Amory Lovins has a vision: The U.S. economy keeps going and going and going—without any oil

By Cal Fussman

Photography by Ben Stechschulte
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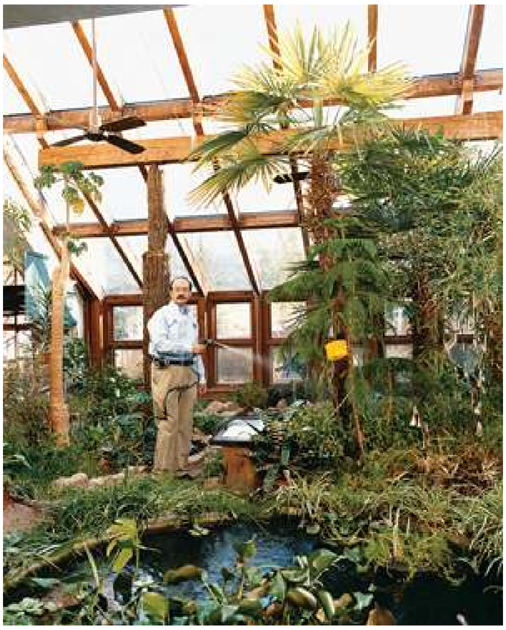
AMORY LOVINS is a physicist, economist, inventor, automobile designer, consultant to 18 heads of state, author of 29 books, and cofounder of Rocky Mountain Institute, an environmental think tank. most of all, he's a man who takes pride in saving energy. The electricity bill at his 4,000-square-foot home in Old Snowmass, Colorado, is five dollars a month, and he's convinced he can do the same for all of us. His book *Winning The Oil Endgame* shows how the United States can save as much oil as it gets from the Persian Gulf by 2015 and how all oil imports can be eliminated by 2040. And that's just for starters.



Lovins waters tropical plants in a hothouse that serves as a "furnace" for his home/office in Old Snowmass, Colorado, where subfreezing temperatures are common throughout the winter. Overhead windows have special coatings that let light through but reflect interior heat. The pond is home to catfish, frogs, and crayfish.

As told to Cal Fussman

When I give talks about energy, the audience already knows about the problems. That's not what they've come to hear. So I don't talk about problems, only solutions. But after a while, during the question period, someone in the back will get up and give a long riff about all the bad things that are happening—most of which are basically true. There's only one way I've found to deal with that. After this person calms down, I gently ask whether feeling that way makes him more effective.

As René Dubos, the famous biologist, once said, "Despair is a sin."

ENERGY

I used to work for Edwin Land, the father of Polaroid photography. Land said that invention was the sudden cessation of stupidity. He also said that people who seem to have had a new idea often have just stopped having an old idea. So I suppose if I bring something unusual to this business, it's that maybe I find it easier to stop having old ideas.

I can't point to any one moment in particular from my past that made me who I am. It's been more like seeing the world through an evolving lens. Gradually, I've learned to ask different questions and look at problems from different angles than most people.

I'm probably best known for having redefined the energy problem in 1976 with a Foreign Affairs article titled "Energy Strategy: The Road Not Taken?"

Until then, the energy problem was generally considered to be: Where do we get more energy? People were preoccupied with where we could get more energy of any kind, from any sources, for any price—as if all our needs were the same. I started instead at the other end of the problem: What do we want the energy for?

You don't generally want lumps of coal or barrels of sticky black goo. You want comfort, illumination, mobility, baked bread, and so on. And for each of these end uses we should ask: How much energy, of what quality, at what scale, from what source will do the job in the cheapest way? That's now called the end-use/least-cost approach, and a lot of the work we do at Rocky Mountain Institute involves applying it to a wide range of situations.

End-use/least-cost analysis begins with a simple question: What are you really trying to do? If you go to the hardware store looking for a drill, chances are what you really want is not a drill but a hole. And then there's a reason you want the hole. If you ask enough layers of "Why?"—as Taiichi Ohno, the inventor of the Toyota production system, told us—you typically get to the root of the problem.

OIL

Let's start with one basic problem. Saudi Arabia has a quarter of the world's oil reserves. It is the sole swing producer with significant capacity to increase output, and therefore it controls the world price.

Two-thirds of Saudi oil flows through one processing plant and two terminals that are in the crosshairs of terrorists. That stuff could go down any day for a long time. And that would presumably crash both the House of Saud and the Western economy. So for the bad guys it's a twofer. They would love to do that, and they've already had a couple of cracks at it.

Now, this should make you uncomfortable. But we don't have to continue on our current path. We can go a different way.

Let's look at oil through a historic analogy. Around 1850, the biggest or second-biggest industry in America was whaling. Most buildings were lit with whale oil. But in the nine years before Edwin Drake struck oil in 1859 in Pennsylvania and made kerosene ubiquitous, at least five-sixths of the whale oil–lighting market had already been lost to competing products made from coal. This was elicited by the relatively high price of whale oil as the whales got shy and scarce.

The whalers were astounded that they ran out of customers before they ran out of whales. They didn't see this coming because they hadn't added up the competitors. Oil fields can be like this today.

The United States today wrings twice as much work from each barrel of oil as it did in 1975. With even more advanced technologies, we can double oil efficiency all over again at a cost averaging $12 a barrel. We can replace the rest of our oil needs with advanced biofuels and saved natural gas at a cost averaging $18 a barrel. Combined, these two approaches average out at a cost of $15 a barrel. That's a lot cheaper than the $61 per barrel oil was the other day or even the $26 that's officially forecast for the year 2025.

How much cheaper than $26 a barrel? Well, about $70 billion a year, plus a million jobs, mostly in rural and small-town America. Plus a million saved jobs now at risk, mainly in the automaking states.

We've got a choice: Either we're going to continue importing efficient cars to help replace foreign oil, or we're going to employ our own people to make efficient cars and import neither the oil nor the car—which sounds like a better idea.

WEIGHT

A modern car, after 120 years of devoted engineering effort since Gottlieb Daimler built the first gasoline-powered vehicle, uses less than 1 percent of its fuel to move the driver. How does that happen?

Well, only an eighth of the fuel energy reaches the wheels. The rest of it is lost in the engine, drivetrain, and accessories, or wasted while the car is idling. Of the one-eighth that reaches the wheels, over half heats the tires on the road or the air that the car pushes aside. So only 6 percent of the original fuel energy accelerates the car. But remember, about 95 percent of the mass being accelerated is the car—not the driver. Hence, less than 1 percent of the fuel energy moves the driver. This is not very gratifying.

Well, the solution is equally inherent in the basic physics I just described. Three-quarters of the fuel usage is caused by the car's weight. Every unit of energy you save at the wheels by making the car a lot lighter will save an additional seven units of fuel that you don't need to waste getting it to the wheels.

So you can get this roughly eightfold leverage (three- to fourfold in the case of a hybrid) from the wheels back to the fuel tank by starting with the physics of the car, making it lighter and with lower drag. And indeed you can make the car radically lighter. We've figured out a cost-effective way to do that so you can end up with a 66-mile-per-gallon uncompromised SUV that has half the normal weight, has a third the normal fuel use, is safer, and repays the extra cost that comes with being a hybrid in less than two years.

PLASTIC

FIBER HOT SEAT

An automotive seat bucket from Fiberforge, a company chaired by Lovins, is ultralight and ultrastrong. Carbon fibers are laid into predetermined positions and sandwiched with reinforcing nylon. The flat, tailored blank is then heated, stamped on a hot molding die, cooled, and trimmed to produce the finished part.

Henry Ford said you don't need weight for strength. If you did need weight for strength, your bicycle helmet would be made of steel, not carbon fiber. And if you want to know how strong a very light material can be, try eating an Atlantic lobster with no tools.

The auto industry needs to move toward ultralight, ultrastrong carbon-fiber composites, almost certainly using thermoplastics that flow when heated and that can be easily molded—instead of the more brittle, expensive thermosets that need chemistry, baking, or some other change to set the resin into its final hard form. Thermoplastics are incredibly tough. They can absorb 12 times as much crash energy per pound as steel. So even though your car will be only half as heavy as it was before, it will still be safer when whacked by a heavier one.

With such materials, you can decouple size from weight. You can make the car big—protected and comfortable. But it won't be heavy—hostile and inefficient. This can save oil and lives at the same time, and it turns out you can greatly improve the economics of making the car because you might have in a carbon SUV only 14 body parts—instead of 140 to 280 in a steel auto body—each needing one low-pressure die set, instead of an average of four high-pressure steel-stamping die sets in the steel body. The parts snap together precisely in the right positions for gluing, like assembling a kid's toy, so you don't need all those jigs and robots. You basically get rid of the body shop this way, and then by laying color in the mold, you get rid of the paint shop too. There go the two hardest and costliest parts of making the car.

New jobs come partly by having a vibrantly competitive car industry rather than a failing one and partly due to the logical evolution of the auto industry toward computerization. Imagine the aftermarket for improved and customized software. The industry structure would be different, but we don't think there would be a net loss of jobs. The jobs would be safer, healthier, and better distributed. And the same revolution that's coming to automaking from advanced materials also applies to anything else that moves.

HYDROGEN

Many automakers are starting to understand that whoever goes ultralight first will take the lead in the hydrogen fuel-cell race.

The winning strategy will be improving the physics of the car. They still need to make a cheap, durable fuel cell. But if they can reduce the fuel cell and the hydrogen storage volume by three times, the cost reduces threefold.

That said, superefficient cars need hydrogen a lot less than hydrogen needs superefficient cars. If you have, say, an ultralight hybrid SUV burning gasoline at 66 miles per gallon, that isn't so bad—at least not compared to a similar one getting 18.5 miles per gallon on the road today.

If you then combine that with E85 fuel, which is 15 percent gasoline and 85 percent ethanol, you just got a 320-mile-per-gallon SUV because the efficiency times the biofuel saving of oil multiplies.

For that matter, if every car or light truck on the road in 2025 is only as efficient as the best hybrid cars and SUVs now in the showrooms, that would save twice as much oil as we currently import from the Persian Gulf. So it's not a very ambitious goal—and it doesn't even involve making vehicles ultralight.

Very efficient vehicles can get most of the same benefits without hydrogen by using today's gasoline/hybrid propulsion. However, once you have such vehicles, there is a robust business case for running them on hydrogen. Until you have those efficient vehicles, that business case is not very convincing.

I think hydrogen will be an important if not dominant energy carrier by 2050. In Winning the Oil Endgame, the comprehensive strategy we've developed at Rocky Mountain Institute for ending oil dependence, we see hydrogen as an optional add-on. It would be the most profitable and efficient way to use and save natural gas. But it's not necessary to get the country off oil at a profit; it's just icing on the cake.

ELECTRICITY

A question I ask a lot is, What's the right size for the job? I have a book called Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size. It points out 207 benefits of distributed resources, such as solar and wind power. When I begin to describe them, you'll find them really obvious:

Renewables, such as wind energy, have less financial risk from volatile fuel prices than fossil-fuel power plants because they don't need any fuel.

Small resources like solar cells or wind turbines have less financial risk than giant power plants that take many years to build.

Portable resources like solar panels have less financial risk than stationary power plants, because if the system evolves differently than you'd expected and you'd rather put it somewhere else, you simply stick it on a truck and move it.

This is all blindingly obvious, yet it hasn't been taken into account by the utility industry while buying its half trillion dollars' worth of assets.

Here's what happened: For the first century of the electricity business, the power plants were costlier and less reliable than the grid, so it made sense to build a bunch of big power plants backing each other up through the grid. Well—surprise—over the last 20 years, power plants have become cheaper and more reliable than the grid. Ninety-nine percent of our power failures originate in the grid—mostly in distribution. So now if you want to deliver reliable, affordable electricity, you need to make it at or near the customer's location.

Many people didn't notice this happening. But despite the market's not yet recognizing the benefits, the decentralized low- or no-carbon generators turn out to be greater in capacity and output than nuclear power worldwide. David already beat Goliath, but nobody noticed.

The nuclear advocates frequently state that only nuclear is big and fast enough to deal with global warming. Well, five years from now the official industry forecast suggests that decentralized low- and no-carbon generators will be adding 160 times as much capacity as nuclear will add up to that year. So those who think that the decentralized generators are small, slow, and futuristic or have an unacceptable risk of not being adopted at scale in the market have some serious explaining to do.

WIND

If I could do just one thing to solve our energy problems, I would allow energy to compete fairly at honest prices regardless of which kind it is, what technology it uses, how big it is, or who owns it. If we did that, we wouldn't have an oil problem, a climate problem, or a nuclear proliferation problem. Those are all artifacts of public policies that have distorted the market into buying things it wouldn't otherwise have bought because they were turkeys.

We have more than enough cost-effective wind power just on available land in the Dakotas to meet the United States' electricity needs. We wouldn't necessarily want to do it all in two states, and there are cheaper combinations of other technologies to do the whole job, but it's an enormous resource.

Germany and Spain each install over 2,000 megawatts of wind power every year. That figure exceeds the average global net addition of nuclear power every year in this decade. Denmark is now one-fifth wind powered; Germany, about a tenth.

Wind power is doubling every three years worldwide and solar power every two, and not because some countries subsidize it strongly. In fact, the subsidies are being phased out slowly in Germany and rapidly in Japan because they have achieved their purpose of creating world-class industries that will be able to make it on their own.

If everything competed solely on merit, wind energy in the United States would be a lot better off. It gets subsidized less than its competitors, and its subsidies are temporary, while its competitors' are permanent. In other words, the fossil and nuclear subsidies—nuclear being the biggest—are permanent, while renewable subsidies are temporary.

Congress's brief and irregular renewals of the tax credit for wind power have several times bankrupted wind-turbine manufacturers in the United States. Similar misguided policies have diminished the solar-cell industry. Half of the solar cells sold in the United States a decade ago were domestically made. Now that figure is only 8 percent.

DEFENSE

A major player in our energy future will be the Pentagon. Here's why: Trailing behind every half-mile-a-gallon Abrams tank—a peerless fighting machine if you can get it there—are two unarmored fuel trucks. Guess what the bad guys shoot at?

This is a very teachable moment—when the Pentagon becomes acutely aware of the cost and the risk of delivering fuel on the battlefield. They obviously need much lighter, more agile, radically more fuel-efficient forces.

A military transformation will have a much bigger payoff, in exactly the same way the Pentagon's research and development created the Internet, global positioning systems, the modern microchip industry, and advanced aero engines.

If you align military science and technology investments to capture this enormous improvement at a tactical, operational, and strategic level, guess what? You thereby transform the car, truck, and plane industries to get the country off oil, so we won't need to fight over the oil because we won't be using it. Mission unnecessary.

BANANAS

When we designed the research facilities at Rocky Mountain Institute, we didn't plan on having a banana farm inside. We're up 7,100 feet in the Rockies, and it has gotten as low as –47 degrees in the winter.

We planned about 900 square feet of jungle space with five different kinds of energy collection: heat, hot air, hot water, light, and photosynthesis. The arch that holds it up has 12 different functions, but I paid for it only once. The whole building exemplifies design integration: getting multiple benefits from single expenditures. It saves about 99 percent of the normal need for space- and water-heating energy, about 90 percent of the household electricity, and half the water. All that efficiency paid for itself in 10 months—and that's with 1983 technology! Now we can do a lot better.

Lovins noshes on a banana in front of one of two 3-by-6-foot tracking photovoltaic collectors that together provide all his household power. Over the years, he and his colleagues have produced multiple banana crops in the hothouse atrium. "We sometimes call the building the passive solar banana farm," Lovins says.

Anyway, we weren't planning on growing bananas here, but somebody who owed me something gave me a banana tree to settle the obligation. He said it would grow to six feet and never fruit—but he forgot to tell the tree. When it got 12-year-old horse manure, it went bananas, grew to 25 feet, put out nine crops in the first year and a half, and tried to go through the roof. Then it tried to eat the fishpond.

I was afraid of a hydraulic disaster, so we chopped it down, dug it up, and put a steel fence between what was left of the root-ball and the fishpond. But it grew back and put out another 18 crops. Eventually, a few years ago, it wore out at twice its designed life, so we took it out for good and put in a variety of young banana trees. We've also done mangoes, grapes, papayas, and passion fruit—here in the Rocky Mountains.

The tangled tale of the banana tree offers a very simple lesson: Be open to possibilities.