# Prescription for the Planet

# PRESCRIPTION FOR THE PLANET

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# Prescription for the Planet

## The Painless Remedy for our Energy & Environmental Crises

**Tom Blees**

as much as we possibly can, and the nuclear waste problem will be a footnote in history.

This would seem to be where we should crunch the numbers to see if this all makes sense economically and logistically. But there's one more energy source we haven't looked at yet, a surprising addition to our stable of hydro, solar, wind, and IFRs. Besides supplying us with energy, it takes care of several other pressing problems in the bargain.

CHAPTER SEVEN

# Exxon Sanitation, Inc.

*Whaddya mean? I'm a legitimate businessman!*
*I'm a waste management consultant.*
— Tony Soprano

I have a confession to make.

Back in the beginning chapters of this book, I promised to suggest workable solutions for a number of seemingly intractable problems: global warming, nuclear proliferation, nuclear waste disposal, air pollution, and resource wars. Though we're not finished yet, you can surely see the outlines taking shape. Before we go any further I have to admit that I held something back. There are even more problems that we can solve with a few revolutionary technologies and some well-considered political and economic decisions. But how could I list all of them so early in the book without sounding like a utopian dreamer? Hopefully by now you'll know that while yes, I'm a utopian dreamer to some extent (imagining that politicians might actually buck corporate pressures and make sound decisions in humanity's best interest), the dreams have a solid grounding in reality. There is more good news to be considered, even more surprising solutions.

From where we stand at this point in our narrative, some nagging issues can be seen around the fringes. Boron/electric hybrids sound like they'll put the oil industry out of business except for the still-needed production of lubricants and plastics and the like. Well, there's good news there too, even some good news for the oil companies—despite the fact that oil drilling will indeed cease as surely as will uranium and coal mining. Then there's the nagging problem of man-made greenhouse gas emissions besides the ones issuing from power plants and vehicles. The leading cause of anthropogenic methane emissions in the United States, for instance, is landfills.[152] As we've seen earlier, methane is twenty times more harmful than carbon dioxide, molecule for molecule, in terms of its greenhouse effect (though fortunately it's considerably less persistent in the atmosphere).

Yesterday (as I write this in early 2007) Al Gore addressed the U.S. Congress and declared that by 2050 developed nations should devise a plan to reduce their greenhouse gas (GHG) output by 90%. Just a week earlier Tony Blair was hailed as "bold" for declaring that we should be shooting for 60%, which I guess makes Al Gore really *super*-bold. Yet their boldness seems to have been limited to the goals themselves, since neither of them proposed any solutions that would have even a hope of achieving those targets. Not only that, but Gore's plan stipulated just a 50% reduction worldwide, with the expectation that developing countries wouldn't be able to meet such ambitious goals. Just how the developed nations are supposed to achieve those reductions, however, was never specified, a fairly glaring omission by any standard. As far as this book is concerned, though, not only do we propose to reduce global GHG emissions by upwards of 95%, but we actually have a concrete plan to make it happen (patience, please, you haven't finished the book yet). That leaves politicians like Blair, Gore, and their successors to be, hopefully, bold enough to make the necessary decisions. They talk the talk, now let's see if they'll walk the walk. Wishing will not make it so.

[152] Fact Sheet, "Final Air Regulations for Municipal Solid Waste Landfills," ed. US EPA (Mar 1, 1996).



If we want to exceed that 95% goal, it would surely help to get rid of landfills, so let's get down to business with that project. Landfills have been a big headache for people all over the world, and out of desperation many municipalities have resorted to burning the trash they generate in giant incinerators. While the proponents of such "waste-to-energy" systems promote them as a solution to the problems of siting garbage dumps, they are far from being a wholly desirable solution. While incinerators undeniably cut down the volume of material to be disposed of, the substances therein and the incinerators' emissions still have to be dealt with.

In earlier years before environmental awareness kicked in, incineration of municipal solid waste (MSW) consisted of simply burning garbage and then burying the ash in a convenient location. That was particularly bad news for the people who lived downwind from the incinerators, though, because the fly ash that was pouring from their smokestacks contained concentrations of heavy metals like mercury, lead, cadmium, arsenic, and copper, as well as some particularly nasty compounds like dioxins and furans.[153] Once this began to be recognized and perceived as a public health problem, a vast assortment of scrubbing devices was invented, and modern MSW incinerators today manage to remove nearly all these substances from the smokestack emissions—when everything is operating perfectly, that is. But we don't live in a perfect world.

> For environmentally sound incineration, air pollution control equipment must be serviced regularly by highly

[153] Committee on Health Effects of Waste Incineration, "Waste-Incineration and Public Health," ed. National Research Council (National Academy of Sciences, 2000).

> specialized personnel. Monitoring equipment is costly and requires aggressive maintenance and servicing by trained technicians. In summary, when incineration is done in a manner that has low adverse health and environmental impacts it is expensive. When it is done poorly (with low financial costs) it can be expensive in terms of human health and environmental impacts.[154]
>
> The difficulty, and the necessity, of maintaining emissions control systems in essentially perfect order over a long period of time is daunting even to industrialized countries. Small mistakes in the operation of such facilities can easily lead to significant emissions of toxic substances.[155]

Even if we assume that this sort of scrupulous dedication to tightly constrained operation and maintenance will be universally practiced all over the world—oh, never mind. You know as well as I do that it wouldn't have a snowball's chance in hell of happening in the USA, nor any other country, much less everywhere in the world. But even if it did, it only means that the heavy metals, dioxins, and other nasties end up in the ash, and you have to put the ash somewhere. This leads to the quandary of figuring out good places to bury it, often with liners of various kinds, to try to minimize the amount of toxic substances that might leach into groundwater. Like the expectation of perfection described above, it can hardly be expected to be universally successful in every community that has an incinerator. The "waste-to-energy" concept, by the way, is somewhat of a public relations ploy. While the heat of incineration can be harnessed

154 Larry Rosenberg and Christine Furedy, "International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management," (UNEP Environmental Technology Center, 1996).

155 Ibid.



for a modest amount of energy, there are far less costly methods of producing energy. It's more a matter of making a bad deal a bit less bad.

Fortunately we needn't resign ourselves to choosing between the lesser of two evils, for landfills and incineration are both far inferior to a technology that is just in the early stages of widespread commercial deployment. Any comparison with incinerators would be superficial and quite inaccurate, for the principle involved is not a combustion process. The technology goes by various names—plasma waste conversion, plasma gasification, even plasma reactor. The trick is in the plasma.

Plasma is considered the fourth state of matter, the other three being the more commonly recognized solid, liquid, and gas. When you heat a solid, you get a liquid (in most cases). When you heat a liquid, you get a gas. When you heat a gas, you get plasma. A thermal plasma is an ionized gas that becomes both an effective conductor of electricity and also incredibly hot. We're talking about almost 17,000°C (30,000° for all you Fahrenheit fans). That's a few times hotter than the surface of the sun. Plasma torches have been used for various industrial purposes for years. If you want to cut a twelve-inch-thick piece of steel, you'll want one. They are sometimes referred to as lightning on a stick.

The happy marriage of plasma and garbage promises to make landfills and incinerators mere relics of a bygone age, alongside coal-fired power plants and gasoline engines. But eliminating garbage isn't the only purpose of a plasma converter. Unlike incineration, a plasma converter is actually a recycling device *par excellence*.

Instead of a garbage truck dumping its contents into a landfill, in a more sensible world it will dump it into a giant hopper, from where it will drop through a massive shredder, if necessary, to break its contents down into a reasonable size for a plasma converter to digest. The garbage mélange is then fed into a chamber where the plasma can do its thing. The intense energy transfer that occurs in the plasma is sufficient to rip the molecular bonds asunder, reducing the components of the garbage into their constituent elements. The resulting products exit the plasma chamber as a gas and a very hot molten stream.

The gas that is thus formed is usually referred to as "synthesis gas," or syngas. Its main constituents are hydrogen and carbon monoxide. Syngas is a very useful substance, for it contains all the building blocks of hydrocarbons, from which we derive the myriad petroleum-based products we use every day: fuel, plastics, lubricants, etc. Many people are familiar with synthetic motor oil, which is one of the many products made from syngas today. It is far superior to petroleum-derived motor oil.

When syngas exits the plasma chamber it is understandably very hot (about 1,200°C), and by running it through a cooler a great deal of steam can be generated that can be used to drive a turbine to produce electricity. But of course that leaves us with the syngas itself. It can be burned immediately through a steam or gas turbine to provide substantially more electricity. About 20-25% of this total amount of electricity can be channeled back to run the plasma torches and the plant, while the remaining power can be fed into the grid for sale. Thus a plasma converter for unwanted garbage can become a significant player in the electricity market. If all the U.S.-generated MSW were processed with plasma, by the year 2020 the expected 1 million tons per day of MSW could supply up to 5% of the nation's electrical requirements.[156] This is equivalent to the electricity generated from 25 nuclear power plants. This amount of renewable energy far exceeds the combined energy anticipated from solar, wind and landfill gas projected to the year 2020.[157]

156 Louis Circeo and Kevin Caravati, "Plasma Processing of Msw at Fossil Fuel Power Plants" (paper presented at the HTPP9 Symposium, Orlando, FL, Feb 22, 2007).

157 Ibid.



If syngas is burned to generate electricity, it will admittedly produce carbon dioxide. However, since the fossil fuel component in municipal solid waste is generally less than 10%, the process is very nearly carbon neutral.[158] It should also be pointed out that by eliminating the inadvertent production of methane that would otherwise result from landfill burial, the situation is improved by several orders of magnitude, since as we've noted before, methane is twenty times more potent than carbon dioxide in its greenhouse effects. Once petroleum is displaced, the percentage of fossil fuel products in MSW will continually decrease until it essentially disappears. At that point burning the syngas to produce electricity will be truly carbon neutral.

There are many other uses for syngas, though, besides just burning it for electricity. Syngas can provide the chemical building blocks for a great variety of products. Methanol can readily be generated from it, at about half the cost of ethanol and in less time. I know this won't be good news to the farmers who've seen their corn prices skyrocket lately due to the heavy subsidization of ethanol plants, but I'm afraid they'll just have to go back to the antiquated notion that farmers grow food for a living. In point of fact the vast majority of taxpayer-funded ethanol subsidies go to giant agribusiness firms, not small farmers. ADM alone rakes in about $1.3 billion dollars/year on ethanol subsidies of 51 cents per gallon. We'd be better off just sending small farmers a check (and telling ADM to pound sand) than to continue subsidizing an energy source with so many disadvantages. It's a greenwashing scam to harvest votes while paying off corporate cronies. As for those who've bought stock in the ethanol plants that are springing up in farming communities throughout America's corn belt, I have one word of advice: sell.

There are other fuels that can be derived from syngas too, with varying degrees of efficiency. Gasoline is the most obvi-

158 Louis Circeo, *Plasma Processing of Msw at Fossil Fuel Power Plants* (Atlanta, GA: Georgia Tech Research Institute, 2007), Poster.

ously usable one. Mobil developed a system to produce gasoline from methanol back in the Seventies. Butanol is another that holds tremendous promise. You may recall the earlier mention of Virgin Fuels, Sir Richard Branson's research project to find a way to power jet aircraft with biofuels. Butanol, a 4-carbon alcohol, is one of the prime prospects. A liquid fuel with an energy density nearly identical to gasoline, butanol can be mixed at an 85% butanol/15% gasoline ratio that will burn in most cars without any modifications to their ignition system. In fact, many older cars can run unmodified on 100% butanol.[159]

Since at least in the near term it may be difficult to engineer boron-powered motorcycles and other small engines, butanol or other alcohols such as methanol and ethanol should be able to fill that gap. It's possible there may need to be slight modifications to a motorbike's ignition system, but clearly the challenges are far from insurmountable, and if necessary they could still run on gasoline derived from waste (and thus carbon-neutral). This would seem to be a minor detail to Americans, but in developing countries around the world the motorbike is a ubiquitous mode of transport. For those of you who haven't had the opportunity to travel in such countries, many of them have a lot of something else that's ubiquitous besides motorcycles: garbage. Butanol on the hoof.

Between boron and butanol, the oil industry is looking more and more like a dinosaur. Plastics, anyone? Sorry, Exxon, syngas from garbage will provide all the chemical components for plastics that petroleum now provides. Synthetic motor oil from syngas is already well on its way to displacing petroleum-derived oil, especially as the public comes to understand its clear superiority (including the fact that it has to be changed much less often). Oh, and speaking of motor oil, we'll be using a lot less of it, if any, when we switch to boronmobiles. As for all the

[159] David E. Ramey, *Butyl Fuel, Llc* ([cited 2007]); available from http://www.butanol.com/index.html.



holdouts who'll be driving their old gas guzzlers (now burning butanol, or garbage-derived—and thus carbon neutral—gasoline), when they change their oil they won't have to take the old drain oil to any special place for disposal. Just throw it in the trash and it'll end up in a plasma converter, ready to be made into new oil or any number of other hydrocarbon-based items.

With all the uses to which syngas can be put, let's not forget there's also the molten waste stream emanating from the plasma chamber. This can itself be used in a variety of ways, and like syngas it will contribute to the profitability of the plasma plant. From the molten state it can be spun directly into rock wool, a substance rather like fiberglass that can be used in much the same way. Since rock wool made in this manner would be considerably less expensive than fiberglass, much more insulation can be added to a structure for the same cost as fiberglass, reducing the energy demands of cooling and heating. Compared to the cost of making rock wool the old-fashioned way, spinning it out of the molten slag stream of a plasma converter will cost about one-tenth the price.[160] Rock wool is also lighter than water and highly absorbent, so it can be used to clean up oil spills. And what, pray tell, would one do with the oily mess of rock wool after such an episode? Drop it into a plasma converter, of course. But this particular application will have limited utility, because hopefully the oil industry will be nothing but a memory in the very near future. There won't be any more oil spills to clean up. Ever. No more black feet after walking those idyllic beaches in the tropics, either. Sometimes it's the little things that make it all hit home.

If the molten slag stream is water cooled, nodules of mixed metals can be recovered. These can be sent to metal refineries and effectively "mined" for their component elements. Thus not

[160] Jonathan Strickland, *How Plasma Converters Work* (2007 [cited May 3 2007]); available from http://science.howstuffworks.com/plasma-converter2.htm.

only iron, aluminum, and other useful metals can be recovered, but heavy metals from the waste stream that have been such a problem with current methods of waste disposal can also be isolated for reuse.

The slag that's left will be comprised mainly of silicates and other minerals, which can be used for tiles, bricks, roadbeds, etc. But if all the garbage in the world is being run through plasma converters, it will provide so much in the line of these building materials that it begs the question of what to do with the excess. Since the molten stream can be simply allowed to cool into a vitrified (glassy) substance that is nearly inert and highly resistant to leaching, it would seem that simply burying it would be a reasonable course of action. But why not put it to better use?

If any plasma plant found itself with a saturated building materials market and had to look at disposal of the slag, the simple expedient of having some molds handy would be ideal. The molten slag could be poured into molds of various shapes optimally designed for use as artificial reefs. There's an organization[161] that has been manufacturing what they call "reef balls" for some time now, constructing artificial reefs around the world. (Currently they're made of concrete, but slag would work great.) Whereas it may seem logical to think that this sort of thing might make sense in the tropics where coral reefs are most commonly found, one need only look at artificial reef projects off New Jersey or even farther north to see that the range of possibilities is nearly endless.

While the sea's seemingly limitless bounty might lead people to believe that it's teeming with life, the truth is that the vast majority of the sea bottom is relatively featureless and barren. All along the continental shelves there stretch seemingly limitless expanses of relatively smooth terrain with a minimal

[161] *Reef Ball Foundation* ([cited 2007]); available from http://www.reefball.org/.



amount of animal and plant life. But drop a pile of nearly any solid material onto the bottom and watch what happens. As soon as there's something to anchor to, planktonic organisms like barnacles, corals, sponges, sea squirts and others will come floating by and latch on. Crustaceans will make their homes in the nooks and crannies. Fish will arrive and take up residence. Pretty soon you've created an entire community, a little neighborhood ecosystem where virtually nothing lived before.

Human communities that have created artificial reefs offshore have seen them generate not only fish but dollars. Sport fishermen who had no reason to visit before now suddenly find good fishing. Even commercial fishing is enhanced, especially where extensive reef building has resulted in ever more diverse fish populations. In a time when pollution and destructive fishing and mining practices have damaged or utterly destroyed natural reefs in many parts of the world, this possibility of dramatically increasing the biological carrying capacity of continental shelves is a golden opportunity. Permits to dispose of reef-ready slag could be issued to plasma operators by local boards using the advice of marine biologists hired to advise on the optimum locations and volumes of artificial reef materials. Who would ever have imagined that our garbage could be put to such good use?

But like nearly any new idea, there are already groups of individuals lining up in opposition to plasma converters. It's a classic case of Voltaire's maxim, "The perfect is the enemy of the good." The anti-incineration forces mistakenly (or disingenuously) regard plasma converters as simply a sneaky kind of incinerator.[162] Facts take a back seat when delusion is driving. One such group promotes a waste-free society, where everything we use would be recycled — the old way. I suppose we're all expected to have a dozen different waste bins in our homes

[162] "Incinerators in Disguise," (Global Alliance for Incinerator Alternatives, April 2006).

into which we'll dutifully sort all our waste—oh, and don't forget the compost heap and the composting toilet. Never mind the fact that plasma converters represent the zenith of recycling without any effort on the part of those creating the garbage. But hey, there's a cause for everyone, isn't there? There's even a Russian group that's agitating to *increase* global warming gases, presuming it'll make Russia far warmer and more habitable.

Getting back to that composting toilet idea, though, brings up yet one more use of plasma converters. The sludge resulting from waste treatment plants needn't be simply buried anymore. That too can be run through plasma converters. There is already a small commercial plasma plant in Japan processing 17 tons of MSW and 4 tons of sewage sludge per day. Pretty much anything can go in there, including dirt. That's no small advantage, since there are many unbelievably trashy places where a front-loader could just drive in and start scooping up trash. In many developing countries there is virtually no garbage collection infrastructure, and residents have no compunction about littering. It seems inadequate, though, to use the relatively innocuous term "littering" to refer to the practice of just tossing every bit of your garbage into the street. Words fail me. Sometimes it just has to be seen to be believed. Some archeologists have suggested that ancient cities are found underground because they've slowly been buried in garbage.

Sometimes natural or man-made disasters resulted in cities being buried more suddenly, though. Looking at the aftermath of Hurricane Katrina in New Orleans, it's not difficult to imagine similar calamities resulting in the total abandonment of ancient cities. The post-Katrina cleanup will likely take years, what with the mix of chemicals, plant and animal debris, and destroyed buildings, all stewing in the heat and humidity. It's a pity we've not quite reached the plasma converter age yet.

One can easily imagine some enterprising business person taking plasma converters to the road in the not-too-distant future. Such a system built aboard one or two large trucks could follow harvests and other intermittent waste-producing events around the country, but at disaster areas is where they would be truly welcome. If New Orleans had had a couple plasma converters already operating nearby to recycle the city's normal MSW load, cleanup could have started immediately, and mobile rigs could have showed up to accelerate the process. It matters not what sort of mixed-up mess of hazardous or more benign material has to be cleaned up. Plasma converters can handle it all, and even make money in the process. Apparently this missed opportunity was not lost on the city fathers of New Orleans, for they're the second city in the USA to announce plans to build a plasma converter.



Looking ahead to its many applications, the profit potential of plasma conversion is tremendous. Private companies could build facilities in developing countries and it would naturally be in their financial best interest to develop the garbage collection infrastructure to support their business. This is a perfect niche for the oil companies. The capital investment is fairly substantial. A plasma plant capable of processing 2000 tons per day—about the amount that a million people produce in the USA (likely less elsewhere, and much less in most places)—would cost about $250 million. The payback time on that investment would vary depending on what the syngas and slag would be used for, but current estimates are about twenty years.[163] This can change considerably, though, since there are so many different uses for the syngas and slag. Also, that payback time is premised on the cost of building the first large plasma converter in the world. The first one always costs the most, of course. The price will surely drop substantially with future construction.

[163] Lynne Sladky, "Florida County Plans to Vaporize Landfill Trash," *USA Today* 9/9/2006.

You may be wondering at these rosy predictions if the first big plant is still in the planning stages. But this technology is already in use and has been for some time. Most of the plants have been modest in size and often built for specific uses. Hitachi has been a leader in the field, having built a plant in 2002 that processes both MSW and automobiles shredder residue (ASR). That plant now processes 300 tons of MSW and ASR per day with two plasma units. Other more specialized converters have been used for everything from nerve gas to munitions, and now the U.S. Navy has begun to put them on ships to solve the problems of waste disposal at sea.

The project everyone's watching is a new plasma converter planned for St. Lucie County, Florida, due to begin operation in 2009. This will build upon the experience of Hitachi's plants, scaling up the 150-ton/day gasifier units to 500 tons/day, with up to six plasma torches in each. The plan calls for several such reactor modules capable of handling 3,000-3,500 tons of MSW per day. Since St. Lucie County has a population of about 250,000, they'll easily be able to process not only their own MSW but also that of several surrounding communities. But they'd also like to get rid of their landfill that's been such a problem to them, so they're planning to use some of their extra capacity to gobble it up, bit by bit, until it's gone in about 18 years. The 120 MW electrical output to the grid should be sufficient to power every household in the county. The old adage "One man's trash is another man's treasure" will soon be demonstrated in spades at St. Lucie County.

Another plasma plant is due to come online in Pennsylvania in April of 2009.[164] This plant will process MSW and agricultural waste, and is being designed to produce ethanol at a cost of about a dollar a gallon. Plans call for building 20-25 plants per year to produce "a couple billion gallons" of ethanol

[164] Thomas Olson, "Gamble on Plasma Turns into Jackpot," *Pittsburgh Tribune-Review* Apr 26, 2008.



annually, more easily and cheaply than that produced from corn today, without resorting to food crops or special plantings for the purpose. Obviously this will be highly competitive with the cost of gasoline even without any subsidization. One wonders, then, just how long it will take the federal government to stop subsidizing Archer Daniels Midland. Any bets?

At the moment, oil companies are sitting on a stash of about $2.35 trillion and growing.[165] Let's assume for a minute that they keep the 0.35 trillion aside for buying garbage trucks and dumpsters. Two trillion bucks would pay for about 8,000 plasma plants at the prices quoted above, but of course those prices will plummet as soon as they start being mass-produced. It would hardly be a stretch of the imagination to guesstimate that their cash stash could build 15,000 plants, enough to handle the MSW of some fifteen billion people who crank out trash as prolifically as Americans. Since there are just a bit more than six billion people on earth right now, and many of them generate precious little trash (or anything else, for that matter), it would seem that the companies that have heretofore been providing us with our oil are perfectly positioned to become the planet's garbage kings while using a mere fraction of their savings to do it.

This would seem almost too ideal, for who has more experience in the multitude of ways to manipulate hydrocarbons than the oil companies? They could possibly even convert some of their existing refinery equipment in the service of syngas manipulation. Since all the elements would be originating from non-fossil fuel sources, there would be no cause for concern about GHGs. Emissions would be carbon neutral any way you slice it. So have at it, Exxon. Go nuts, BP. Enjoy your new business. And while you're at it, put a little money aside for anti-littering social engineering.

[165] Greg Palast, *It's Still the Oil* (3/18/2007 [cited]; available from http://tinyurl.com/2vuesr.

Baby boomers know what I mean. Back in the day it was pretty standard procedure to toss stuff out the window as you drove along. Of course in those days most food wrappers and cups and such were made of paper. But it took a while for a consciousness of littering to take hold, until today those who litter are pretty much considered boors in most developed nations. Once garbage infrastructures are in place, it'll be to the advantage of the sanitation companies to inculcate that consciousness worldwide, since it's a lot easier and more efficient to collect trash from bins than to pick it up off the roadside piece by piece. A heck of a lot more pleasing to the eye, too.

As for the tens of thousands of landfills that are already closed or full to bursting, emitting methane and often contaminating groundwater, there is an alternative to digging out all that old garbage. Using a process called In-Situ Plasma Vitrification (ISPV), boreholes can be drilled into old landfills and cylindrical plasma torches can be inserted deep underground. As the plasma gasifies and melts the material below, syngas can be drawn off at the surface. All the solids will remain underground, cooling into an inert glassy slag, effectively entombing the troublesome heavy metals and other substances that have been a continuing pollution hazard for groundwater supplies. If the boreholes are spaced closely enough, the molten pools will coalesce into a solid layer, and as the plasma torches are slowly raised to the surface the molten layer will be transformed into a glassy underground monolith. While the ground can be expected to subside substantially during the process, the end result will be a completely stable surface with none of the pollution concerns of the past. The syngas that has been drawn off can of course be used however the "miners" prefer. When the ISPV process becomes fully developed, it may become very cost-effective to mine existing landfills for energy production.

This process of drilling boreholes holds more than pecuniary promise, however. Remembering that plasma conversion



breaks down compounds into their constituent elements, consider the many severely polluted sites that desperately need to be cleaned up to prevent groundwater contamination and illness to nearby residents. In the USA these have been designated as Superfund sites, named for the pile of money that Congress has intended to allocate for solving the most serious localized pollution problems.

Most of these sites are polluted with toxic chemical compounds. The plasma torches, burrowed deep into the problem areas, would break down most of these compounds into their harmless constituents. In cases where some of the elements themselves are problematic, such as heavy metals, they would end up tightly bound in the vitrified slag, impervious to leaching for thousands of years. Whereas most Superfund sites today are cleaned up by hauling out untold truckloads of contaminated soil—at tremendous cost—plasma conversion would accomplish the task much more effectively on site. After all, when contaminated soil is trucked away it's usually a matter of trying to make a bad situation a bit less bad by finding a less sensitive place to dump it. With plasma conversion, though, there is no waste product to be disposed of at all. The cost of cleaning up these pollution hotspots can be reduced by an astounding amount, and be accomplished quickly to boot. Up to now the cleanup has been hampered by both budget constraints and devilish technical challenges. Neither will be an issue once plasma technology is employed.

Even though plasma converters cannot transmute radioactive contamination into non-radioactive elements, the system was nevertheless called upon in an attempt to clean up the ground contamination at the Savannah River nuclear power plant in Georgia. This effort, under the direction of the U.S. Department of Energy, succeeded in entombing all the radioactive elements in a vitrified underground mass, which prevented its spread through the water table and essentially nullified the problem. The DOE, having been rather desperate to solve that prickly dilemma, declared ISPV to be ready for commercialization.[166] The technology clearly demonstrated its ability to convert the most problematic hazardous, toxic, and even radioactive wastes and contaminated soils into stable, vitrified forms.

The effectiveness and economy of harnessing ISPV for Superfund cleanup can transform that program from a lumbering, costly and procrastinating beast into an efficient and profitable enterprise. Despite its misleading moniker, the Superfund has been consistently starved for cash and the cleanup of over 1,200 sites around the USA has proceeded in pathetic fits and starts. At last we have a means of accomplishing this formerly daunting task by harnessing the power of plasma.

If oil companies decided to go whole hog into the garbage business, and even went so far as mining old landfills, their total investment would still leave at least hundreds of billions of dollars, probably over a trillion, just sitting in their coffers waiting to be used. Fortunately for them, municipal solid waste represents just a small portion of the total waste stream. Far more material is available in the form of industrial wastes, agricultural waste, and construction debris. Many of these materials have the unfortunate characteristic of being hazardous in one degree or another, and the industries that produce them as a byproduct of their operations pay substantial sums to have them disposed of by companies that specialize in such operations. Undoubtedly you've heard of many cases where such hazardous waste "specialists" have surreptitiously dumped their cargo at sea, in rivers, in landfills, or shipped them to unfortunate countries in the developing world where they've sickened

[166] P.G. Zionkowski R.F. Blundy, "Final Report, "Demonstration of Plasma in Situ Vitrification at the 904-65g K-Reactor Seepage Basin."", ed. DOE (Aiken, SC: Westinghouse Savannah River Company, Dec 1997).



or killed the hapless residents.[167]

Once plasma converters are widely deployed, hazardous waste disposal prices will drop substantially, since the process of dealing with them will be greatly simplified. Like the other inevitable economic casualties along the way to our new energy paradigm, the illustrious employees of Slippery Tony's Midnight Hazardous Waste Disposal will have to find honest jobs. I hear Exxon Sanitation is accepting applications.

As for agricultural waste, it's usually preferable to recycle it directly into the soil even though it could be converted to usable materials in a plasma converter. But there will be no shortage of raw material beyond garbage to make plasma conversion a burgeoning growth industry in the very near future. Virtually any byproducts of industrial or agricultural processes that are now discarded will be candidates for transmutation into beneficial products. Syngas and metals will be the prime values. One can't help but think that the mainly silicate slag will ultimately be so abundant as to make building and paving materials ridiculously cheap. But with judicious reef building programs, the slag that ultimately finds its home along the margins of our continents may end up indirectly translating into one of the most valuable products of the plasma systems.

It's even possible that plasma conversion could turn out to be the most direct and economical method of recycling boron oxide for our automobile fleet. Given plasma's ability to sever molecular bonds, it seems reasonable to suggest that feeding boron oxide into a plasma converter would result in the oxygen being liberated as a gas while the boron reverts to its pure elemental form. If so, then the oxygen could be drawn off and combined with hydrogen from an adjoining plasma converter that's busy with the task of converting garbage, agricultural waste, or any other organic materials. The hydrogen-oxygen

[167] Zada Lipman, "A Dirty Dilemma," *Harvard International Review* 23, no. 4 (Winter 2002).

combination produces a prodigious amount of heat (it's used to fuel the space shuttle) that could be used to run a steam turbine and generate electricity to power both plasma burners. Unlike relying on other sources of energy to create steam via a heat exchanger, the combination of oxygen and hydrogen creates not only plenty of heat but water — conveniently in the form of steam. Such a system would preclude the use of electricity from the grid for the boron oxide recycling process, instead deriving its energy from the incoming streams of oxygen (on the boron oxide side) and hydrogen (on the garbage side).

In such a scenario, drawing the hydrogen off from the syngas on the garbage side would leave mainly carbon monoxide. If that was simply liberated into the atmosphere it would be carbon neutral (being made from organic materials rather than fossil fuels). But rather than releasing it, why not sequester it underground? After all, aren't we all being led to believe that carbon sequestration is the answer to our continued use of coal? If it's so feasible, then here's where it could be employed to chip away at our atmosphere's GHG problem in a big way, for the organic materials feeding the plasma converter would have derived their carbon from the atmosphere. The process of carbon sequestration, as proposed by the coal industry, involves deep drilling into stable formations. Who knows how to do that from a long history of having already done so? Sure, the oil companies, now in their new incarnation as garbagemeisters. They've even got the drilling rigs to do it, which will be sitting around rusting in a modern version of a Halliburton nightmare. They might as well put them to some positive use.

While wholesale conversion to all-electric households can proceed quite smoothly in industrialized countries, developing nations lacking extensive electrical transmission grids will be far more dependent on liquid fuels for cooking and other energy needs. Boron will be able to fill the bill to some extent, but the generation of methanol, butanol, and other fuels from plasma



converters will be invaluable in converting the energy infrastructure of developing nations to environmentally sound systems, even before their electricity grids are built. The ease with which methanol can be produced from syngas is especially welcome, since it will provide an inexpensive and easily transported fuel for cooking stoves. It would be well worth it for the developing nations to subsidize methanol for these purposes, perhaps with a modest tax on either boron or electricity. This is not a purely altruistic notion. A large part of the Asian Brown Cloud is made up of particulates from the dung or wood cooking fires of millions of poor people, who also suffer horribly from the indoor pollution that only belatedly makes its way outdoors. The sheer number of people using such cooking methods creates a pollution hazard that respects no international boundaries.

Aiding the most impoverished among our planetary brethren isn't the only guilt relief that the many benefits of plasma technology will provide, however. Parents will be able to diaper their babies with disposable diapers, knowing that the diapers (plus their bio-cargo) will all be converted into usable materials.[168] My son — long since out of diapers — even came up with the concept of the Guilt-Free Car, made almost entirely out of garbage. Rock wool spun from molten slag will take the place of fiberglass in a car body that obtains most of the elements of its accompanying polymer resin from syngas. Likewise the tires and plastics used throughout, even the upholstery fabrics, would be derived from syngas. Metals can be recovered from the nodules produced by the plasma factories. Even the upholstery padding can be made of rock wool. The Guilt-Free Car will run on boron, of course, which may even end up being recycled using the energy from MSW or other waste products. Now there's a car any environmentalist would be proud to drive.

[168] American babies alone use about 18 billion disposable diapers a year, and their use is increasing rapidly around the world.

Plasma converters represent the ultimate in recycling, making virtually 100% of the waste a household normally produces into usable and even valuable end products. There would be no need to have two garbage pickups every week, one for trash and one for recyclables that people have perhaps been conscientious enough to separate. Everything could go in the trash. One might wonder about glass, though, because whereas the mainly silicate slag is itself a glassy substance, it couldn't be used to make glass containers because it would be mixed with other minerals. On the other hand, silica (from which glass is made) is the most abundant mineral on earth, so even if people don't sort their bottles it wouldn't really be that big a deal. It's not like we're going to run out of sand. We can make all the bottles, jars, and windows we want, and we'll still have plenty left over for important things like computer chips and breast implants.

As for the ex-oil companies, now kings of all the garbage they survey, there would not only be a profitable business, but they could quit worrying about peak oil. There will never be a peak garbage point, at least not until the human population of the earth starts to shrink. Not only is that population, alas, still growing by leaps and bounds, but as prosperity spreads people end up producing more garbage. Yet since everything can be so thoroughly recycled, there's no need to be overly concerned about it.

Those who feel virtuous about sorting their garbage, driving a hybrid, and wearing a sweater so they can keep the thermostat down will just have to find other reasons to feel virtuous. With free depleted uranium providing unlimited cheap electricity to heat (or cool) everyone's home, if you don't mind paying a little more on your electric bill every month you can feel free to doff the sweater. You can toss whatever you want in your single garbage can, then run outside and jump in your boron-powered SUV and cruise away. In such a future there will be one thing in short supply, though: guilt.



Does this all sound too good to be true? Sure, the plasma converter and all its offshoots clearly constitute a viable enterprise in and of themselves, but if we're talking about building thousands of IFRs the costs must be astronomical. If we want to run an all-electric world powered by IFRs with boron-fueled vehicles and plasma converters working away, just how many reactors will we need and how much is it all going to cost?

**WARNING!**

The following chapter may induce big number vertigo.
Enter at your own risk.