in homes, commercial buildings, and vehicles. The laboratory thereby directly contributes to our nation's goal for finding new renewable ways to power our homes, businesses, and cars.

**R&D Expertise:** NREL's focused R&D capabilities are positioned to advance national energy goals by developing innovations to change the way we power our homes and businesses, and fuel our cars. Our R&D capabilities allow us to develop and advance renewable energy and energy efficiency technologies more effectively through the full R&D life-cycle—from basic scientific research through applied research and engineering; to testing, scale-up, and demonstration. NREL's R&D areas of expertise are:

- Renewable electricity
- Renewable fuels
- Integrated energy system engineering and testing
- Strategic energy analysis

**Technology Transfer:** A critical part of the Lab's mission is the transfer of NREL-developed technologies to renewable energy markets. NREL's Technology Transfer Office supports laboratory scientists and engineers in the successful and practical application of their expertise

and the technologies they develop. NREL's world-class R&D staff and facilities are recognized and valued by industry, as demonstrated through hundreds of collaborative research projects and licensed technologies with public and private partners. NREL's innovative technologies have also been recognized with 42 R&D 100 awards. The engineering and science behind these technology transfer successes and awards demonstrates NREL's commitment to developing and applying innovative renewable energy solutions for the nation's secure and sustainable energy future."

## 2. Compressed Air Driven Cars

Compressed air vehicles are being developed around the world. Below are a few articles to provide some insight on these vehicle developments.

What's Up with Compressed Air-Powered Vehicles?:

<http://www.theautochannel.com/news/2008/11/24/260043.html>



MDI's Mini FlowAir compressed air-powered car

"Recently, we were asked "What companies make Air Powered Cars?" Given all the noise that surfaced about 10 months ago concerning the state of this amazing technology we thought an update was needed.

There are at least three companies working on producing compressed air-powered vehicles. The most well-known is MDI, based in France. MDI is headed up by Guy Negre ([www.mdi.lu](http://www.mdi.lu)). It is MDI's company that has, or had, an agreement with Tata Motors (India) to bring an air car to market. MDI (with an American affiliate) exhibited a working prototype of the car at last Spring's NY Auto Show, where it won an award for innovation. When Guy Negre originally made his deal with Tata Motors it was said that the vehicle would be ready for distribution in some global markets by 4th quarter of this year (2008). So far there's no sign of it, and the status of his relationship with Tata is unknown.

For several years, Guy Negre had an associate in Spain, Miguel Celades Rex, but a business dispute ended their relationship. Miquel now runs Air Car Factories in Barcelona. ([www.aircarfactories.com](http://www.aircarfactories.com)).



Air Car Factories design 1



Air Car Factories design 2

At the beginning of 2008 Air Car Factories also announced that they would have a compressed air vehicle ready for the public at the end of the year. We had planned to visit the company two

months ago, in September, to test drive the vehicle, but we were informed that the vehicle was still just in design and that there were no working test cars.

Angelo Di Pietro in Melbourne, Australia ([www.engineair.com.au](http://www.engineair.com.au)) has developed an air-powered rotary engine that he has put to work on small utility vehicles.

Di Pietro had been a Wankel rotary engine mechanic in Stuttgart, prior to immigrating to Australia in 1971; hence his familiarity with rotary engines.



Angelo Di Pietro



Di Pietro's vehicles

While none of these innovators are really ready for prime-time, the concept and the technology appears to be more than just vapor-ware. Unfortunately, there's a lot more to bringing a new engine to market than just proving it works, you also have to have a manufacturing and distribution relationship with carmakers that are really interested in making it happen, and who aren't concerned that the new technology will make your other technology too obsolete or irrelevant."

### ***Rotary Engine***

Engineair's Ultra-Efficient Rotary Compressed-Air Motor - Elegant minimalist design eliminates most of the working parts traditionally associated with internal combustion engine; offers nearly 100% energy efficiency for a variety of transport and stationary applications by Mary-Sue Haliburton, Pure Energy Systems News, Copyright © 2006



EngineAir Motor Prototype

"Imagine a vehicle with nothing under the hood (or bonnet), no gearbox, no transmission, no carburetor or other fuel feeds. Yet it converts virtually all the energy fed to its motors into actual motion. With the elegance of absolute simplicity, this concept makes traditional internal-

combustion cars look like the Rube-Goldberg contraptions they are: using way too many parts and stages to do what is really a simple task.

All we have to do is to get wheels to turn, preferably with as little wasted motion and energy as possible.

By comparison, the traditional car's engine uses up to about 65% of the energy potentially available from the fuel, just to move all its parts such as pistons and cams, plus what is wasted generating excess heat. Then the transmission uses 6%, the accessory load 2% and idling losses come to about 11%, leaving about 16% of the energy actually engaged in making the wheels turn. Because of the weight of all these structures, the engine block, crankshaft, gears, transmission, etc., that 16% of the energy is having to move a vehicle weighing perhaps a ton and a half – which may have only one person sitting in it, weighing only 150 lb.

There is a lot wrong with that 100-year-old picture. It should be laughed off the road as unsuitable for the 21st century.

In Melbourne, Australia, an Italian-born mechanical engineer named Angelo Di Pietro has been experimenting for many years to find a more efficient design than the traditional reciprocating combustion engine. Inspired by his earlier work on Wankel rotary engines at Mercedes Benz in Germany, he pursued the notion of a rotary engine with fewer parts. Since his 1999 breakthrough, Di Pietro has been testing and perfecting his unique design which also eliminates traditional pistons and their housings. Though it weighs only 13 kilograms (28.6 lb), this rotary air motor is capable of powering a car without creating any pollution.”

The following article, “Zero Pollution compressed Air Car set for U.S. launch in 2010”, is from gizmag Automotive, February 29, 2008:



“The Zero-Pollution MDI Air Car, invented in France and licensed by Tata Motors in India, is coming to American shores. Zero Pollution Motors have announced they will begin taking reservations for the first U.S. deliveries in the next couple of months, but it will be 2010 before Americans get their first taste of the ingenious compressed-air motor, which runs to 35mph entirely on air, or uses a trickle of petrol to heat and compress more air to reach higher speeds up to 90mph. It'll cost next to nothing to run (how do 30,000km service intervals sound?), have a range of up to 1000 miles, and retail for well under US\$20,000.”

This article provides some overview information and pictures associated with the Indian air car: AIR CAR-FROM INDIA ([http://www.housejeanie.com/air\\_car.htm](http://www.housejeanie.com/air_car.htm))

“This is the same company who, a few months back, came out with a car that costs only \$2,500.00 new (but it's not available in the US, why does that not surprise me?). A non polluting vehicle that eliminates the reason to buy gasoline from off shore companies. How bad is that?

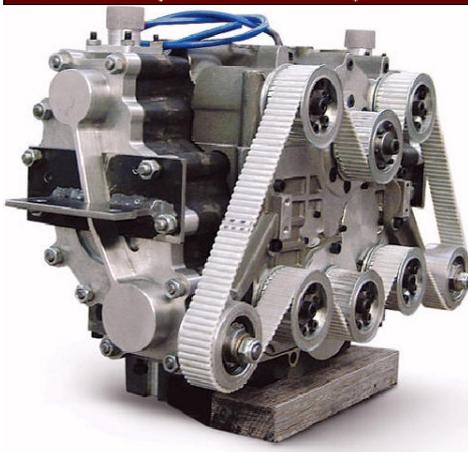
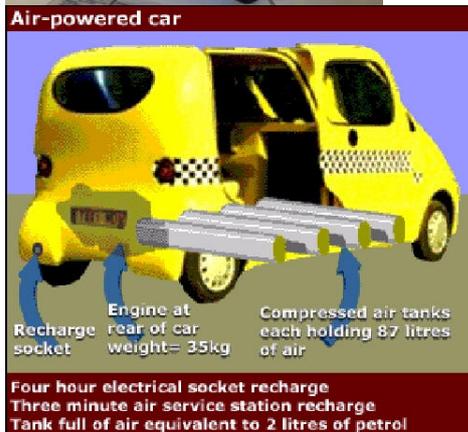
### **AMAZING AIR CAR!**

The Compressed Air Car developed by Motor Development International (MDI) Founder Guy Negre might be the best thing to have happened to the motor engine in years.

The \$12,700 CityCAT, one of the planned Air Car models, can hit 68 mph and has a range of 125 miles. It will take only a few minutes for the CityCAT to refuel at gas stations equipped with custom air compressor units. MDI says it should cost only around \$2 to fill the car up with 340 liters of air!

The Air Car will be starting production relatively soon, thanks to India's TATA Motors. Forget corn! There's fuel, there's renewable fuel, and then there's user-renewable fuel! What can be better than air?

Check it out yourself and see - What A Cool Car! Enjoy!





### 3. Hybrid Electric Vehicle

Hybrid electric cars are also making headway, and China's BYD (Build Your Dream) corporation is trying to bring their hybrid technology vehicles to the West. The following is an article, supplemented by a couple of BYD charts, that provides some information about their vehicle. Their hybrid vehicle greatly reduces the CO<sub>2</sub> emissions as compared to petroleum fueled vehicles.

**China's BYD Unveils Second Plug-in Hybrid Model at Geneva Motor Show; Plans to Begin Sales in Europe in 2-3 Years**, <http://www.greencarcongress.com/2008/03/chinas-byd-unve.html>

5 March 2008:

"China's BYD Co Ltd., which introduced its plug-in hybrid electric vehicle technology at the North American International Auto Show in January (earlier post) in the form of the F6DM (Dual Mode, for EV and HEV), has introduced another, smaller model using its hybrid powertrain at the Geneva Motor Show: the F3DM.



*The F3DM.*

The F6DM shown in Detroit, a variant of the front-wheel drive F6 sedan that BYD introduced into the China market earlier this year, offers three modes of operation: full battery-powered EV mode driving its 75 kW, 400 Nm motor; series-hybrid mode, in which a 50 kW, 1.0-liter engine drives a generator as a range-extender; and parallel hybrid mode, in which the engine and motor both provide propulsive power.

Wang Chaunfu, BYD's Chairman, said that the company planned to introduce a dual-mode sedan in Europe as early as in 2010.

*"Battery technology is our core competency, and we think we are well-placed against GM and Toyota," he said, adding that BYD's dual-mode car could be driven 110 km on electricity before recharging.*



## BYD Dual Mode: F3DM

- ⊖ **Range:**
  - EV: 60 miles or 100 Km per charge (90% efficiency)
  - HEV: 200 miles (@ ~40 mpg)
- ⊖ **Battery Life:** 2000 cycles, 10 years
- ⊖ **Electricity consumption:**
  - 16 kwh per 100km
- ⊖ **Power:** 48Kw **0-60:** 10.5s
- Top Speed:** 100 mph
- ⊖ **Quick charge:** 50% in 10 min
- ⊖ **Overnight charge:** 110/220V outlet

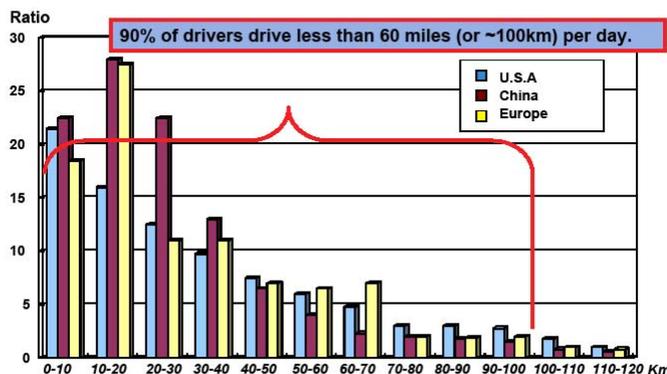


The F6DM shown in Detroit uses a 20 kWh lithium iron phosphate battery pack, based on BYD's own production cells (which the company calls its Fe cells). The pack, which runs down the center console, has a lifetime of 2,000 cycles. A 100% recharge with household 220 VAC takes approximately 9 hours. BYD says that the pack can achieve a 50% recharge in 10 minutes.

The company has said it will apply the DM technology across its product line.



## Average Driving Distance



BYD recently **celebrated** the opening of its engine plant and a new R&D center in Shenzhen. The design and testing of the core components of BYD's electric vehicle technology will be done in the new R&D center.”

### 4. Buckypaper

This new material is bringing international attention to its developers at Florida State University. The material looks like ordinary carbon paper, but it could revolutionize the way things are made.

The following article will provide some insight into this remarkable material: Stronger Than Steel, Harder Than Diamonds: Researcher Developing Numerous Uses For Extraordinary 'Buckypaper', <http://www.buckypaper.com/>

"Working with a material 10 times lighter than steel -- but 250 times stronger -- would be a dream come true for any engineer. If this material also had amazing properties that made it highly conductive of heat and electricity, it would start to sound like something out of a science fiction novel. Yet one Florida State University research group, the Florida Advanced Center for Composite Technologies (FAC2T), is working to develop real-world applications for just such a material.

Ben Wang, a professor of industrial engineering at the Florida A&M University-FSU College of Engineering in Tallahassee, Fla., serves as director of FAC2T ([www.fac2t.eng.fsu.edu](http://www.fac2t.eng.fsu.edu)), which works to develop new, high-performance composite materials, as well as technologies for producing them.

Wang is widely acknowledged as a pioneer in the growing field of nano-materials science. His main area of research, involving an extraordinary material known as "buckypaper," has shown promise in a variety of applications, including the development of aerospace structures, the production of more-effective body armor and armored vehicles, and the construction of next-generation computer displays. The U.S. military has shown a keen interest in the military applications of Wang's research; in fact, the Army Research Lab recently awarded FAC2T a \$2.5-million grant, while the Air Force Office of Scientific Research awarded \$1.2 million.

"At FAC2T, our objective is to push the envelope to find out just how strong of a composite material we can make using buckypaper," Wang said. "In addition, we're focused on developing processes that will allow it to be mass-produced cheaply."

Buckypaper is made from carbon nanotubes -- amazingly strong fibers about 1/50,000th the diameter of a human hair that were first developed in the early 1990s. Buckypaper owes its name to Buckminsterfullerene, or Carbon 60 -- a type of carbon molecule whose powerful atomic bonds make it twice as hard as a diamond. Sir Harold Kroto, now a professor and scientist with FSU's department of chemistry and biochemistry, and two other scientists shared the 1996 Nobel Prize in Chemistry for their discovery of Buckminsterfullerene, nicknamed "buckyballs" for the molecules' spherical shape. Their discovery has led to a revolution in the fields of chemistry and materials science -- and directly contributed to the development of buckypaper.

Among the possible uses for buckypaper that are being researched at FAC2T:

- If exposed to an electric charge, buckypaper could be used to illuminate computer and television screens. It would be more energy-efficient, lighter, and would allow for a more uniform level of brightness than current cathode ray tube (CRT) and liquid crystal display (LCD) technology.
- As one of the most thermally conductive materials known, buckypaper lends itself to the development of heat sinks that would allow computers and other electronic equipment to disperse heat more efficiently than is currently possible. This, in turn, could lead to even greater advances in electronic miniaturization.
- Because it has an unusually high current-carrying capacity, a film made from buckypaper could be applied to the exteriors of airplanes. Lightning strikes then would flow around the plane and dissipate without causing damage.
- Films also could protect electronic circuits and devices within airplanes from electromagnetic interference, which can damage equipment and alter settings. Similarly,

such films could allow military aircraft to shield their electromagnetic "signatures," which can be detected via radar.

FAC2T "is at the very forefront of a technological revolution that will dramatically change the way items all around us are produced," said Kirby Kemper, FSU's vice president for Research. "The group of faculty, staff, students and post-docs in this center have been visionary in their ability to recognize the tremendous potential of nanotechnology. The potential applications are mind-boggling."

FSU has four U.S. patents pending that are related to its buckypaper research.

In addition to his academic and scientific responsibilities, Wang recently was named FSU's assistant vice president for Research. In this role, he will help to advance research activities at the College of Engineering and throughout the university.

"I look forward to bringing researchers together to pursue rewarding research opportunities," Wang said. "We have very knowledgeable and talented faculty and students, and I will be working with them to help meet their full potential for advancement in their fields."

## 5. Getting to Root Cause – Why the 5 Why's?

Added for a little change in pace, but very usable.

Source: [http://www.mindtools.com/pages/article/newTMC\\_5W.htm](http://www.mindtools.com/pages/article/newTMC_5W.htm)

"The 5 Whys is a simple problem-solving technique that helps users to get to the root of the problem quickly. Because it is so elementary in nature, it can be adapted quickly and applied to most any problem. The strategy involves asking: "Why?" and "What caused this problem?" multiple times (can be more or less than five) until reaching the true root cause.

Here is an example of the **5 Whys in action**:

The Jefferson Monument was disintegrating.

**Why?** Use of harsh chemicals

**Why?** To clean bird mess

**Why so many birds?** The birds eat the spiders around the monument

**Why so many spiders?** The spiders eat the gnats around the monument

**Why so many gnats?** They are attracted to the light at dusk

**Solution** Turn on the lights at a later time

As you can see, many times the solution to a problem doesn't require a great deal of resources. Try out the 5 Whys the next time you need to solve a problem!"