Bob Fozzard

22 OCT 2009

19th October 08

THE SENATE
Senate Select Committee On Fuel and Energy
Suite SG.60 PARLIAMENT HOUSE
PO Box 6100
PARLIAMENT HOUSE
CANBERRA
ACT 2600

Attention: Ms Roxane Le Guen. Committee Secretary,
Inquiry into Fuel and Energy

Subject: Additional Supporting Documents

Further to my submission to the Inquiry into Fuel and Energy, I attach additional supporting information for consideration by the Committee.

The additional supporting information is in the form of the following extracts:

Publication: Popular Mechanics September 2008.

THE SHAPE OF FUELS TO COME [Pages 56 to 64] By Jennifer Bogo

Publication: Government News October 2008.

Myriad benefits from Aussie bio-fuels. [Page 40]

Heavy haulage is a gas. [Page 38]

Call for action on fuel hike. [Page 38]

Publication: New Scientist 13 September 2008

Super-Foods wanted [Page 18]

Publication: AIAST News Release

GM Crops; Risk and Benefits. [Sydney Conference 12 November 08]

Yours Sincerely

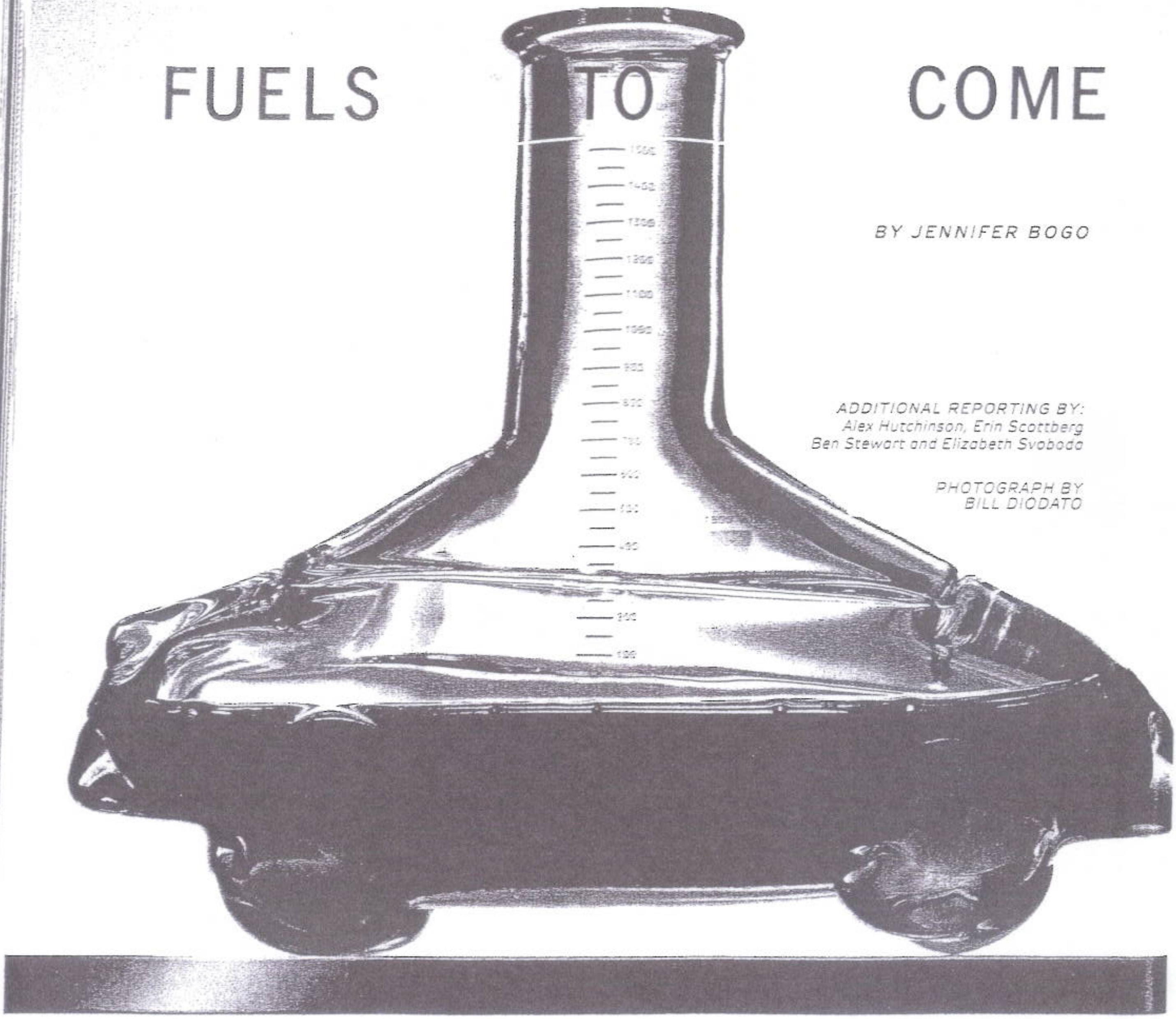
Bob Fozzard

THE SHAPE OF FUELS TO COME

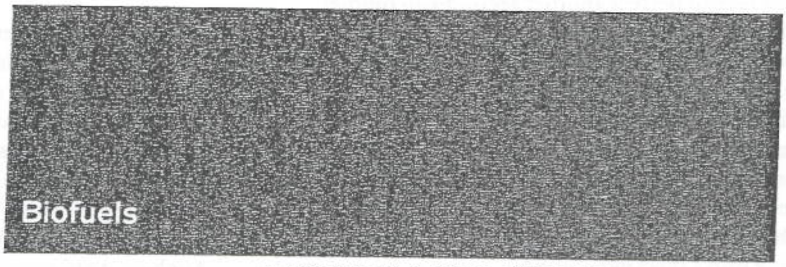
BY JENNIFER BOGO

ADDITIONAL REPORTING BY:
Alex Hutchinson, Erin Scottberg
Ben Stewart and Elizabeth Svoboda

PHOTOGRAPH BY
BILL DIODATO



AMERICANS BURNED THROUGH MORE THAN 142 BILLION GALLONS OF GASOLINE LAST YEAR—SOME 16 MILLION GALLONS AN HOUR. IT'S AN EXPENSIVE HABIT AT OVER $4 (AND 20 POUNDS OF CO_2 EMISSIONS) A POP. NO WONDER THE MARKET HAS NEVER LOOKED BETTER FOR ALTERNATIVES SUCH AS BIOFUELS, ELECTRIC CARS AND HYDROGEN. AND THE TECHNOLOGIES ARE FINALLY CATCHING UP.



Biofuels

IT'S BEEN A LONG SUMMER. With world crude oil prices at record highs, the seasonal fuel crunch has been particularly painful. The decade has been full of long summers, each worse than the last: The average price of gas has jumped at least 20 cents a gallon every year since 2002—and this year it's projected to soar by more than $1 a gallon (diesel, nearly a dollar and a half). Drivers are no longer hoping for a reprieve: They're looking for other options.

Three years ago, corn-based ethanol seemed like a no-brainer. It exploited a crop we were already good at growing with a process we'd been using since the colonists brewed beer. To stimulate the fledgling industry, the government mandated the increased use of renewable fuels. Last year it upped the standard to 36 billion gal. by 2022.

In one sense, the mandate worked. Last year, U.S. plants churned out 6.5 billion gal. of ethanol and 250 million gal. of biodiesel. But with about 21 percent of the country's corn harvest and 13 percent of its soy diverted to biofuel production, food prices surged. And oil imports barely dropped. What's more, recent studies revealed that biofuels derived from food crops don't alleviate climate change. Once you add up all the energy used to fertilize, transport and process feedstock, and the vast amount of carbon released by converting land to grow it, "You suddenly have a biofuel that releases more greenhouse gas than if you just burn gasoline," says David Tilman, an ecologist from the University of Minnesota. "It actually harms the global climate."

So the quick fix backfired, proving that fossil fuel replacements will not be fast and cheap but will come on line slowly—and become cost-effective gradually, as the market shifts. The skyrocketing price of gas added urgency to the efforts of researchers already working on more promising technologies, from improved electric vehicles to new ways of harnessing hydrogen.

Scientists have also been chipping away at a second generation of biofuels—one made from feedstocks that grow well on degraded land, without the heavy input of fertilizer and water, or from waste products that don't use land at all. "We really need to understand the life-cycle impact of the fuels we're producing," says Lena Hanson, a senior consultant for the Rocky Mountain Institute's Energy & Resources Team. "It's incredibly important to recognize that not all biofuels are created equal."

The sugar in these new feedstocks, such as prairie grass and sawdust, is locked up in lignocellulose—a compound more complicated and expensive to break down than corn kernels. "We know how to do it," Hanson says. "The challenge companies now face is trying to find the process or the enzyme that will make it cost-effective." Several claim to be getting close. SunEthanol in Massachusetts has discovered a microbe that can convert organic matter directly into ethanol, consolidating several costly steps. Illinois-based Coskata first uses 5000 F plasma-torch technology to turn virtually any carbon-based material, including garbage, into a synthesis gas, increasing yields.

The race to perfect another second-gen biofuel, biodiesel from algae, has also become increasingly crowded, but the payoff, if it happens, promises to be huge. Oil yields from algae can be a hundred times that of soy. Plus, waste CO_2 is algae's main feedstock, so the process has the potential to reduce greenhouse-gas emissions.

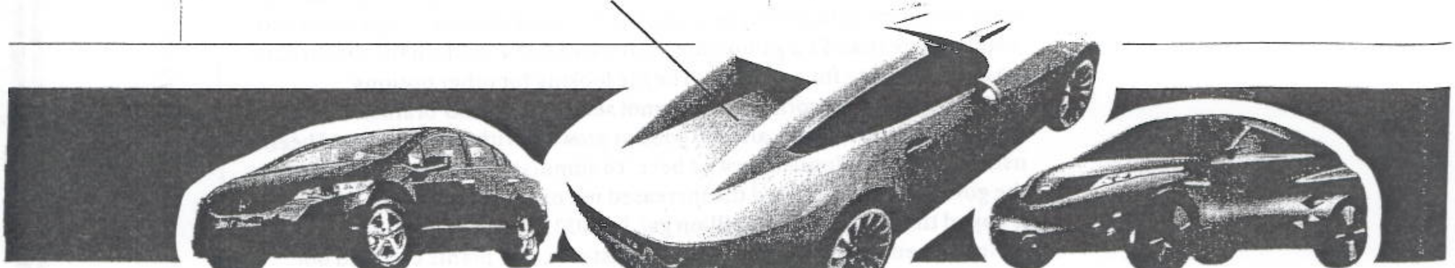
A handful of companies are now pushing into a third generation—biofuels that act like fuels we already use. "Biology is very good at making specific molecules," says Neil Renninger, co-founder of Amyris Biotechnologies, which has engineered yeast to turn sugar into hydrocarbons. "The molecule we produce is actually in diesel. On top of that, it is designed to have all the best attributes of diesel." So not only will it drop into today's infrastructure, it packs roughly the same energy as its petroleum counterpart while burning more efficiently.

Tilman estimates the U.S. can sustainably generate about 500 million tons of dry biomass annually; that's enough to produce 40 to 50 billion gal. of ethanol, which would displace a quarter of today's gasoline consumption. But while manufacturing vehicles to run on ethanol is easy—there are roughly 60 models for 2008 that can accept E85—biofuel companies have yet to prove they can scale up to meet the challenge. And they won't, for at least three more years. "This is not going to be the quick fix," says Dan Kammen, director of the Renewable and Appropriate Energy Lab at the University of California, Berkeley. "It's going to be part of a longer strategy to diversify our fuels away from gasoline, while at the same time toward fuels that are good on greenhouse gases."

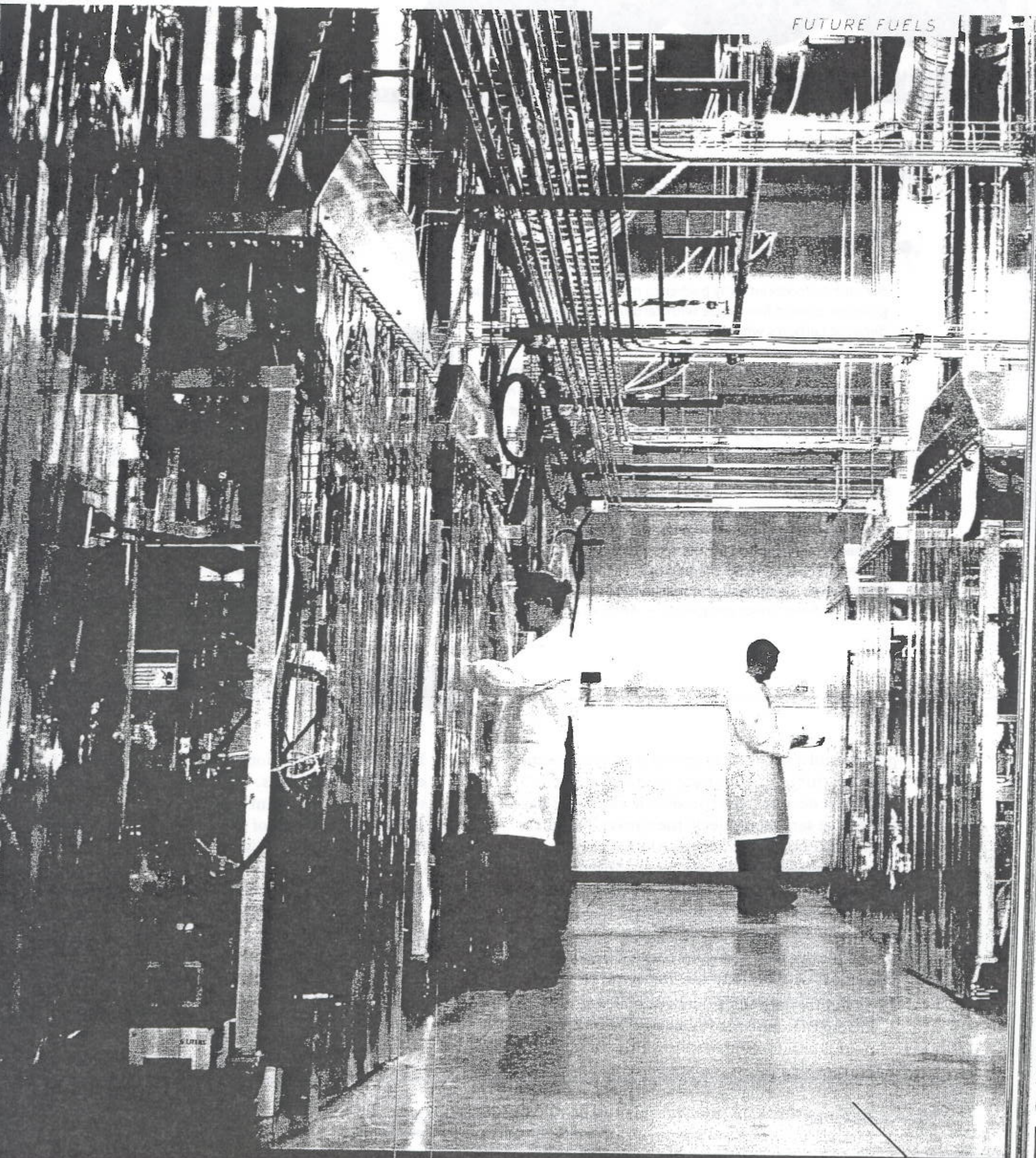
In the meantime, Kammen's lab has analyzed one more way to exploit biofuels: Skip the liquid fuel stage entirely. Gasifying biomass could produce electricity to flow directly into the grid, facilitating another transportation alternative—electric vehicles.

Electric Vehicles

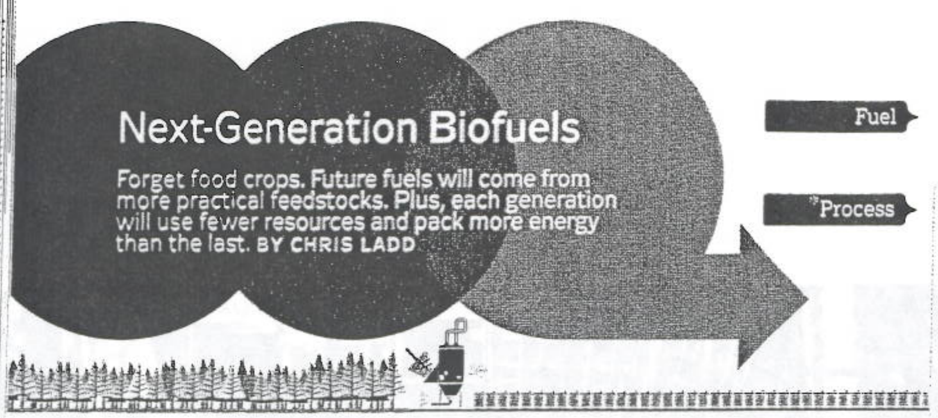
IN THE NEXT TWO years, a flurry of electric vehicles will hit the mass market, finally putting several years' worth of R&D in the hands of consumers. By 2010 Mercedes-Benz plans to offer an all-electric version of the Smart, and both Nissan and Mitsubishi plan to introduce electric models. Besides taking advantage of existing infrastructure, using off-peak electricity to charge these cars at night "shifts our fuel from mostly foreign oil to domestic sources like coal, wind and natural gas," says Michael Webber, associate director of the Center for International Energy & Environmental Policy at the University of Texas at Austin. "It also shifts the environmental impact from 300 million tailpipes to 1500 power



Left to right: Honda's hydrogen-powered FCX Clarity, rolled out in California; the pure-EV Lightning GT, on preorder in the U.K.; Nissan's all-electric Mixim, still a concept car.



Small-scale pilot plants in Virent's Madison, Wis., laboratory use catalysts to turn biomass into biogasoline. It provides the same energy as regular gas and can run in existing engines.



Next-Generation Biofuels

Forget food crops. Future fuels will come from more practical feedstocks. Plus, each generation will use fewer resources and pack more energy than the last. BY CHRIS LADD

	CELLULOSIC ETHANOL *(Biological method)*	CELLULOSIC ETHANOL *(Gasification method)*
Fuel	CELLULOSIC ETHANOL *(Biological method)*	CELLULOSIC ETHANOL *(Gasification method)*
*Process	Raw biomass is typically ground up and pretreated in an acid steam bath before soaking in a massive hot tub for several days. Enzymes break down rigid cellulose into simple sugars like xylose, similar to the sweetener in toothpaste, which can be fermented by yeast or bacteria; it is then distilled into fuel-grade ethanol.	Cornstalks, garbage and even old tires are blasted with several-thousand-degree heat in an anaerobic chamber. With no oxygen, biomass can't combust. Instead, feedstocks break down into carbon monoxide, hydrogen and carbon dioxide. This synthesis gas, or syngas, is cleaned, cooled and either ingested by bacteria or mixed with catalysts to produce ethanol and other alcohols.
Bottom Line	Fermenting cellulose currently involves a lot of water and several time-consuming steps, adding to expense. The first commercial facility is expected to open in Iowa by late 2011.	This method uses substantially less water and provides greater yields, but it has yet to be scaled to levels that compete with the ethanol fermentation industry. Plants are set to open in Pennsylvania and Georgia in late 2009.
**Freshwater Usage		
Innovators	*Logen (backed by Shell), POET, SunEthanol, Verenium*	*Coskata (backed by GM), Range Fuels*
***Energy Yield	66%	66%

The Chemistry in Your Tank

Somebody once asked Clyde Barrow why he robbed banks. He's said to have replied: "Because that's where the money is." Obviously.

Now, with all the emphasis on reducing our carbon footprint, why bother to make biofuels that mimic gasoline, a liquid fuel dense with carbon and hydrogen? Because carbon's where the energy is. Specifically, in the bonds between carbon atoms.

• **BACK TO BASICS:** We add oxygen to fuels to combust them. When the molecular bonds in the fuel break and new bonds form with oxygen atoms, we get water (H_2O) and carbon dioxide (CO_2). We also get energy released as heat. Breaking the bonds between carbon atoms provides more heat than breaking the bonds between hydrogen and carbon atoms, or those between hydrogen atoms alone.

Gasoline and diesel fuel are a rich potpourri of large molecules consisting of long chains of hydrocarbons. By comparison, ethanol and butanol are alcohols made up of smaller, simpler molecules with fewer high-energy carbon-carbon bonds. These fuels are not as energy-dense. That adds up to fewer miles per gallon. — *MIKE ALLEN*

plants. And if you want to mitigate environmental impacts, this is an important way to go about it."

But for decades, electric-vehicle engineers have been hitting the same roadblock: the battery. Pound for pound, lithium-ion batteries—the EV gold standard—currently pack less than one twenty-fifth the energy of gasoline, leading to short vehicle ranges and long recharge times. In June, presidential candidate John McCain underscored the magnitude of the problem with his proposed Clean Car Challenge, which would award $300 million to the developer of any car battery tech that significantly hikes energy density and lowers cost.

Still, thanks to a slew of recent breakthroughs, experts have begun to question the notion that EVs will forever be automotive sidekicks. "There's been a big renaissance with respect to lithium-ion battery technology," says Don Hillebrand, director of the Center for Transportation Research at Argonne National Laboratory. "Laptops and cellphones have been pushing the technology forward, and now we're learning how to scale those principles up."

Leading the charge is North Carolina–based Superlattice Power, which in June announced development of a cathode material designed to boost the energy density of lithium-ion batteries. The material consists of nanospheres closely linked in a lattice configuration, allowing engineers to squeeze more capacity into smaller spaces.

ILLUSTRATION BY DOGO

* May vary slightly from company to company.

** Gallons per gallon of fuel, based on early projections; amount may vary depending on final production process.

*** Compared to a gallon of gasoline.

ALGAL BIODIESEL

Specially selected or genetically modified strains of algae are grown in enclosed bioreactors—tubes or plastic bags filled with water—and fed waste CO_2 from heavy emitters like coal-fired power plants, cement kilns or breweries. The algae are then separated from water by centrifuge, and the oil is extracted with a solvent. It is then processed in high-temperature and high-pressure conditions to convert the oil to biodiesel.

Algae produce thousands of gallons more oil per acre than crops such as soy or palm, but growing and processing them at scale still present challenges. A number of U.S. facilities are slated to come on line by 2012.

GreenFuel, HR Biopetroleum (backed by Shell), Solazyme, Solix

103%

GREEN GASOLINE

Simple sugars—either derived from breaking down tough, cellulosic feedstocks or from sources such as sugarcane—are reacted over solid catalysts to remove the oxygen locked inside their molecules and form high-energy hydrocarbons. Like crude run through traditional refineries, raw sugar feedstocks are separated to create the range of molecules in the fuels we know as gasoline, diesel and jet.

Green incarnations of today's fuels are the holy grail, but until cellulose can be cheaply converted to simple sugars, domestic potential will be limited. Virent hopes to have its gas in car tanks by 2012.

Virent (backed by Shell and Honda)

100%

BIOBUTANOL

Like ethanol, biobutanol is fermented by microorganisms from sugars, which are broken down from raw feedstocks and mixed with water. But for this process, the microbes have been genetically modified to produce an alcohol with a longer chain of hydrocarbons. Since butanol doesn't mix with water at high concentrations, the finished fuel can be stored easily and transported within existing gasoline pipelines.

Butanol is the rocket fuel of alcohols, but it has traditionally been derived from petroleum. Plants to produce it cheaply from renewable sources by 2012 are in the works in the U.S. and U.K.

N/A

Cobalt Biofuels, Dupont (backed by BP), Gevo, Tetravitae Bioscience

90%

DESIGNER HYDROCARBONS

By swapping out natural genes for synthetic ones, scientists trick microorganisms such as *E. coli* and yeast into converting simple sugars to diesel, gasoline and jet fuel instead of into fats or alcohols. As in traditional ethanol production, microbes ferment the sugars (in this case, from sugar cane) in a slurry, but since finished fuels don't mix with water, the hydrocarbons are easily separated by centrifuge without expensive distillation.

Designer fuels are ready to drop into engines, but unless they're made in a closed-loop system, they're water-intensive. The first commercial plant will be located in Brazil and is expected to start producing diesel in 2010.

LS9, Amyris

106%

FOURTH-GEN FUEL

Scientists have genetically engineered algae not just to turn CO_2 into oil, but to continuously excrete that oil directly into the surrounding water. Since oil floats, harvesting it becomes simple work compared with the energy-intensive drying and extraction traditionally used for typical algae, which store oil within their cell walls. As with second-generation methods, the oil can then be processed into biodiesel.

If they can perform at scale, these mutant algae may well be game changers. Synthetic Genomics hopes to have commercial amounts of biodiesel on the market within five years, though no plants have been built yet.

Synthetic Genomics

103%

It also promotes speedy ion diffusion, meaning a faster charge and discharge. A123 Systems, a battery supplier headquartered in Massachusetts, is experimenting with nanoscale chemical and structural tweaks as well.

General Electric's Global Research division is taking the alternate tack of refining an energy-storage system that switches between two batteries. One is optimized for raw power—how fast energy can flow in and out of the cell—while the other packs a large amount of energy into a small space. "As you step on the gas to accelerate, you want a battery with a high power density," says GE engineer Vlatko Vlatkovic. "After that, if your speed is constant, you want high energy density. With an intelligent system like this, you can reduce cost and increase range." Mitsuhiko Yamashita, Nissan's executive vice president for research and development, predicts that average electric-vehicle ranges will rise to more than 200 miles by 2015 (they currently hover at around half that).

Though technological barriers are starting to lift, substantial economic and practical ones remain. Andy Burke, an electric-hybrid vehicle engineer at the University of California, Davis, estimates that today's lithium-ion batteries cost about $1000 per kilowatt-hour. Even reducing that figure by 50 percent to account for upgrades and scaled production, the battery for a car that meets the magic 200-mile-range mark would cost

$15,000. Considering that battery packs may need to be replaced at least once over a car's lifetime, that translates into a hefty investment—one out of range for many buyers. Startup company Project Better Place aims to address that problem in Israel by offering an inexpensive battery-lease plan.

Cramming more capacity into EV batteries also carries a suite of attendant risks. While most experts agree that lithium-ion batteries are a vast improvement over the nickel-metal-hydride packs that appear in hybrids like the Toyota Prius, lithium's flip side is its potential for instability. As a lithium-ion battery ages, its negative electrode chemically reacts with the electrolyte, potentially touching off a heat-generating "thermal runaway" event that could send the car up in flames. "You can get around that by having a battery-management system where you monitor every cell of the battery," Burke says, "but then you run into the cost issue again."

Upcoming plug-in hybrids like the Chevy Volt offer drivers the option of falling back on their gas tanks. But they also shoulder the double burden of two power plants—one for gasoline and one for electricity. In order to offset the weight, which restricts range, most models will be compact cars. Urbanites may love them, but big families plotting a multistate vacation may never find the flexibility they need in an electric vehicle—which means that improvements to battery packs may ultimately pay off in hydrogen cars.

EXPERTS HAVE BEGUN TO QUESTION THE NOTION THAT ELECTRIC VEHICLES WILL FOREVER BE AUTOMOTIVE SIDEKICKS.

Hydrogen

WHEN PRESIDENT Bush announced the $1.2 billion Hydrogen Fuel Initiative in 2003, fuel cells were the talk of the alt-fuel world. Startups blossomed; research money flowed. "It was like a little dot-com bubble," recalls Keith Wipke, an engineer with the National Renewable Energy Laboratory. "Only it never really burst." Public interest faded, but research plodded along—so slowly that, in order to protect itself from the long timeline to commercialization, hydrogen pioneer Ballard Power sold its automotive fuel cell division to Daimler and Ford in January.

So the splashy production debut of Honda's fuel cell–powered FCX Clarity in June caught many by surprise. A four-passenger sedan with a range of 280 miles per tank of hydrogen and efficiency equivalent to 74 mpg, the FCX Clarity will be leased for $600 a month to 200 people in California and Japan. General Motors, meanwhile, has ordinary drivers testing 100 fuel cell–powered Chevy Equinoxes in New York, Washington, D.C., and California. And Toyota's fuel cell–electric hybrid, the FCHV-adv, with a groundbreaking single-tank range of over 500 miles, will be available for lease in Japan later this year.

In other words, fuel cells have exited the lab. These new models "have all proved to be 'real' vehicles," says Larry Burns, GM's vice president for R&D. That brings new urgency to an old question: Will there be an infrastructure capable of supporting them? The three large hurdles—production, distribution and storage—remain, despite a surplus of bright ideas.

The Department of Energy has been funding 69 different projects for production alone, ranging from gasification of poplar wood slurry to nuclear-heated electrolysis of water. A pair of renewable approaches has generated particular excitement: University of Colorado researchers will use a "high-flux solar furnace" to heat biomass to more than 2000 F, generating a gas that's easily converted to hydrogen. And several groups are harnessing bacteria that use photosynthesis to produce hydrogen with sunlight.

But for now, most hydrogen will continue to be made from natural gas, as it will be at the public refueling station—a joint venture between GM and Clean Energy Fuels Corp.—that is opening near Los Angeles International Airport this fall. DOE data indicate that hydrogen produced at such distributed sites currently costs $3.90 per gallon of gasoline equivalent, which means it's already cost-competitive.

Because of hydrogen's low density, the real sticking point appears to be storage. "Even at 10,000 psi, it's hard to pack enough hydrogen gas into a normal-size car to get a 300-mile range," says Salvador Aceves, a researcher at Lawrence Livermore National Laboratory. Liquid hydrogen, which has to be kept at minus 423 F, is three times denser than compressed gas; BMW's Hydrogen 7 car runs on it. But liquid hydrogen gradually boils off, leaving infrequent drivers with the prospect of an empty tank. Aceves's group recently demonstrated a new "cryogenic pressure" tank that holds liquid hydrogen, but can also retain gas that boils off—a development carmakers are keeping their eyes on.

The ultimate goal for improved safety and longer range is "solid-state" storage, using compounds that can trap hydrogen in solid form and release it on demand. The problem is finding a compound that can absorb enough hydrogen in a short time (the DOE wants fill-ups to take 3 minutes) and release it into the fuel cell without requiring extreme heat. Independently, progress toward each of these goals has been steady, says Lennie Klebanoff of Sandia National Laboratories—but uniting all the properties in one material has been elusive.

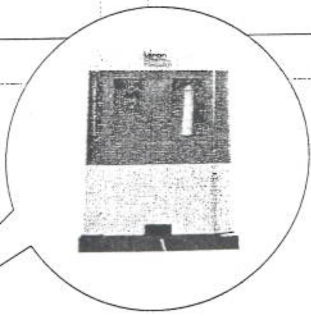
Though some hydrogen cars are on the street, it's going to take time before they're a presence on the lot. Even Honda's FCX Clarity is not nearly ready for mass production. Stephen Ellis, American Honda's manager of fuel cell marketing, estimates it will be 10 years before the cost comes down to the level of a luxury car. Drivers may have to wait even longer for infrastructure that can deliver hydrogen when and where they want it.

The basic technology for next-gen biofuels and EVs, on the other hand, is already in place. In the nearer term, "Biofuels coupled with what could be fairly dramatic efficiency improvements in a plug-in hybrid really take us into a new world of fuel economy," says David Cole, chairman of the Center for Automotive Research—on the order of 400 mpg of gasoline, if the liquid fuel used is E85. Plug-ins designed to use either a fuel cell or combustion engine could maximize the potential of all three technologies.

The Rocky Mountain Institute estimates that America's automotive fleet will have completely turned over by 2040. By then, the optimized vehicles that will have evolved from today's labs could sustain U.S. mobility using only domestic oil, along with homegrown renewable fuels and electricity. No matter what combination these alternative technologies are used in, everyone agrees on one point: They will all be needed to forge a path toward truly sustainable transportation. PM

DIY Fuel

Ready to make your own gas alternative? These products can give you a start—but energy independence won't come cheaply.



Ethanol

The **EFuel100 MicroFueler** home-brews ethanol by fermenting a mix of table sugar and nutrient-treated yeast in the system's 250-gal. tank. The resulting fuel, which is 99.9 percent ethanol, can either be stored in the unit or pumped into a gas tank through the 50-ft. hose. It takes 10 to 14 pounds of sugar to produce 1 gal. of ethanol, so the cost of fuel is only as cheap as the feedstock. Available in late 2008.

PRODUCTION
Up to 35 gal. per week
PRICE
$9995
COMPATIBILITY
Flex-fuel vehicles; conventional cars if mixed with 90 percent gasoline

Biodiesel

Powered by a 120-volt outlet, the **FuelMeister II** mixes used vegetable oil with lye and methane to produce biodiesel. The process takes about 7 hours from start to finish—but only 1 hour involves hands-on work, such as connecting hoses, pumping methane and testing the final product. The fuel meets ASTM biodiesel standards and, unlike straight vegetable oil, can be burned in regular diesel engines.

PRODUCTION
40 gal. in 5 hours
PRICE
$2995
COMPATIBILITY
Any diesel-powered vehicle

Electricity

The modular **Envision Solar Lifeport** can support up to 32 polycrystalline 200-watt photovoltaic panels, which can produce up to 6.4 kilowatts of electricity. The panels are wired to an inverter, and then through your home's electric meter. With this configuration the panels will power your home, but DIYers can mod the Lifeport into a solar-powered carport by running electricity back to an outlet in the 23 x 23–ft. structure.

PRODUCTION
Up to 6.4 kw
PRICE
$45,199 for a 4.8-kw-rated kit
COMPATIBILITY
Plug-in hybrids and pure EVs

Hydrogen

A mix of natural gas, air and water is catalyzed in the **Honda Home Hydrogen Fueling Station** reformer, creating a gas that is 40 to 50 percent hydrogen. A membrane filters out pure hydrogen gas, which is then compressed for fuel. There's no storage tank, so your car slow-fills from the pump at night; it takes about 6 hours to reach max capacity—171 liters at 5000 psi. The catch: Hydrogen from gas isn't emissions-free, and Honda says consumers still have a several-year wait.

PRODUCTION
50 standard liters per minute
PRICE
Not yet available
COMPATIBILITY
Hydrogen cars

Myriad benefits from Aussie biofuels

> Australia could develop a sustainable biofuels industry without forcing up food prices according to a new report.

The report provides an encouraging outlook for second-generation biofuels that could reduce Australia's reliance on oil, add value to agricultural industries without impacting on food crops and develop new opportunities for rural communities.

Future Biofuels for Australia, produced by CSIRO for the Rural Industries Research and Development Corporation (RIRDC), provides an outline of the current state of lignocellulosics, or second-generation, biofuel development in Australia and highlights areas in need of further research.

Second-generation biofuels use non-food plant materials such as wheat straw, sugar cane bagasse, native grasses, plantation waste, newsprint, wood and cotton trash as their feedstock. These products can be specifically harvested or diverted from landfill into biofuel production.

RIRDC's general manager, new rural industries, Roslyn Prinsley, said the report concluded that while more research needed to be done, the signs were encouraging.

"Internationally there is significant funding being put into these technologies, from basic research and development through to pilot and commercial scale plants," Dr Prinsley said.

"Australia has a modern, technologically savvy farm sector that could benefit from the development of new regional industries based around non-food biofuel crops.

"Rural communities also have the opportunity to explore options for growing energy crops such as oil mallees and woody shrubs and perennials on underutilised or less-productive land. New jobs could also be created in rural areas from these industries. Perennial species also have environmental benefits such as salinity prevention and native species can have biodiversity benefits."

Report authors, CSIRO's Victoria Haritos and Andrew Warden from the Energy Transformed Flagship, said Australia was well placed for a lignocellulosic biofuels industry.

"The advantages of having a lignocellulosic biofuels industry are that the source materials are relatively cheap, domestically available, are less likely to divert resources from food production and can add value to existing rural industries and commodities."

Dr Haritos said Australia's efforts in developing second-generation biofuels were modest by international standards and the report identified areas where further research was needed, including biomass availability and sustainable harvest; potential for new biofuel crops; pre-treatment and processing technologies; life cycle assessment and technical and economic modelling; and integrated biorefineries where biobased products such as plastics, packaging, chemicals from lignin and sugar, char, and plant oil can be produced alongside biofuels and bioenergy.

Heavy haulage is a gas

LNG Refuellers Pty Ltd, a consortium comprising seven Tasmanian transport operators, recently announced a deal with industrial gas company BOC for the supply of LNG fuel for more than 120 natural-gas–powered heavy vehicles in Tasmania.

According to the chairman of LNG Refuellers Pty Ltd, Ken Padgett, the project will result in the establishment of the first commercial pipeline-to-truck supply for heavy vehicle transport in Australia.

"We have formed a new refuelling company that will own and operate a network of six commercial LNG (liquefied natural gas) refuelling stations across Tasmania to manage the fuel logistics needs of most Tasmanian fleets on the major freight routes," he said.

Unlike oil, the plentiful supply of natural gas in Australia helps maintain a stable price making it an ideal fuel for heavy transport. LNG releases up to 25 per cent less greenhouse gases compared to diesel-powered trucks.

"With rising fuel prices and the long-term security of oil supplies under question we began looking for alternate fuels," Mr Padgett said.

"Our investigation led us to the conclusion that natural gas provides an effective overall solution from a commercial, economic and environmental perspective. This deal represents a $150 million vote of confidence in the commercial merits of natural gas as an alternative to wholesale use of diesel fuel for road transport in Tasmania."

BOC, part of the Linde Group, is a market innovator in the design, construction and operation of micro-LNG plants for the domestic transport market.

To secure the LNG supply, BOC will build and operate a new micro-LNG plant near Westbury, subject to securing all necessary planning and development approvals. BOC became the first company in Australia to produce LNG when it established its Dandenong facility almost 30 years ago.

BOC will also design and construct the entire supply chain infrastructure for LNG Refuellers including LNG road tankers and six refuelling stations.

"We are drawing on our global experience to implement a market leading solution," said Alex Dronoff, BOC's General Manager LNG.

"This alternate fuel is cleaner, which is a win for our customers and the environment. We look forward to working with LNG Refuellers to deliver clean and efficient fuel for the Tasmanian heavy transport sector."

He said the LNG plant would have the capacity to produce 50 tonnes of LNG a day, the equivalent of 70,000 litres of conventional diesel.

LNG Refuellers plans to provide briefings to potential customers in the Tasmanian transport industry over the next six months.

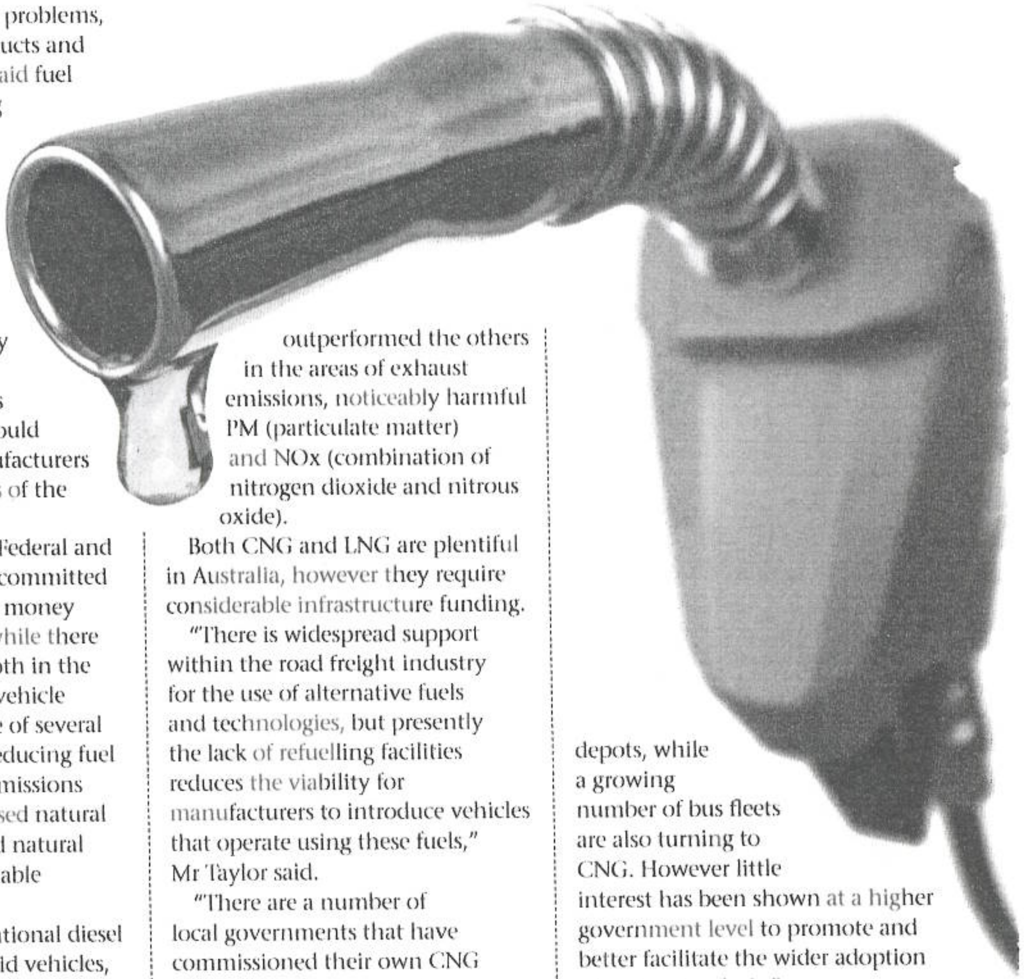
The announcement represented the culmination of more than two years of work involving Tasmanian transport operators with the Tasmanian Department of Economic Development, and experts in financial management and alternative fuels.

"This project would not have been possible without the hard work of the LNGR shareholders, the provision of resources by the Tasmanian Department of Economic Development and Tourism, and a $5.05 million grant provided through the Tasmanian Community Forest Agreement Industry Development Program, a joint Australian and Tasmanian government initiative," Mr Padgett said.

According to Alex Dronoff future market potential for LNG included transportation such as buses, trains and ferries and garbage trucks.

"In the US and the UK LNG has been shown to be used successfully in garbage trucks. In fact the application to the transportation sector is limitless," he said.

Call for action on fuel hike



> The Federal Government must take a greater leadership position on fuel pricing, reducing emissions and exploring the opportunities of alternative fuels, according to Isuzu Australia Limited director and CEO, Phil Taylor.

Mr Taylor said rising fuel prices were not only affecting all motorists every time they refilled, they were indirectly leading to a hike in the price of consumables, due to more expensive transportation costs.

"Unfortunately there is no magical panacea to address the problem of constantly rising fuel prices," Mr Taylor said.

"However it's something that governments should have begun tackling some time ago.

"As a result we now get band-aid remedies from both the Government and Federal Opposition – the idea of cutting fuel excise by five cents a litre or freezing the GST on fuel is about short-term politicking and not a long-term solution.

"We believe an important consideration is to lessen our dependency on fuels such as petro diesel."

Mr Taylor said that manufacturers had an expanding role to play in addressing some of these problems, by offering superior products and advanced technology to aid fuel efficiency while reducing emissions.

"Truck manufacturers are increasingly showing initiative in research and development to bring new, more environmentally friendly technologies to market, however to expedite this process, government should offer incentives to manufacturers as they do in other parts of the world," he said.

"Earlier this year, the Federal and Victorian governments committed a substantial amount of money to hybrid technology; while there is a niche for hybrids both in the automotive and heavy vehicle industries, it is only one of several potential solutions to reducing fuel costs and minimising emissions – fuels such as compressed natural gas (CNG) and liquefied natural gas (LNG) offer some viable alternatives."

Compared to conventional diesel and diesel-electric hybrid vehicles, the CNG-powered vehicle strongly outperformed the others in the areas of exhaust emissions, noticeably harmful PM (particulate matter) and NOx (combination of nitrogen dioxide and nitrous oxide).

Both CNG and LNG are plentiful in Australia, however they require considerable infrastructure funding.

"There is widespread support within the road freight industry for the use of alternative fuels and technologies, but presently the lack of refuelling facilities reduces the viability for manufacturers to introduce vehicles that operate using these fuels," Mr Taylor said.

"There are a number of local governments that have commissioned their own CNG refueling infrastructure at council depots, while a growing number of bus fleets are also turning to CNG. However little interest has been shown at a higher government level to promote and better facilitate the wider adoption of alternative fuels."

AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE AND TECHNOLOGY
Bringing The Elements Together

AIAST NSW Division & NSW Weed Society
Date: 12 November commencing 9.00
Topic: GM Crops Risk and Benefits
Presenters: Dr Rex Stanton, Professor Julian Cribb, Jonathan Benyei, Dr Suzanne Warick, Max Foster, Murray Scholz, Clare Hughes
Venue: Vibe Hotel, Milsons Point

GM technology is widely seen by many as a panacea for many of the challenges facing agriculture today. Others express concern that GM technology is being promoted without adequate research and development (R&D) to address the implications of the widespread use of GM crops in managing our future farming systems in a sustainable manner. Wider community concerns are also expressed on issues such as product labelling, health and legal protection for non- GM farmers. The NSW Division of the Australian Institute of Agricultural Science & Technology (AIAST) and the Weeds Society of NSW are jointly mounting this seminar to explore these issues. It is designed to present a balanced program that addresses the benefits, risks and concerns associated with the release of GM crops in Australia generally and in New South Wales in particular. The economics of growing GM crops, together with agronomic issues such as the risks of gene government to non-GM crops and weedy relatives, increased resistance to GM-tolerant weeds and shortcomings in research and development of GM crops will be explored.

The seminar room will be set up in cabaret-style to facilitate interaction and discussion among participants. This will limit bookings to 100 registrants only. Although bookings will be available until 1 November, we recommend booking early as Vibe Hotel is located adjacent to Milsons Point Railway Station, providing convenient travel by public transport. As we believe the available places will be taken quickly.

The Vibe Hotel is located adjacent to Milsons Point Railway Station (on Sydney Harbour Bride) and overlooks the harbour and its foreshores. It is therefore a

convenient location to reach by public transport and we recommend you travel to the venue by CityRail (Milsons Point station is immediately south of North Sydney on the North Shore Line). Accommodation is available at Special 'Conference Rates' of $190/room with breakfast – Phone 13 84 23.

Register via www.aiast.com.au Select Events Calendar; go to 12 November double click on GM Crops Seminar. Go to 'Book Now' at the bottom of the page and follow the prompts. Alternatively, a paper copy registration is available on the www.aiast.com.au home page. For further information, contact Bob McKillop (AIAST NSW Division Secretary), phone (02) 9958 4516 or email rfmckillop@bigpond.com or Warwick Felton (Weeds Society of NSW), phone: 0425 248 151.

Superfoods wanted

Research aimed at feeding the hungry needs to recognise that what we put in our mouths is just as important as how much, says **Matt Walker**

IT IS hard to ignore the fact that we are facing a food crisis. As *New Scientist* has reported, recent increases in the prices of staples such as rice, wheat and eggs could push 100 million people who have escaped from poverty back into it, and make life for the poor even more desperate. The cause seems simple: demand for grain and meat are rapidly rising, while production is failing to keep pace. What's clearly required is another green revolution, one that can quickly boost crop yields to supply the world with the food it desperately needs.

That's not the whole story, though. Almost as important as having food to eat is eating the right kind of food. A full stomach may ward off hunger, but it doesn't necessarily stop people dying. People also need a diet that contains the right blend of micronutrients.

If that sounds like a minor issue, then chew on this: according to the World Health Organization (WHO), almost 1 billion people suffer from a condition called goitre, a swelling in the neck caused by an enlarged thyroid gland. This is because they do not get enough iodine in their diet. Iodine deficiency also causes measurable brain damage in almost 50 million people, and cretinism, a stunted growth condition, in another 16 million.

An estimated 127 million pre-school children are affected by vitamin A deficiency, with up to half a million going blind each year, half of whom then die within 12 months. Anaemia caused by iron deficiency affects 2 billion people a year, killing 800,000. A lack of zinc is directly related to the severity and frequency of diarrhoea, a major problem in poor countries, while lack of folate, or vitamin B_{12}, causes neural tube defects and spina bifida in newborns and cardiovascular disease and cancer in adults. The list goes on. Exact figures aren't known, but informed estimates suggest that at least one-third of the world's population don't get the micronutrients they need, and millions die because of it every year.

This is the other food crisis – the one that doesn't make the headlines. The reason micronutrient malnutrition is so widespread is because much of the world's population increasingly relies on just a few staple foods, such as rice, maize, wheat and cassava, which cannot provide the range of nutrients required. In Africa, for example, popular varieties of cassava, maize and sweet potato contain almost no beta-carotene (a precursor of vitamin A).

In theory, the solution is simple – give people more foods to choose from. The reality is far more complex. The WHO seeks to tackle the problem in four ways: combating infectious diseases such as malaria, which can exacerbate conditions such as anaemia; increasing the production and supply of micronutrient-rich foods; handing out micronutrient supplements; and fortifying foods.

Combating infectious disease is a gargantuan issue in itself. Raising yields of crops that are naturally rich in micronutrients is almost impossible in many parts of the world, as local conditions do not allow most varieties to be grown in bulk. Supplements have an immediate impact, but they are relatively costly. For example, 500 million capsules of vitamin A are distributed globally each year, at a cost, after distribution and logistics are taken into account, of $1 a capsule (*Current Opinion in Plant Biology*, vol 11, p 166). Breeding a crop fortified with vitamin A that could be grown by local farmers might cost just 0.2 per cent of that. So engineering high-yield crops to contain higher levels of essential micronutrients offers our best hope of solving the problem long term.

> "Little research has been done on whether fortified foods provide people with more nutrients"

In recent years, researchers have been working to fortify major crops in this way. Their successes include crops engineered to contain higher levels of carotenoids, vitamin E and folate. There is a problem, however.

Huge amounts of research have gone into genetically engineering crops to boost their nutrient content. But as plant geneticist and paediatrician Kendal Hirschi of the Baylor College of Medicine in Houston, Texas, argues in *Trends in Plant Science* this month, very little has been done to answer the question that matters: whether these foods actually give people more nutrients when eaten (DOI: 10.1016/j.tplants.2008.05.009). A classic example is golden rice, developed in 2000 to contain higher levels of beta-carotene. Eight years on and scientists are still pondering its nutritional benefit. Part of the problem is a lack of research to verify the nutritional content of such fortified foods, and part is that many plants themselves contain "antinutrients", chemicals that bind to nutrients preventing their uptake in the gut.

One small success came earlier this year when researchers from Dartmouth College in Hanover, New Hampshire, finally showed that carrots cultivated to contain more calcium do indeed deliver the mineral when eaten (*Proceedings of the National Academy of Sciences*, DOI: 10.1073/pnas.0712330105). Most other fortified crops, however, have yet to be proven in this way, and more research is urgently needed.

Of course we need to find ways to boost productivity of crops. But let's ensure that the food we grow is nutritious as well as a plentiful. ●

Matt Walker is a science and natural history journalist based in Bristol, UK