



TAKING THE LONG VIEW

Scenario Planning Puts the Future into Perspective

It's 2015. The baby-boomers are reaching retirement age, the Social Security fund has all but dried up, and the federal budget deficit is bigger than ever. An aging, health-conscious public demands safe drinking water, but capital is tight and water utilities can't maintain their infrastructure.

Media reports of waterborne illness are an almost daily occurrence.

Those who can afford it take matters into their own hands, investing in new home treatment systems. As more water users give up on municipal treatment, support for maintenance dwindles further. The provision of treated water is developing a two-tiered structure: the rich buy their own, basic ratepayer-supported services are minimal, and universal quality is no longer assured. Unable to fight the trend, some utilities abandon centralized treatment altogether, and instead provide customers with essentially raw water and home treatment systems...

Don't worry, it almost certainly won't happen. And neither will any of the other three scenarios presented in "The Future of Municipal Water Services," a scenario planning exercise RMI conducted this summer and fall for the U.S. Environmental Protection Agency.

What's important about these scenarios is not whether they "get it right," but how they challenge our assumptions about the future. Developed by Royal Dutch/Shell in the 1960s, scenario planning throws out the notion of predicting the future—a risky business at best—and instead focuses on preparing for it and helping to invent it. By creating several different but equally plausible "stories" about the future, scenario planners gain a deeper understanding of the many interlinking factors that will shape whatever future finally unfolds.

RMI's Amory Lovins has been involved in scenario planning since the mid-1970s, when he used early versions of the process in consulting for the oil industry. His now-famous "soft" and



"hard" energy paths—scenarios by another name—first took shape on the blackboards of Royal Dutch/Shell in London, and he and other RMI staff have since taken part in various proprietary scenario exercises on energy and transportation issues.

Now RMI is in the midst of its two biggest scenario planning projects to date. In addition to the EPA water study, the Institute will participate this winter in a similar project examining the future of cars and transportation, hosted by Global Business Network, the world's foremost scenario planning consultancy, headed by RMI Board member—and former Shell planning head—Peter Schwartz.

BACKDROPS AND WILD CARDS

Building scenarios is as much art as science. The goal is to sift through dozens or hundreds of potential factors—"driving forces," as scenario planners call them—to identify the handful that will be most important in shaping the future.

For the EPA water study, RMI researchers Richard Pinkham and Scott Chaplin listed about 70 relevant driving forces and asked experts in the field to rate each factor in two ways: how important it would be to municipal water services, and the likelihood of its occurring in the next 20 years.

Scenario planners look for two kinds of drivers. "Predetermined elements" are important factors

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The Newsletter

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LETTERS TO THE EDITOR

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About the Institute

Rocky Mountain Institute is an independent, nonpartisan, nonprofit research and educational foundation with a vision across boundaries.

Seeking ideas that transcend ideology, and harnessing the problem-solving power of free-market economics, our goal is to foster the efficient and sustainable use of resources as a path to global security.

Rocky Mountain Institute believes that people can solve complex problems through collective action and their own common sense, and that understanding interconnections between resource issues can often solve many problems at once.

Founded in 1982, Rocky Mountain Institute is a §501(c)(3)/509(a)(1) public charity (tax-exempt #74-2244146). It has a staff of approximately 40 full-time, 45 total. The Institute focuses its work in seven areas—agriculture, economic renewal, energy, green development, security, transportation, and water—and carries on international outreach and technical-exchange programs. Its E SOURCE subsidiary (1033 Walnut, Boulder, CO 80302-5114, 303/440-8500, fax -8502) is the leading source of information on advanced techniques for electric efficiency.

PERSPECTIVES

By L. Hunter Lovins, Executive Director

We're not futurists at RMI, although our work has everything to do with the future.

Our mission is not to predict the future but to influence it for the better.

Hence RMI's ongoing involvement in scenario planning (see cover story). By definition, scenarios *aren't* predictions. They're stories that train us to question present assumptions and prepare for diverse possible futures. Scenarios can be

supported by very complex computer models, but at heart, they're just mental models of how things will play out. They differ from ordinary expectations in that the assumptions are made explicit, and thereby available for scrutiny and refinement.

In his book *The Art of the Long View*, RMI Board member Peter Schwartz likens scenario planning to "rehearsing the future." We don't know which version of the future will be accurate but, like an actor in a repertory theater, we can rehearse several different scripts. Then when the future happens, we'll have our lines down.

The real beauty of scenarios, I think, is that they're not inevitable. Each one is plausible enough that it *could* happen, but none of them *must* happen. That means that if the outcome of a particular scenario is unattractive, we examine the assumptions that led to it. Are they really plausible? Then we'd better work now to see that they don't happen.

In the scenario planning business this is called *backcasting*—as opposed to *forecasting*. The fact that a scenario is merely the playing out of a number of assumptions should remind us that the future is precisely the outcome of decisions we make in the present. Trend is not destiny; the future is not fate but choice. We *can* play a part in choosing a better future, or at least averting a worse one.

But other people are trying to influence the future, too, and some have a vested

interest in convincing the rest of us that their version of the future is the only one possible.

Peter Schwartz warns of humans' tendency to accept an "official future"—a single, often simplistic script written by the powers that be. Buying into it is a form of fatalism that leaves us unprepared for surprises, and disenfranchises us from the process of shaping the future.

Since 1994, followers of House Speaker Newt Gingrich have been writing the official script for our national future—the Contract with America was an early draft—and they've done such a persuasive job of it that it's hard to imagine anything else. Perhaps it's no coincidence that Gingrich's guru is the noted futurist



Alvin Toffler, whose books *Future Shock* and *The Third Wave* tend to portray the future as an unstoppable juggernaut.

I don't fault those folks for seizing the future in this way. What I'm wondering is, where are the writers of other scenarios? What hedges are we making against the possibility that the official future is wrong, or at least suboptimal?

And what if it's right? Poll after poll shows that a majority of Americans support the environmental and consumer safeguards that the House is trying to dismantle. What will our future be like if the bureaucracy-busters succeed? Will business embrace resource efficiency to solve pollution problems and gain a competitive edge? Or will inefficient and expedient rodents exploit the demise of the cat?

Few of us—even those of us supposedly working on behalf of the future—spend enough time evaluating the implications of decisions made today, or planning the future we'd like to live in. Yet if we don't, someone else will. 🌐

SECURING THE FUTURE

Announcing RMI's First Capital Campaign

Neering its 15th anniversary, Rocky Mountain Institute faces the most challenging opportunity in its history. To secure a permanent home and save a large tract of critical wildlife habitat from development, RMI has embarked upon its first capital fundraising effort.

Many readers of this newsletter may be unaware that RMI outgrew its headquarters years ago. The building can accommodate no more than a dozen workers; most of the rest of the Institute's 40-odd employees, including the entire research staff, work in leased office space a half-mile away on property owned by The Windstar Foundation, an environmental/peace organization founded by singer John Denver and aikido master Tom Crum.

Earlier this year, the National Wildlife Federation (NWF), which owns an undivided half-interest in the 957-acre Windstar property, including the 5,500-square-foot office building that RMI partly leases, announced its intention to sell its stake. RMI has purchased an option to buy it, and with this issue of the newsletter announces its \$3 million Securing the Future Campaign.

Acquiring a joint interest in the Windstar property is a pragmatic approach to meeting RMI's long-term needs. It costs less than building or leasing space elsewhere, protects us from future office cost increases or the need to relocate, and generally makes us more self-sufficient. Further, the land offers a long-term potential for staff housing—which would use all the latest "green" techniques and greatly enhance our ability to attract and retain highly qualified staff.

Finally, our acquisition would ensure the land's continued preservation for wildlife. The land is critical elk winter range, and also serves as a vital elk and deer migration route: with the growing pressure on habitat in our valley, access to Windstar is essential for the survival of one



Judy Moffatt

Windstar: A least-cost solution to RMI's long-term needs, and a key component to protecting one of the largest migratory elk herds on the continent.

of the largest migratory elk herds on the continent. And RMI's effort to protect Windstar has great potential leverage, as the property is considered a key component in an effort to protect 10,000 acres of nearby private land for wildlife—potentially the biggest such effort in Colorado.

NWF has set an 18-month deadline for RMI to raise the \$1.6 million purchase price for its half-interest. The price will be reduced to \$1.5 million if RMI can raise that amount by 31 December, 1996. Windstar has agreed that if RMI purchases NWF's share, the entire property will be placed in a jointly governed nonprofit land trust for its perpetual protection. The Institute will continue to maintain its offices there. Each organization will retain its own identity, policies, staff, and board of directors.

RMI will also seek to create a \$1 million endowment to restore and sustain the Windstar land in perpetuity. The land has been heavily invaded by noxious weeds, and erosion is a major problem.

RMI embarks on this new phase with a sound plan, but a huge need for renewed assistance from its individual supporters. We hope part of the money can be raised

from neighboring landowners in the Capitol and Snowmass Creek valleys who support protecting this beautiful land from development. Some might come from foundations. But much will have to come from people who care about RMI's work and are committed to its future.

Rocky Mountain Institute will be appealing to its supporters individually to help us meet the goals of our Securing the Future Campaign. Your participation will help ensure the ongoing well-being and vitality of RMI and the restoration and protection of land that is deserving of all our best efforts. Please call Campaign Coordinator Judy Moffatt or RMI Executive Director Hunter Lovins if you have a question or would like to help. 🌍

HOW THE MONEY WILL BE USED

Purchase of Land	\$1,600,000
Endowment of Land	
Renewal/Stewardship	1,000,000
Land Restoration/Building	
Repairs	250,000
Transaction Costs	30,000
Other/Contingency	128,000
Total	\$3,008,000

TAKING THE LONG VIEW

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that are very likely to happen, so they will form a backdrop for all the scenarios. In the case of the water study, RMI identified two main ones: an aging, health-conscious population, and a water infrastructure in need of repairs or upgrades in many places.

But what really breathes life into scenarios are the so-called “critical uncertainties.” These are the wild cards—the driving forces deemed most important and plausible but of *uncertain* likelihood. In other words, it’s a toss-up which way they’ll go, but either way they’ll have a profound effect on the outcome. The RMI team chose two such factors: the nature of the federal government’s regulatory role in water, and the availability of funds and public support for improving infrastructure. By choosing two critical uncertainties and assuming two different outcomes for each, the team had the skeletons for four hypothetical futures. The predetermined elements, other known factors, hard data, hunches, and

educated guesses helped flesh them out.

The scenario that started this article was based on a downbeat combination of a weak regulatory environment and a lack of funds and support for improvements. It qualifies as the proverbial worst-case scenario. The other three point more optimistically toward a wider acceptance of efficiency measures, and each contains at least one surprising development. For example, in a future of weak regulation and strong customer support, environmental lawsuits against regulators and polluters would probably increase.

The future is unlikely to look exactly like any of RMI’s scenarios. But the stories they tell should help water managers, government officials, and concerned citizens understand the interplay of forces and the influence of surprises in the future that actually does unfold.

FURTHER EXPLORATIONS

If all goes well, the Global Business Network project will turn up some sur-

prises, too. Despite all the time RMI has already spent envisioning the future of transportation, our crystal ball is still exceedingly cloudy on this subject.

How would a widespread shift to hypercar technology affect the auto industry? What about steel, plastics, oil, electronics, insurance, unions? Which companies and countries might profit from the shift, and which could be left behind? What would be the effect of government support of hypercar development? How could the future differ in a radical free-market environment? These are questions we’re eager to explore.

Scenario planning is a powerful tool for any organization that spends as much time thinking about the future as RMI. A technique that challenges people’s assumptions about the future is especially important for an organization concerned with sustainability, since most people’s idea of the future is “more of the same,” and more of the same isn’t sustainable.

And like RMI, scenario planning explores the hidden connections between seemingly unrelated issues; it encourages people to look at the big picture, and to take the long view.

Some environmentalists might feel uncomfortable that the technique was pioneered by an oil company. For RMI, which frequently works with the corporate world, that’s actually a plus. For decision-makers, scenario planning isn’t some easily dismissable eco-rap—it’s part of their culture. Nor does it hit executives over the head with dire predictions; it’s a non-threatening way of presenting different images of the future against which they can evaluate the wisdom of the decisions they make today. The process can reveal if they’re banking on just one future coming to pass, and raise the question, “Are you willing to bet the store on this particular future?”

Finally, it’s a reality check for us, too. Building scenarios helps us see the strengths and weaknesses of what we’re trying to get across. After all, we can’t teach people about the future if we haven’t “wind-tunneled” our ideas and made sure they’ll really fly. 🌐

In the Pilot’s Seat

Step into the cockpit and adjust the controls. Check the weather, terrain, irrigation efficiencies. . .

Irrigation efficiencies?

This isn’t an airplane, it’s the Snake River Explorer, a “management flight simulator” that models water flows in Idaho’s Snake River Basin. Developed by the Idaho National Engineering Laboratory (INEL) and Washington State University, the interactive software teaches decision-makers about the watershed’s complex dynamics and helps them develop sustainable management strategies.

Modeling a whole river system is unusual, if not unique. Water management models are typically designed to solve narrowly defined problems in isolation—for instance, how to regulate the release of water from a single reservoir to optimize its hydroelectric generation. Casting a much wider net, the Snake River Explorer emphasizes the interconnections between the watershed’s many resource issues.

Since a model is only as good as its assumptions, INEL invited RMI to identify the major causes and effects (“inputs” and “outputs”) that the model ought to track. Irrigation efficiency is just one of dozens of inputs; others include surface and ground flows, water rights, crop yields, and the location and size of hydroelectric dams.

Something akin to an airline flight simulator, the Snake River Explorer lets the user set the inputs and then calculates their consequences for the watershed up to 200 years out. The simulation may simply confirm expectations, but given the model’s many cause-and-effect interactions and feedback loops, it often reveals unexpected outcomes that are important to understand.

The Explorer is undergoing further refinement. Although the model was developed primarily to study the Snake River, it should be possible to tailor it for other watersheds in the United States and perhaps in other countries. 🌐

\$100,000 BILLS ON THE SHOP FLOOR

A Tale from a New RMI Book Challenges Economic Dogma

Theoretical economists commonly assume that cost-effective opportunities to save resources don't exist, because if they did, somebody would already have exploited them.

RMI's newest book hit the stands in October—in German. It's *Faktor Vier: Doppelter Wohlstand—halbierter Naturverbrauch*, which roughly translates as *Factor Four: Live Twice as Well, Use Half as Much*.

Coauthored by Ernst von Weizsäcker, head of Germany's Wuppertal Institute, and Amory and Hunter Lovins of RMI, the book presents 50 compelling case studies of companies and organizations that have achieved fourfold or greater increases in resource productivity.

The Lovinses have now teamed up with longtime friend Paul Hawken, author of *The Ecology of Commerce*, to rewrite *Faktor Vier* for the North American audience. The book's focus will broaden from resource productivity to "total factor productivity"—an approach that challenges the modern corporate obsession with labor costs, and instead seeks to optimize both labor *and* resource use. Provisionally titled *Natural Capitalism*, it will be published in the United States by Hyperion, probably in late 1996.

In the meantime, here's a story from the book that weaves together many of its key themes:

Theoretical economists commonly assume that cost-effective opportunities to save resources don't exist, for the same reason you don't see \$20 bills lying in the street: if they existed, economists figure, somebody would have found and pocketed them long ago. But the real world seldom works that way.

In 1981, energy efficiency coordinator Ken Nelson organized a contest among Dow Chemical's 2,400-worker Louisiana Division. Staff were encouraged to suggest projects that would save energy or reduce waste, pay for themselves within one year, and cost less than \$200,000. Submissions were peer-reviewed, and the most promising and profitable ones were implemented. The contest proved so successful that it became an annual event. From nearly a thousand projects, a startling pattern emerged.

The confirmed return on investment for 575 audited projects averaged 204 percent per year, with average annual savings of \$110 million. In only one year did the average annual return for the implemented projects even slip below triple digits (to 97 percent). Dow Louisiana found not \$20 bills but \$100,000 bills lying all over its shop floors.

And the energy savings became even larger and



more profitable. Far from exhausting the cheapest opportunities, Nelson's contests expanded them even faster through institutional learning and better technologies. It's as if each \$100,000 bill they picked up exposed a couple of new ones underneath.

In the first year, 27 projects costing a total of \$1.7 million had an average annual return on investment of 173 percent, and according to Nelson, "many people felt there couldn't be others with such high returns." They were wrong. The next year, 32 projects costing a total of \$2.2 million returned an average of 340 percent per year. Learning quickly, Nelson changed the rules to eliminate the \$200,000 limit—with such lucrative opportunities, why stick to the small ones?—and to include projects that would raise manufacturing output. In 1989, 64 projects costing \$7.5 million yielded a 470 percent annual return on investment (the best so far). Even in the 12th year of the contests, 1993, the 140 winning projects averaged a 298 percent annual return.

Though meticulously measured and documented, Nelson's additions to Dow's bottom line do not come from fancy management theories, quality circles, empowerment processes, or other managerial rituals. Rather, they come from a practical shop-floor process that translates volunteer ingenuity into profits.

But here's the most surprising part. Far from instantly spreading throughout the chemical industry, Nelson's techniques have hardly even spread through Dow. Worse, in 1993, Nelson retired; reorganization wiped out his coordinating committee; and any continuing efforts can no longer be tracked.

It's a pity so few market economists have ever met anyone like Ken Nelson. Most would be hard pressed to believe the many examples like his; they can hardly conceive that such juicy savings would have lain untapped for decades, let alone that exploiting them should turn up even bigger and juicier ones. The faith that what's worth doing has already been done is unfortunately not just an intellectual error; it has the disastrous practical consequence of concealing what *can* be done.

How many market economists does it take to screw in a compact fluorescent light bulb? None (goes the joke)—the free market will do it. But without a Ken Nelson and without the common sense and hard work of the employees he inspires, the lamp will never get from the shelf into the socket. 🌐

RENEWABLES ARE READY

Two New Books See a Bright Future for Alternative Fuels

The tax credits have gone, the political climate is distinctly chilly, and many utilities are lying low amid continuing fears of industry restructuring. Yet the future of renewable energy has never looked brighter.

Since the mid-1980s, renewable energy technologies have been allowed to sink or swim in the free market—and they're swimming vigorously. The cost of electricity from renewable sources has fallen steadily in the past decade, to the point where some technologies—notably wind—can compete with and even beat fossil and nuclear fuels (see graph). Growing electricity demand in developing countries is creating a strong international market for renewables. In this country, photovoltaics have proved their worth for off-the-grid sites, and a proposed power-plant-sized PV installation in Nevada promises to usher in a new era of competitive solar power (see sidebar).

Against this backdrop, two new books offer contrasting, but equally useful, views of renewables' prospects.

A dispatch from the grassroots, *Renewables Are Ready: People Creating Renewable Energy Solutions* reports on the quiet revolution that's being forged by individuals and citizen



George Turner, SMUD
Changing times: The Sacramento Municipal Utility District has erected a grid-connected array of PV panels on the grounds of its now-abandoned Rancho Seco nuclear power plant.

groups at the community level.

Most observers agree that the remaining barriers to renewable energy aren't technological but institutional. *Renewables Are Ready's* mission is to show how communities have overcome typical economic, legislative, and social barriers, and it offers five strategies for repeating their successes:

- **Work with electric companies.** Like it or

not, no significant renewable project is going to happen if the local utility isn't on board. Many utilities just need a little coaching to see the advantages of diversifying into renewable sources.

- **Build niche markets.** Renewables—particularly photovoltaics—are often most cost-effective for specialized applications. Exploiting these "niche" uses broadens the

PHOTOVOLTAICS: COMING OF AGE

Newsletter reader Steve Stuebner recently attended a conference on global photovoltaic business opportunities in Sun Valley, Idaho. He sent us this report.

If the talk at Sun Valley was any indication, photovoltaics are rapidly coming of age.

For some utilities, like the Sacramento Municipal Utility District, PVs are already part of a long-term strategy to diversify. But with generating costs nearing 10¢ per kilowatt-hour, PVs are starting to look competitive in their own right.

The economics of photovoltaics may change forever in late 1996, when Amoco/Enron Solar Development Corp. is

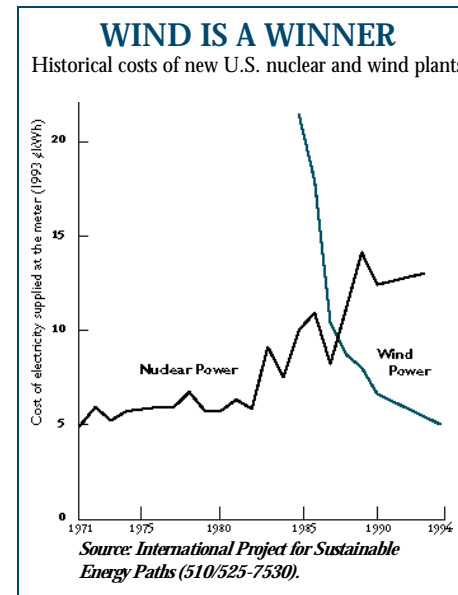
scheduled to bring on line a grid-connected 100-megawatt solar farm in the Nevada desert—the first of its kind. The power from that project will be sold initially for about 5.5¢ per kilowatt-hour, rising to an average somewhat over 7¢, putting it in the same league as many other sources. "We think that the market is here now," Amoco/Enron CEO Robert Kelly said. "And we think the market is huge."

Part of that huge market involves large developing countries such as India, China, and Brazil. Two billion people in these countries live in remote communities that aren't connected to an electric grid. With power line extensions costing an average of

\$30,000 a mile, PVs are often a far more cost-effective alternative, even at today's prices.

The World Bank, fulfilling its promise to reduce carbon dioxide emissions on a global scale, has pledged \$400 million for PV expansion in developing countries. "The World Bank is ready to finance PVs," Dennis Anderson, energy advisor to the World Bank, told the Sun Valley gathering. "What we need now is for people in the utility and energy industry to help encourage projects."

From megadams to microplants—that's quite a change for an institution like the World Bank. It seems as sure an indication as any that solar power has finally arrived. ☺



market for renewables, helping bring prices down even further.

- **Seek creative financing.** Renewables not only cost more upfront: they're also harder to finance using conventional sources. Fortunately, there are plenty of alternatives, ranging from state and federal grants to utility rebates to local cooperatives.
- **Change the energy rules.** Society still views renewables as futuristic or flaky. Combating this skepticism is easiest at the local level, where citizen activism can bring about more progressive government policies and a more favorable climate for renewables.
- **Educate by example.** Many people assume exploiting renewable energy isn't feasible, simply because they so rarely see it done. Demonstration projects help build public awareness and inspire other projects.

Case studies support the dictum that "whatever exists is possible," and *Renewables Are Ready's* generous use of them makes it a book after RMI's heart.

Power Plays: Profiles of America's Independent Renewable Electricity Developers takes a different tack, but one that's equally important to RMI. A market survey for investors

and institutions, it works within the financial system: by providing information often overlooked by mainstream analysts and media, it helps correct market failures and clear the way toward a soft energy path.

Published by the Investor Responsibility Research Center, *Power Plays* is updated every three years or so and contains in-depth analyses of the prospects for large-scale development of biomass, geothermal, wind, hydro, solar-thermal, and photovoltaic power. The 1995 edition profiles 100 companies working in these sectors. It's not exactly bedtime reading, but those looking to put their money to work in support of more benign energy sources will find it invaluable.

And what's the book's assessment of the investment potential for renewables? Over the long term, bullish. *Power Plays* doesn't

gloss over the industry's struggle to pull itself up by the bootstraps with dwindling government support, nor the challenge of competing with natural-gas-fired plants (now providing electricity for as little as 3¢ per kilowatt-hour). But it notes that strong overseas demand may ultimately drive the domestic market. Given continued technological advances and perhaps an increase in fossil-fuel prices and taxes, "renewable sources are favored to become the fastest-growing—and perhaps a dominant—source of power in the 21st century."

Renewables Are Ready is published by Chelsea Green and can be ordered from Real Goods Trading Company (800/762-7325).

Power Plays is available from the Investor Responsibility Research Center (202/833-0700). ☺

THE RENEWABLE SCENARIO

Not surprisingly, most in the energy industry believe that fossil fuels will continue to provide the lion's share of the world's energy well into the next century. Reports in the past few years by the World Energy Council and the International Energy Agency have forecast only a trifling role for renewables through 2020.

But a few dissenting voices are beginning to be heard, and they're not coming just from the fringes.

Shell International Petroleum Company's business environment group—the team that pioneered modern scenario planning (see cover story)—last year drafted a scenario in which renewables come to dominate world energy production by 2060. Driven by global economic liberalization and democratic reform, energy demand in developing nations grows rapidly, while increased competition favors greater energy efficiency and ever-cheaper renewable technologies.

A second scenario, based on greater political tensions and economic protectionism, envisions slower growth in energy

demand and less efficiency, but still suggests a growing role for renewables, especially in developing countries.

Heretical as it may sound to the energy industry, Shell's first scenario is consistent with projections by the Union of Concerned Scientists, the United Nations Solar Energy Group for Environment and Development, and other reputable groups.

And the notion is gaining credibility.

The Economist, a magazine not previously known for its love of renewable energy sources, has recently begun to take notice of their increasing viability in a free market. "As the arguments for giant hydro and nuclear plants grow weaker, the case for renewables gets stronger," argues a 7 October editorial. It goes on to note that renewables have a number of competitive advantages over conventional large-scale power sources, notably that they are less capital-intensive, can be constructed much more quickly, and don't require costly grid extensions—an echo of RMI's ongoing research into the benefits of "distributed resources" (see Summer 1994 *Newsletter*). ☺

HYPERCAR ECONOMICS 101

Can Ultralight Hybrids Be Affordable?

Advanced materials. Power electronics. Automobiles that are “more like computers with wheels than cars with chips.” The high-tech nature of hypercars may make them more efficient, better performing, and easier on the environment, but all those benefits will cost a lot...right?

Probably not, according to recent research by RMI’s Hypercar Center and a well-known technical cost modeling firm.

RMI and IBIS Associates of Wellesley, Mass. used a computer model to analyze the production and lifecycle costs of a carbon-fiber composite body-in-white (BIW), the technical term for the unfinished body and chassis of a car. As a case study, the model used the 1991 GM Ultralite, which, while not optimized for weight and cost, made extensive use of advanced materials, was built by a major automaker, and was simulated for crashworthiness.

GM only built two Ultralites, and their carbon-fiber bodies each cost more than \$13,000 just for materials. But things change if you build, say, 100,000 Ultralites instead of two: manufacturing economies of scale improve, cheaper manufacturing technologies can be employed, and composite vehicles can be judged at volumes similar to those normal for steel.

Thus RMI and IBIS looked at a hypothetical mass production of Ultralite BIWs, and compared both manufacturing as well as lifecycle (fuel, repair, and recycling) costs to those of a comparable steel BIW.


So how did the Ultralite fare against its steel counterparts? In

mass production of 100,000 vehicles per year, the Ultralite BIW, with numerous conservative design, manufacturing, and lifecycle assumptions, cost around \$2,500 to build. So far, so good, but still not as low as the steel BIW’s \$1,750.

Next, the team looked at several important, yet uncertain, variables to see how strongly they affected the results. Most important of these were carbon-fiber price and BIW mass.

Using a standard modeling procedure, they found that if the composite design is mass-optimized according to Big Three estimates (the Ultralite’s BIW was unnecessarily heavy), the composite BIW costs the same as steel when the price of carbon fiber drops to \$7.50 a pound—only about 6 percent less than the current bulk price. Still lighter BIWs are also feasible. And the current price may well fall. One major manufacturer estimates that the price of carbon fiber would drop to about \$5 a pound if carbon-fiber-bodied hypercars captured just 10 percent of the U.S. market.

It is, admittedly, a chicken-and-egg situation: the big automakers may want to wait on hypercars until the cost of materials come down, while the cost of materials won’t come down until the automakers start mass-producing hypercars. But regardless of which comes first, RMI’s research suggests that profits await both chicken and egg.

To order “Costing the Ultralite in Volume Production: Can Advanced Composite Bodies-in-White Be Affordable?” (T95-35), please see page 9. 

Basic Training for the Military

Why do Army buildings so often cost more money and deliver lower performance than comparable commercial-sector buildings? The Army’s Construction Engineering Research Laboratory wanted to know, and this summer called in RMI to investigate.


Ironically, the answer to CERL’s question may lie in procurement and design specifications that were supposed to keep costs down. In a two-day workshop conducted by RMI’s Green Development Services and other consultants, the team found that the Army’s specifications are almost entirely concerned with initial construction costs, giving purchasers little room to choose better, more efficient components that save on operational costs over the long haul.

More insidiously, while “value engineering” guidelines are supposed to take into account lifecycle costs, in practice purchasers analyze costs and benefits component by component, without regard to their interworkings—a penny-wise, pound-foolish policy that pursues small-scale savings and ends up promoting large-scale waste.

Simply changing these procedures could spell huge savings for a federal department that spends \$500 million a year on buildings and infrastructure (and for the taxpayers who ultimately foot

the bill). RMI submitted its recommendations to top Army officials in September. Since CERL commissioned the report, Army brass are likely to listen up.

Other presentations to the Navy and Marines also elicited much excitement and a growing momentum for basic reforms in design and procurement processes. Military leaders invited RMI to suggest ways to improve an office retrofit that had already been 95-percent designed, and despite severe timing and historic constraints, major savings were identified at little or no extra cost. Another workshop, aimed at reorienting the Navy’s multi-billion-dollar base-housing renovation and construction programs, is scheduled for November.

Lastly, an update on the greening of the Pentagon (Fall/Winter 1994 *Newsletter*): Being but one part of a massive \$1.2-billion renovation project, the RMI-coordinated report was sidelined for several months until its final release by the Pentagon Renovation Office in July. Renovation of the first “wedge” (one side of the five-sided building) was already under way, and so is expected to implement only some of the report’s recommendations, but subsequent wedges are likely to incorporate such proposals as high-performance windows and efficient direct/indirect lighting. 

RAISING THE ROOF

Major Improvements Make RMI's Headquarters Better Than Ever

RMI takes seriously its role as a demonstration site for state-of-the-art efficient technologies. We also want our workplace to be as comfortable as possible. So this summer it was time to make some major improvements to our 12-year-old headquarters building.

First on the list of priorities was the roof, which, after weathering some 40,000 pairs of visitors' feet, had developed leaks at the edge of its waterproof membrane. Thanks to donations by North Carolina Foam Industries of Mount Airy, N.C. and Isothermal Protective Coatings of Pearland, Texas, we now have a roof that's even better than before.

We kept essentially all of the old rigid foam insulation, but topped it up with another 3 inches of sprayed polyurethane that seals tightly to the parapet. A 1-inch thickness of this foam has an insulation value of R-7, so the new layer adds about R-20 to the previous R-60. (Actually, the improvement is probably greater, because the sprayed-on foam stops warm-air leaks up through cracks between the old sheets of foam.) The blowing agent was a relatively benign HCFC, since completely chlorine-free agents are not yet available



Digging in: André, Franz, Ruth, and Kate clear gravel from the old roof.

for this system.

Meanwhile, it was time to replace some of the building's superefficient windows, whose seals were beginning to break down due to higher than anticipated humidity from the greenhouse.

When it was completed in January 1984, RMI's headquarters boasted the first commercial application of argon-filled

Heat Mirror windows, which we had to have custom-built. Now, happily, they're mass-produced and far more reliable. The krypton-filled replacements, donated by Hurd Millwork of Medford, Wis., Alpen, Inc. of Boulder, Colo., and Southwall of Palo Alto, Calif., feature even better performance than their predecessors, with center-of-glass insulation values ranging from R-8.1 to R-10. In the near future we plan to install additional heat-exchanging ventilators to reduce humidity.

Our refrigerator and freezer were also nearing the end of their useful lives. Sun Frost of Arcata, Calif., provided replacements at a substantial discount. Like the originals, they're superinsulated and powered by top-mounted compressors and motors, making them roughly seven times more efficient than conventional units. The fridge also uses an external cooling fin for passive refrigeration in winter, roughly redoubling its efficiency.

RMI is deeply grateful to all the companies that donated their products for these renovations. We'd also like to thank Gordon Kapes, whose generous gift helped us buy many of the tools needed to carry out this work. 🌐

New Publications

GENERAL

G95-26. "Amory Lovins: The *Progressive* Interview." Q&A on everything from hypercars to photovoltaic water purifiers. 3 pp, \$2.00

E95-29. "Energy Efficiency: Time To Introduce Negative Action." A brief overview of "nega-" possibilities, from *Environment Strategy America 1994/95*. 2 pp, \$1.50

G95-31. "Rebel with a Cause." *New Scientist* profile touching on many aspects of RMI's recent work. 4 pp, \$2.00

TRANSPORTATION

T95-30. "Hypercar Talk to 1993 Asilomar Conference on Strategies for Sustainable Transportation." On superefficient cars and least-cost transportation options. 11 pp, \$6.00

T95-32. "Hypercar: A Threat to the Oil Industry?" Short interview with Amory Lovins in *Oil & Gas Journal*, plus a background piece from the same publication. 6 pp, \$3.00

T95-33. "Amory Lovins: Moving Toward a New System." Informal interview on hypercars, from a Society of Automotive Engineers book. 7 pp, \$4.00

T95-35. "Costing the Ultralite in Volume Production: Can Advanced Composite Bodies-in-White Be Affordable?" (see article, page 8). 14 pp, \$10.00

RESOURCE-EFFICIENT BUILDINGS

E95-28. "The Super-Efficient Passive Building Frontier." ASHRAE speech on how big energy savings can work better and cost less than small ones. 3 pp, \$2.00

RMI CATALOG

The *RMI Catalog* is now available. Call, fax, or e-mail us for a free copy. You can also view it and order publication from our homepage (<http://solstice.crest.org/rmi>).

SEMINAR INFORMATION

Space is still available in two upcoming Esalen Institute seminars in Big Sur, Calif.: "Energy, Resources, Environment, Development, and Security," led by Amory Lovins (15-17 Dec.), and "Green Buildings with Magical Spaces" (17-22 Dec.), led by Greg Franta. For registration information, call 408/667-3000.

1995: THE YEAR IN REVIEW

We're proud of our achievements in 1995. Here are the highlights:

Transportation

- ✦ Published a book on the materials and policy implications of hypercars, major papers on hypercar design and economics, and many other papers, presentations, and broadcasts.
- ✦ Published "Reinventing the Wheels," a major feature in *The Atlantic Monthly*.
- ✦ Expanded hypercar collaborations to include 25 current and would-be automakers, with capital commitments totaling around \$1 billion.
- ✦ Helped persuade the California Air Resources Board to propose new standards that could qualify hypercars as "zero-emission vehicles."
- ✦ Worked with local citizens and officials to seek alternatives to a contentious four-laning project in our own western Colorado valley.

Green Development

- ✦ Published and reprinted *A Primer on Sustainable Building*, a blueprint of sustainable techniques for architects and designers.
- ✦ Researched and began writing *Green Development: Integrating Real Estate and Ecology*, a guide for real-estate professionals.
- ✦ Worked with the Army, Navy, and Marine Corps to boost resource efficiency in multi-billion-dollar construction (see page 8).
- ✦ Consulted on green designs for a paper plant in Atlanta, an environmental education center in Vermont, an inner-city redevelopment in Chicago, and university housing nationwide.
- ✦ Launched a national experiment to test performance-based design fees in energy-efficient buildings.
- ✦ Played a central role in creating a consortium to develop large commercial buildings that set new energy and environmental standards.
- ✦ Helped create a CD-ROM based on the RMI-led "Greening of the White House."

Energy

- ✦ Published *Homemade Money*, a manual on cost-effective household energy savings.
- ✦ Published *The Energy Directory Kit*, software enabling users to create their own directory of energy-efficient goods and services.

- ✦ Continued research on the extra economic value of decentralized electric resources.
- ✦ Helped persuade California regulators to reject "retail wheeling," a utility restructuring proposal that would have destroyed existed market-based incentives for efficiency.
- ✦ Added two more titles to the *Home Energy Briefs* series.
- ✦ Published a half-dozen other technical papers on energy issues.
- ✦ Made presentations on advanced energy efficiency to audiences in nine countries.

Corporate Sustainability

- ✦ Co-authored *Faktor Vier*, a German-language book on advanced resource efficiency (see page 5).
- ✦ Created (with Global Futures Foundation) The Future 500, a corporate roundtable to spread the practice of resource efficiency for greater profits and competitiveness.
- ✦ Established a Systems Group on Forests, growing out of our mediation between Mitsubishi Corporation and Rainforest Action Network, to explore alternative forestry practices that are both sustainable and profitable.
- ✦ Organized "Jobs and the Environment," a conference on the job-creating potential of sustainable and renewable technologies in Colorado.

Global Security

- ✦ Authored *Christian Science Monitor* and *Wall Street Journal* pieces on the extension of the Nuclear Nonproliferation Treaty.
- ✦ Briefed Navy and Marine Corps leaders on resource efficiency and national security.

Economic Renewal

- ✦ Published *The Community Energy Workbook*, a step-by-step guide to revitalizing local economies through energy efficiency.
- ✦ Researched and wrote a booklet outlining opportunities for resource efficiency and pollution prevention at the local level.
- ✦ Revised and updated *The Economic Renewal Guide*, soon to be released in its third edition.
- ✦ Published a paper examining the hidden costs of rapid community growth.

- ✦ Collaborated with communities in eight states on sustainable economic development.
- ✦ Participated in the Colorado Governor's Smart Growth Policy project.

Water & Agriculture

- ✦ Led a scenario planning project on the future of residential water services (see cover story).
- ✦ Helped develop a system-dynamics model for sustainable watershed management in Idaho's Snake River Basin (see page 4).
- ✦ Contributed a chapter on water efficiency to *The Encyclopedia of Energy Technology and the Environment* and peer-reviewed water publications for several other organizations.
- ✦ Made presentations to the Water Pollution Control Federation, sponsored a meeting of the new Colorado Water Conservation Alliance, and helped save water at the White House.

Communications

- ✦ Implemented marketing and promotional plans for three new RMI books.
- ✦ Produced RMI's first-ever publications catalog, in both paper and Internet versions, and expanded our Net presence.
- ✦ Helped place or prepare stories about RMI's work in hundreds of newspapers and magazines and dozens of radio and TV broadcasts.
- ✦ Fielded an average of 200 calls a week from householders, students, teachers, small businesses, large corporations, utilities, real-estate developers, and others.
- ✦ Showed RMI's facilities to over 1,000 visitors.

Facilities & Operations

- ✦ Negotiated for the purchase of a nearby property to secure permanent office space and land for long-term staff housing (see page 3).
- ✦ Continued upgrading computer systems and added ISDN lines to enhance PictureTel and inter-building Ethernet capabilities.
- ✦ Replaced or upgraded roof insulation, glazings, refrigerators, and photovoltaic systems (see page 9).
- ✦ Created custom software for more productively fulfilling orders and outreach.

PUTTING ALL OUR BEGS IN ONE ASKIT



Dear Friends,

Once—and only once—each year Rocky Mountain Institute makes a special appeal to you, our partners and supporters, to include the Institute in your year-end giving. We call this “putting all our begs in one askit.” Many of you have expressed appreciation for this low-key approach to fundraising, and for our practice of not selling, renting, or lending our mailing list. These policies remain in effect. So does the tax-deductibility of your support.

RMI has pioneered in developing and promoting mutually beneficial ways to use resources efficiently, respect the earth and its inhabitants, and still prosper. Often this research has been ahead of the mainstream in grant funding, and 1995 has been no exception. More than half of the highlights on the facing page were achieved *pro bono* (either as a public service or to maintain unquestionable objectivity) or with only partial grant funding.

Through this research, RMI seeks solutions to resource problems that transcend ideology and benefit everyone. In an age of partisan confrontation, the Institute's objective, pathfinding research and nonadversarial approach have gained the respect of parties with widely differing views. Our independence, high standards, and refusal to lobby or litigate remain among the Institute's core strengths.

In the past, our readers' support has been generous and deeply appreciated. Your gifts provide much of the unrestricted income that gives RMI the flexibility to grasp fast-changing opportunities to work toward resource sustainability, global security, and a healthy environment. Together we have accomplished much, but there is much left to do. Please help.

Everyone at the Institute joins us in sending season's greetings. May peace be with you and with the world.

Sincerely,

L. Hunter Lovins,
Executive Director

Amory B. Lovins,
Director of Research

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Our sincere appreciation is offered to these friends who have contributed to RMI's support between 1 May and 31 August 1995. Numbers in parentheses indicate multiple donations. Please let us know if your name has been omitted or misspelled so it can be corrected in the next issue.

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