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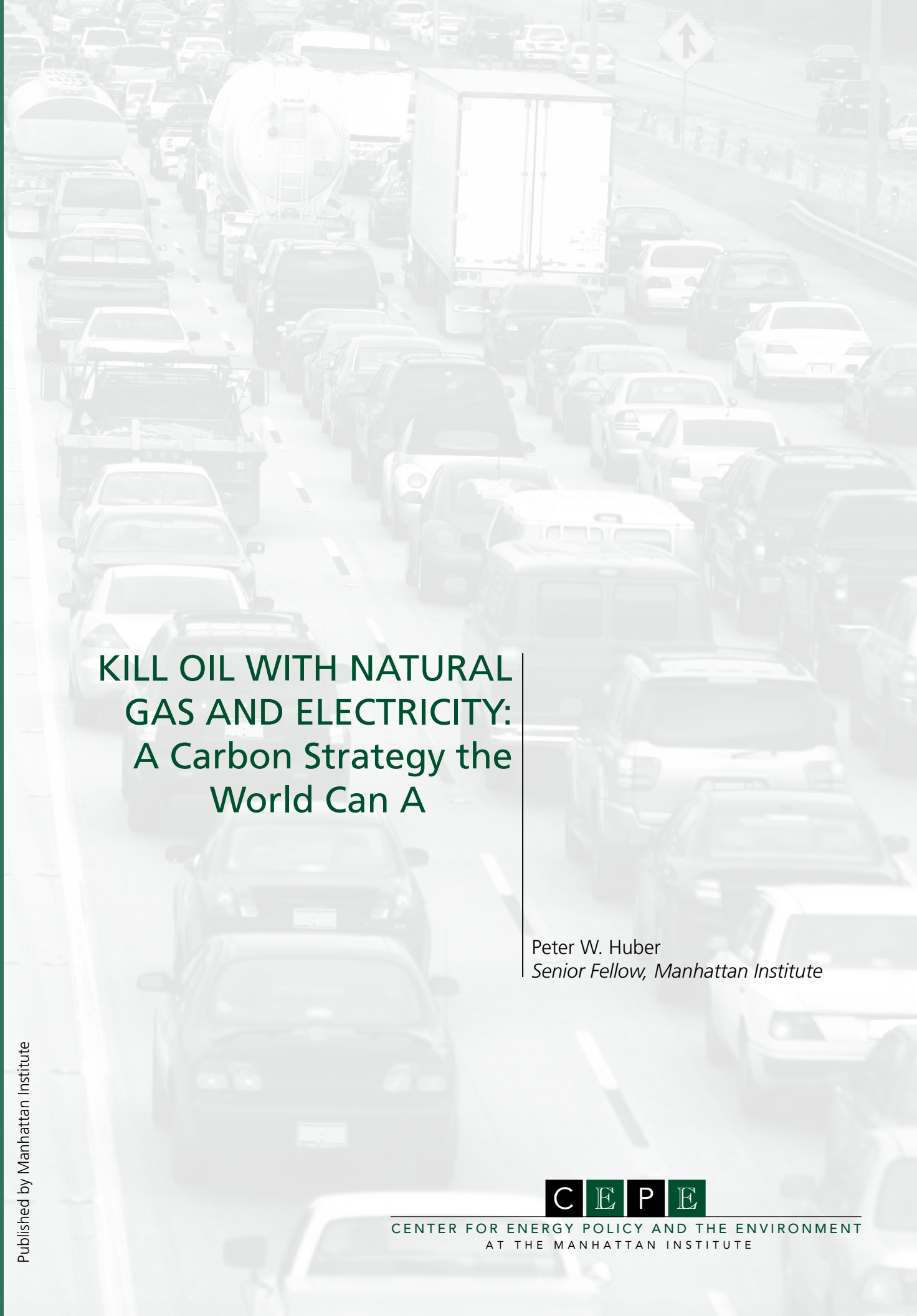

KILL OIL WITH NATURAL GAS AND ELECTRICITY: A Carbon Strategy the World Can A

Peter W. Huber
Senior Fellow, Manhattan Institute

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CENTER FOR ENERGY POLICY AND THE ENVIRONMENT
AT THE MANHATTAN INSTITUTE

Executive Summary

Chasing carbon, we're often told, will get us over oil, too. Most of the rest of the world doesn't believe it. About 80 percent of the world's people live in poor countries that are as eager as we are to get beyond oil. The people who can least afford to be wrong have also accepted the inconvenient economic truth: coal, gas, and uranium are the only practical, affordable substitutes for oil, and will remain so for a very long time to come. They're cheaper, and plentiful supplies are scattered all over the planet.

Oil can be beaten. Its share of the U.S. energy market peaked just shy of 50 percent in 1977; today, it's under 40 percent. The global trends have been similar. Gas and coal grabbed half of what oil lost. Uranium took the rest. Oil now depends on transportation for over 70 percent of U.S. demand. A similar blend of coal-gas-uranium electricity and straight gas can squeeze oil off the highway, too.

Natural gas currently powers about 10 million vehicles worldwide—most notably buses and urban fleets of trucks and delivery vehicles. Oil owes much of its hegemony on our own U.S. highways to decades of bungled government policy that left vast amounts of gas stranded underground and countless potential buyers unable to buy it at any price. Getting gas to the highway was never a priority.

It should have been. Gas-handling technologies had improved quite enough to make natural gas a practical alternative when the Arabs embargoed their oil in 1973. Larger vehicles can easily accommodate the larger tanks that compressed gas requires to provide acceptable range. In much of the world, gas is cheaper. At current levels of production, gas could power all our U.S. wheels, and we could almost certainly increase production enough to cover all the wheels and all current uses too.

Electric cars are certainly coming as well, and the poor will embrace them too when the hardware gets cheap enough. But no foreseeable battery pack is going to move forty-ton trucks cross-country, batteries will remain impractical for most heavy-duty vehicles of any size, and the cheapest way to light the grid is to burn coal.

Absent new carbon mandates, gas will first be used to displace oil. Carbon mandates will instead promote the use of gas to displace coal—a policy that will be quietly welcomed by the autocrats who control 80 percent of the world's easily accessible oil. The world's poor will ignore the mandates and adopt ostensibly greener technologies only piecemeal. As a result, the most touted hardware will probably end up raising carbon emissions, not lowering them. Using gas to beat oil is the best carbon strategy because it costs less, not more, so the 80 percent of the planet that emits more than half of the greenhouse gas can embrace it, too.

Our fossil-fuel policy should be to continue developing gas-extraction technologies, promote their use in the United States, and by improving what we already do so well, help kick oil out of hundreds of millions of furnaces and engines worldwide. At home and abroad, the less affluent will be delighted to join the rich in swatting down oil with cheaper gas, and will reduce carbon emissions as they do.

About the Author

PETER W. HUBER is a senior fellow at the Manhattan Institute and a columnist for *Forbes* magazine. He is the author of numerous books and articles on energy, the environment, science and technology, legal policy, scientific evidence, and telecommunications. He taught mechanical engineering at the Massachusetts Institute of Technology, and clerked for Judge Ruth Bader Ginsburg at the D.C. Circuit Court of Appeals and for Justice Sandra Day O'Connor at the U.S. Supreme Court. He has a Ph.D. from MIT and a J.D. from Harvard Law School. His most recent book, co-authored with Mark P. Mills, is *The Bottomless Well* (Basic Books, 2005).

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Kill Oil with Natural Gas and Electricity: A Carbon Strategy the World Can Afford

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Washington's latest fuel-economy mandate—36 miles per gallon by 2016—looks timid beside India's new Tata Nano, which gets 50 today. The Nano won't, however, reduce India's oil imports or carbon emissions. It's a much better car than Henry Ford's Model T, it gets two to three times better mileage, and sells for about one-eighth the price. It is, in short, just the kind of car that will allow India and much of the rest of the world to start catching up with America's wheel count: five cars and two trucks or buses for every ten citizens. Look for 2 billion new cars added to the planet's present fleet of 500 million, 800 million new trucks and buses to join the 200 million already rolling, soaring demand for oil, sky-high prices, more cash for the oil nasties, and more carbon in the air.

Chasing carbon, we're often told, will get us over oil, too. Most of the rest of the world doesn't believe it. About 80 percent of the world's people live in poor countries that are as eager to get over oil as we are—they, too, want to escape the economic clutches of autocrats who rule 10 percent of the people but control 80 percent of the easily accessible oil. The poor, however, have made clear that they won't be spending what money they have curbing carbon, though collectively they emit more greenhouse gas than we do and their emissions are rising much faster. The people who can least afford to be wrong have accepted the inconvenient economic truth: coal, gas, and uranium are the only practical, affordable substitutes for oil and will remain so for a very long time to come.

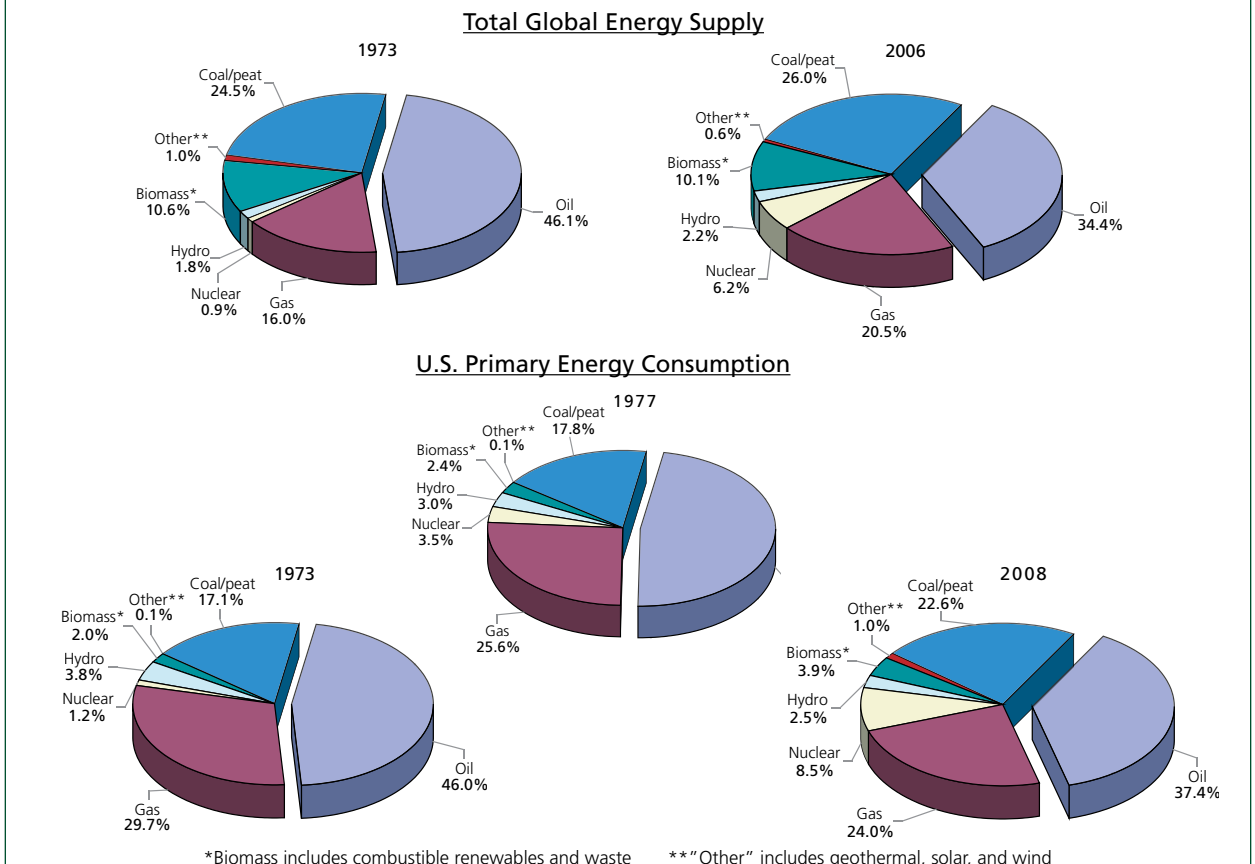
Earth to the carbon police: kill oil first. Do that, and you'll kill some carbon too. Chase carbon willy-nilly instead, and the poor will ignore you, oil will thrive, the oil nasties will celebrate, and carbon emissions will rise, not fall.

SQUEEZING OIL

Rich and poor alike have been trying to get over oil since the Arab oil embargo of 1973. We failed—global consumption has risen 40 percent. But we succeeded, too—oil's share of both the global and the U.S. energy pies is down more than ten points and continues to drop. Gas and coal grabbed half of what oil lost, and uranium took the rest. Electricity producers ditched oil almost completely. Taking into account the electricity generated with those three fuels, coal, gas, and uranium have crushed oil in markets that (putting aside oil used as a feedstock in the petrochemical industry) account for over 70 percent of total U.S. energy consumption. Gas alone now dwarfs oil in both the residential and commercial sectors and is about even in the industrial sector.

There's no mystery why. Coal and uranium are far cheaper than oil in meeting base-load demand for electricity. Gas has chased oil out of the smaller electric power plants that burn higher-grade fuel to meet intermittent periods of peak demand because even the very crudest fraction of crude—"residual fuel oil"—is usually quite a bit more expensive. Diesel and gasoline, oil's higher-grade components, cost even more, and the gap has widened as oil prices have spiked upward. Huge deposits of easily mined coal are found all over the planet. Gas is equally ubiquitous,

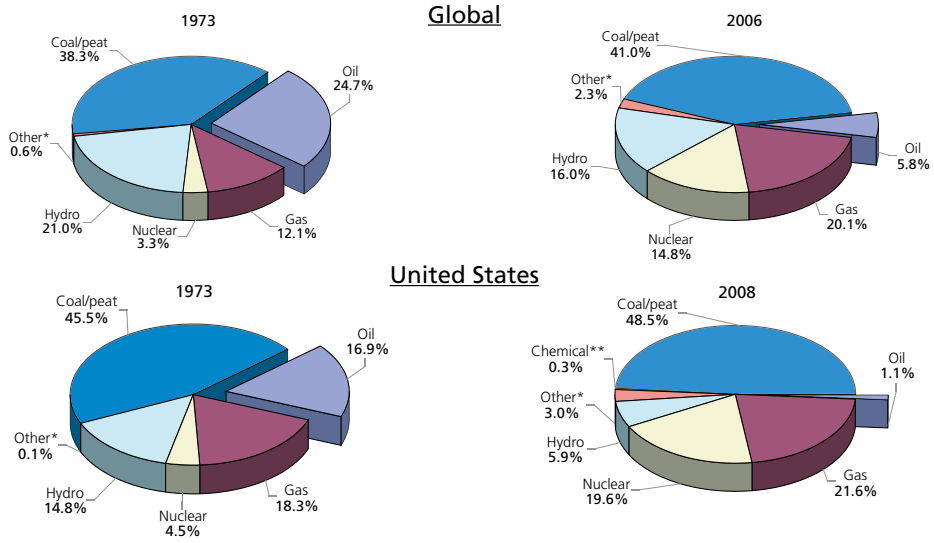
Figure I. Squeezing Oil Out of Global and U.S. Energy Markets



*Biomass includes combustible renewables and waste **"Other" includes geothermal, solar, and wind

Sources: International Energy Agency, http://www.iea.org/textbase/nppdf/free/2008/key_stats_2008.pdf; Energy Information Administration, http://www.eia.doe.gov/emeu/aer/txt/ptb0103.html

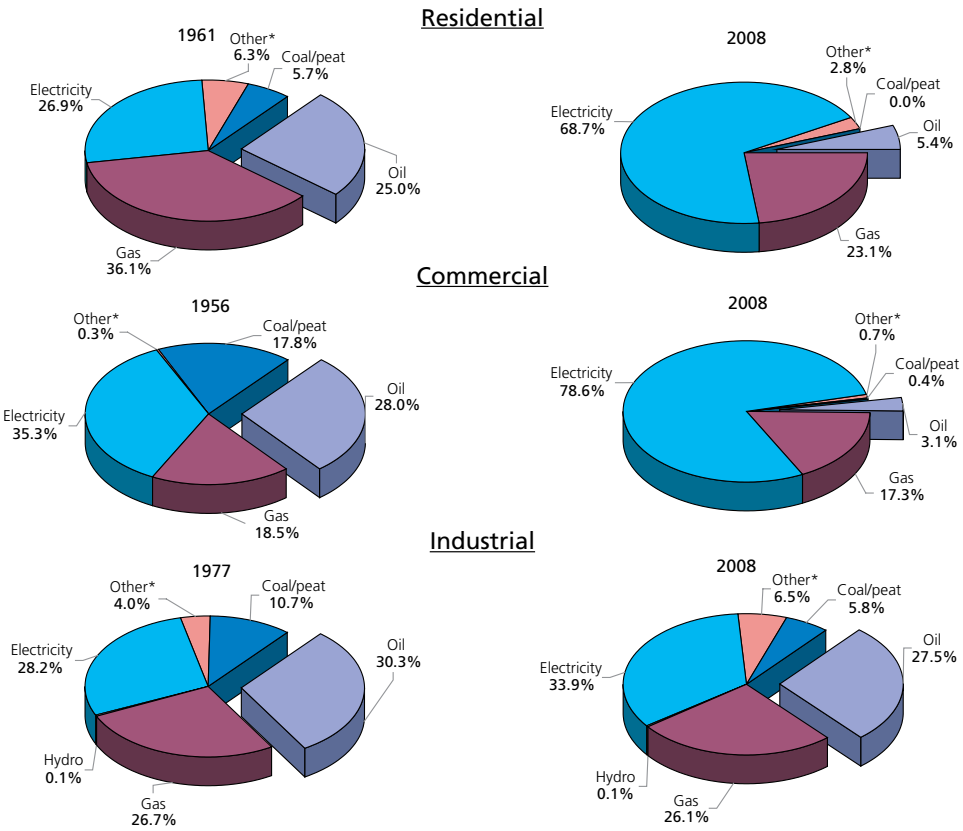
Figure 2. Squeezing Oil Out of Electric Power Plants



*"Other" includes geothermal, solar, wind, combustible renewables and waste, and heat
**Batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, miscellaneous technologies, and, beginning in 2001, non-renewable waste (from non-biogenic sources and tire-derived fuels)

Sources: International Energy Agency, http://www.iea.org/textbase/nppdf/free/2008/key_stats_2008.pdf; Energy Information Administration, http://www.eia.doe.gov/emeu/aer/txt/stb0802a.xls

Figure 3. Squeezing Oil Out of Three U.S. Sectors — Peak and Present

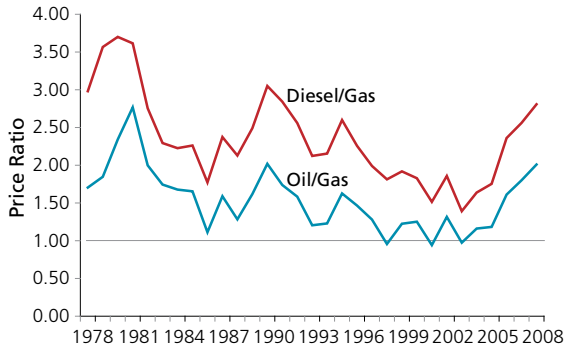


*"Other" includes geothermal, solar and biomass

Source: Energy Information Administration, http://www.eia.doe.gov/emeu/aer/txt/ptb0201b.html; http://www.eia.doe.gov/emeu/aer/txt/ptb0201c.html; http://www.eia.doe.gov/emeu/aer/txt/ptb0201d.html

easier to extract than oil, easier to transport than coal, and burns more cleanly than both. Uranium is readily available from stable, reliable suppliers in Canada, Australia, and elsewhere.

Figure 4. Energy-Equivalent Price Ratios



Source: Energy Information Administration
http://www.eia.doe.gov/emeu/mer/contents.html

So we've got oil cornered. Squeezed out of much of the rest of the energy market by the closing jaws of straight gas and coal-gas-uranium electricity, oil now depends on transportation for over 60 percent of global demand, closer to 70 percent of U.S. demand, and closer to 80 percent of the demand for oil that's used for energy rather than as feedstock for the petrochemical industry. And the jaws of gas and electricity can squeeze oil off the highway, too.

GAS AND PIPES

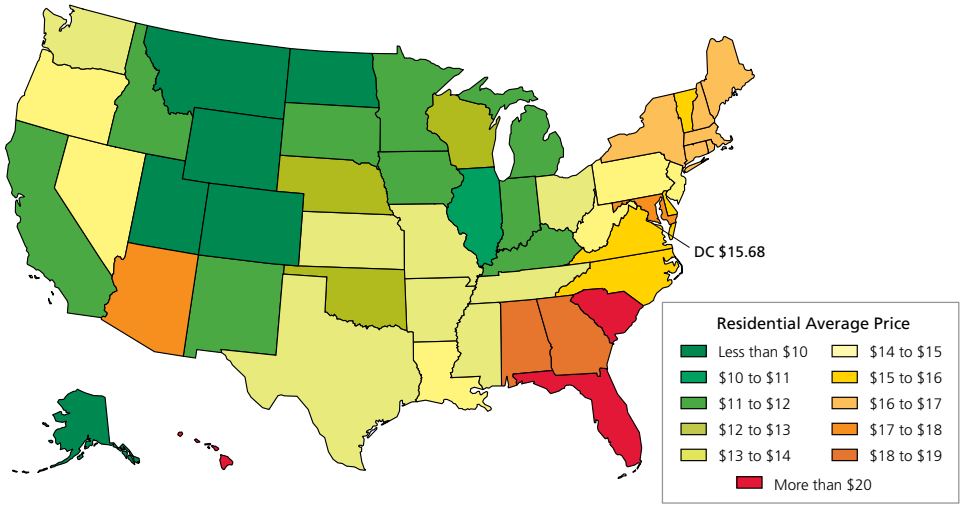
The squeeze should have started long ago. With the technology available in the days of Ford's Model T, using liquid fuels made it much easier to get lots of energy quickly and securely on board. But gas-handling technologies had improved quite enough to make natural gas a practical alternative when the Arabs embargoed their oil in 1973. With minor changes in design, today's truck and car engines can run equally well on gas: major manufacturers have had no trouble modifying existing diesel engines to run on gas and bolting them on to existing engine mounts in trucks and buses. Larger vehicles can easily accommodate the larger tanks that compressed gas requires to provide acceptable range. And in much of the world, gas is cheaper.

This is why other countries got the squeezing started some time ago. Natural gas currently powers about 10 million vehicles worldwide—most notably buses and urban fleets of trucks and delivery vehicles. About half are in South America, the Indian subcontinent, and other parts of Asia. If gas had been ubiquitously available at U.S. gas pumps all along, it would already be powering many of our own wheels, too. Being able to drive only 150 miles rather than 300 between refueling is a showstopper if the pumps are 151 miles apart, but only a modest inconvenience if fuel is available every fifteen miles. And as millions of shoppers prove when they trek to distant Wal-Marts every weekend, modest inconvenience isn't enough to maintain big price spreads.

Oil does still have one big advantage over gas—with existing tanks it can pack roughly twice as much energy into the same weight and space. That's a real but by no means decisive advantage in designing practical vehicles—but it has been a huge advantage in dealing with the government. From the beginning, oil's portability allowed it to move from the wellhead to end users without waiting for a go-ahead from the authorities—oil can easily move on the same waterways and tracks as other goods, and then in tanker trucks that use the same roads as the cars they fuel. Gas can't. Thin, slippery, and hard to contain, it depends on pipes that run across public land, so it moves only when and where the government says it should. Getting new pipes approved has never been easy, and the process has spawned all sorts of regulatory mischief.

For forty years, the pipe police figured they should also regulate retail gas prices. For twenty-five, they felt they ought to regulate wholesale rates at the wellhead, too. For nine, they barred construction of new gas-fired electric power plants and restricted the use of gas in industrial boilers in order to protect other users from higher gas prices. All this left vast amounts of gas stranded underground and countless potential buyers unable to buy it at any price. To this day, gas costs twice as much in pipe-poor parts of the country as it does in states that produce it, or that are crossed by major trunk lines, or that have friendly pipe regulators. Fickle changes in the regulatory winds have caused scarcities, gluts, and boom-and-bust price instabilities

Figure 5. U.S. Residential Natural Gas Prices by State, 2007 (Dollars per Mcf)



Source: Energy Information Administration, graph adapted from *Natural Gas Monthly*, October 2008, http://www.eia.doe.gov/neic/brochure/oil_gas/rngp/index.html

as ruinous in gas markets as any ever orchestrated by OPEC for oil.

Gas should have been unleashed to fight oil in 1973, but Washington had other ideas. The authorities capped oil prices, rationed gasoline, issued the first fuel-economy mandates, exempted ethanol from federal automotive fuel taxes, instructed electric utilities and large industrial users to lay off both oil and gas to save oil for driving and gas for home heating, and launched a $20 billion program to convert coal to liquid fuel. The price caps and rationing precipitated huge lines at gas stations, and were soon abandoned. The fuel-use restrictions were repealed a decade later. Coal liquefaction was a bust. And oil's share of the U.S. energy market peaked just shy of 50 percent in 1977.

As the price of oil then fell back to Earth, the energy constables shifted their attention from dollars to environmental currencies. The gas-fired electric power plant outlawed earlier by the fuel-use law now became sort of mandatory, and there was a spasm of green interest in powering cars with gas, too. The free-market faithful and the gas-is-greener crowd joined forces to deregulate gas, but at such a glacial pace that the market couldn't react until the 1990s, by which time the Asian economic crisis was driving the price of oil down toward the historical low it hit in 1998. Ramping up production takes years in an industry where both supply and demand depend completely on the ubiquity of government-approved pipes.

All the regulatory obstacles notwithstanding, gas has been much cheaper than gasoline, and significantly cheaper than diesel, for most of the last thirty years. Stationary users switched to gas one furnace or boiler at a time, when the natural gas pipes finally arrived and the old hardware was ready to be junked. New power plants and factories were deliberately sited near big pipes. But getting natural gas to the highway so it could compete head-to-head against oil was never a policy, still less a priority. Oil owes much of its hegemony on our highways to decades of bungled government policy. If natural gas were readily available on the highway today, many trucks and buses—and quite a few cars too—would be tanking up on it within ten years.

CARBON AND MONEY

Absent new carbon mandates, gas will first be used to displace oil. Using gas to displace 4 billion barrels of oil a year—roughly what it takes to power all U.S. wheels—would save $100

billion or so a year on the highway, while using it to displace an equivalent amount of coal would cost us $100 billion or so on the grid, the exact numbers depending on the prevailing price of each fuel. The carbon police, by contrast, will aim to kill coal first. As they see things, no fossil fuel is good, but gas is the least bad and coal is the worst, so the best use of gas is to displace coal. Nuclear power, though carbon-free, is disliked for other reasons. So carbon mandates will, above all, promote the use of gas to displace coal. The oil nasties will quietly welcome this development. The world's poor will ignore the mandates and adopt ostensibly greener technologies only piecemeal: as a result, the most touted hardware will probably end up raising total carbon emissions, not lowering them.

The great green hope, it seems, is to get us all cruising down that ribbon of highway on electric wheels powered from a grid lit by wind and sun. Until we get there, efficiency mandates will curb emissions from cars and trucks, and liquid biofuels will displace a chunk of oil and zero out net carbon emissions as they do. But how will these hopes play out in New Delhi and Beijing?

The poor love efficiency even more than we do, and they excel at making the most out of the least. As discussed by Marvin Harris in *Cows, Pigs, Wars, and Witches*, the sanctity of the cow in India protects an animal that feeds largely on waste and weeds, serves as "the Indian peasant's tractor, thresher, and family car," provides milk to a protein-poor economy, and produces tens of millions of tons of dung used as fuel for cooking. The hyperefficient cow thus sustains more Indians, more cows, and more total energy consumption, not less. Indians still like their cows, but many would now prefer to drive a Nano, and will be able to all the sooner because twice the mileage cuts the per-mile price of gasoline in half.

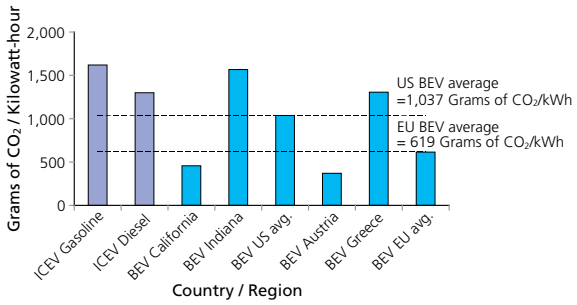
Biofuels have other problems. Almost all the world's ethanol is produced by the United States (from cheap corn) and by Brazil (from cheap sugar) and almost none by people who still strain to eke calories out of their fields. Biodiesel can be produced from inedible sources as well, but the enzymes that melt fuel out of cellulose don't care whether it comes from an agricultural waste pit, a virgin prairie, or a rain forest. It will also take vast amounts of new cellulose to make a serious dent in oil—combustible biomass currently supplies about one-third as much energy as humanity gets from oil. And calling things renewable doesn't mean they get renewed—the developing world is cutting down old trees much faster than it's growing new ones. On the global greenhouse ledger, agriculture, forestry, and deforestation already cost the planet more than twice as much as transportation.

How about electric cars? Efficiency mandates are pushing the developed world toward hybrid-electric cars in any event, and hybrids can easily start plugging in. Humanity already funnels as much energy into its grids as into its wheels, and could easily boost generating capacity enough to power the wheels, too. And because huge power plants burn cheaper fuel and run much more efficiently than car engines, they can power vehicles very cheaply, if there's a cheap way to get the power to the wheels.

The cheapest way to light the grid, however, is to burn coal. Every few years, China and India are building as much new coal-fired capacity as we currently operate nationwide. It makes economic sense to use gas only in smaller plants that run intermittently to meet peak loads: and even then, peak power is so expensive that the poor settle for rolling blackouts instead. California has the greenest grid in the country—almost half the electricity it generates comes from gas and almost none from coal—and its power costs twice as much as Indiana's, which is mostly coal. The indubitably green World Wildlife Fund concludes that rolling on electricity rather than gasoline will lower carbon emissions even in Indiana because higher power-plant efficiency more than offsets the dirtier fuel. But rolling on a less efficient and even more coal-rich grid in China might well end up less green than rolling on gasoline.

Unwelcome though the fact may be, coal, gas, and uranium are the only fuels big enough to have a noticeable impact on oil and carbon in the foreseeable future. Since 1973, the growth in total energy consumption has far exceeded the growth in

Figure 6. CO_2 Intensity of Motive Energy



ICEV stands for Internal Combustion Engine Vehicle
BEV stands for Battery Electric Vehicle

Source: Gary Kendall, *Plugged In: The End of the Oil Age*, World Wildlife Fund, p. 89, http://assets.panda.org/downloads/plugged_in_full_report___final.pdf

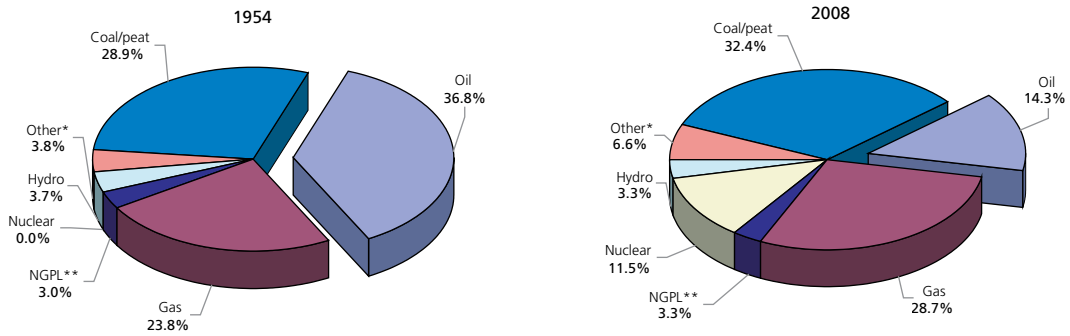
energy supplied by biomass, waste, geothermal, solar, wind, and tidal power. Optimistic projections about rising market *share* in decades to come routinely fail to mention that the market's total *size* is projected to grow even faster: so in absolute terms, the renewables continue to lose ground. Carbon fuels—fresh plants and fossilized ones—supplied 97 percent of the world's energy in 1973 and 91 percent in 2006, with almost all the drop caused by the rise of nuclear power. Since 1973, uranium has delivered the only significant global reduction—about 5 percent—in carbon emissions per unit of energy supplied. All along, green pundits have had spreadsheets proving that wind, sun, and other keen new alternatives were already cheaper than the old-guard fuels, or soon would be. But wind, sun, and the rest weren't visible on the global pie chart in 1973, and they still aren't today.

SQUEEZING OIL OFF THE HIGHWAY

A blend of gas and grid will end up squeezing the oil out of most of the wheels, just as it will continue to squeeze oil out of the residential, commercial, and industrial sectors of the world's economies. Stationary users have relied more heavily on electricity than gas; on the world's highways, gas has already achieved much more than electricity, and will have to do all the heavy lifting for the foreseeable future. Electricity may very well end up powering many smaller, light-duty vehicles. But no foreseeable battery pack is going to move forty-ton trucks cross-country, and batteries will remain impractical for most heavy-duty vehicles of any size.

If we choose to extract it and get it to our wheels, there's plenty of gas to power them. Oil's share of domestic U.S. energy production peaked in 1954, gas production overtook oil for the first time in 1970, U.S. fields now provide more than twice as much gas as oil, and the gap will widen fast from here on out. At current levels of production, gas could power all our U.S. wheels, and we could almost certainly increase production enough to cover all the wheels as well as all current uses. Deregulated gas got its first real chance to take on oil at its worst only recently, as oil prices shot up from the 1998 historical low to the 2008 historical high. Gas delivered—so well that we're now at the threshold of the biggest shift in energy markets since Colonel Edwin Drake struck oil in Pennsylvania in 1859.

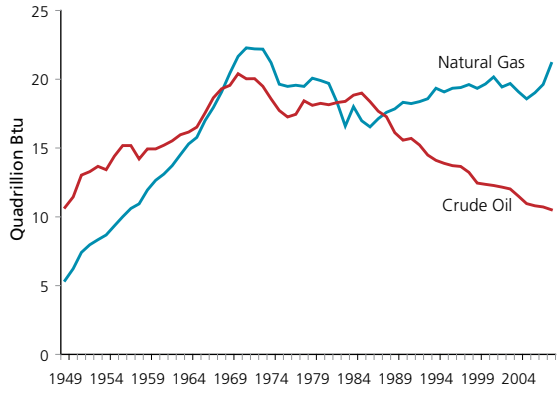
Figure 7. U.S. Primary Energy Production



*"Other" includes geothermal and biomass **Natural gas plant liquids

Source: Energy Information Administration, http://www.eia.doe.gov/aer/txt/ptb0102.html

Figure 8. U.S. Gas and Oil Production



Source: Energy Information Administration,
http://www.eia.doe.gov/aer/txt/ptb0102.html

Until very recently, most of our gas came from huge bubbles trapped under caps of impervious rock —producers didn't bother with the "tight" gas locked up in the pores of shale rock. Now they're pumping high-pressure water to create webs of tiny cracks in the rock through which the gas then readily flows to the main bore hole. Thin, slippery, and hard-to-contain, it turns out, has one big upside: gas, unlike coal and oil, really wants to get out of the ground, and it was soon whistling out of new shale fields in Louisiana, Texas, Arkansas, and Pennsylvania. The U.S. pipe network has been dramatically expanded and extended in the last decade, and the building continues. U.S. shale rock probably contains enough gas to displace all of our current levels of oil consumption for the next fifty years. Or, alternatively, all of our coal consumption for the next century.

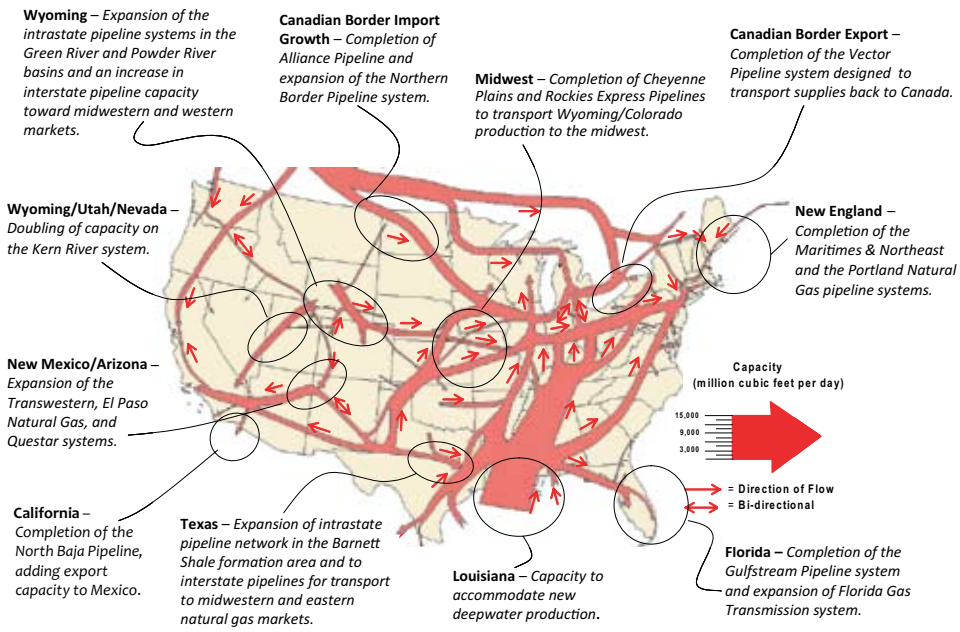
The global numbers are on the same track. Gas-bearing coal and shale are distributed around the globe. Oil supplied three times as much energy as gas in 1973; that ratio has been cut in half. Oil production has risen about 40 percent since 1973; gas production almost tripled. The oil nasties nominally control huge amounts of gas trapped in bubbles above their oil but can't move it cheaply to major buyers. Asia, South America, and Africa all have significant proven reserves of conventional gas and almost certainly also have huge amounts of gas in shale and deposits that now look a lot less tight than they did a decade ago.

With gas, as with electricity, rising demand will help push prices down, not up, for years to come, if the pipe police cooperate. Linking more sources of gas to more users will simultaneously expand supply by opening up new fields and push down delivery costs by making

Figure 9. Gas Shales in the United States

Source: Energy Information Administration,
http://www.energyindustryphotos.com/shale%20gas%20map.jpg

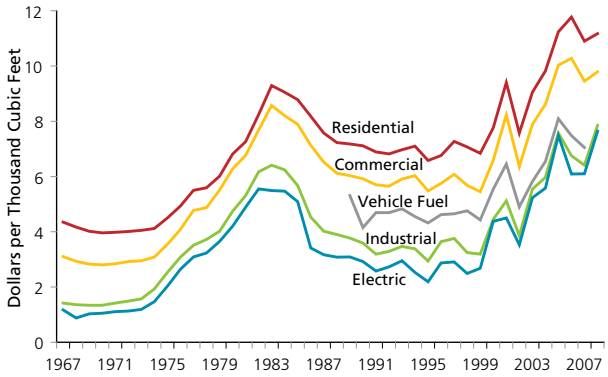
Figure 10. Major Additions to Natural Gas Transportation Capacity 1998-2008



Source: Energy Information Administration, *Major Changes in Natural Gas Pipeline Transportation Capacity, 1998-2008* (PowerPoint Presentation), http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/develop.html

more efficient use of expensive pipes. Delivery currently accounts for as much as 50 percent of the final price paid by residential consumers, who buy gas mainly for heating in winter; utilities and large industrial users pay much less because cost drops sharply when bigger pipes are used at full capacity more of the time. By consolidating a lot of steady demand at a single point, vehicle-refueling stations have recently begun to provide gas almost as cheaply as utilities.

Figure 11. Natural Gas Prices by Sector



Source: Energy Information Administration
http://www.eia.doe.gov/emeu/aer/natgas.html

There's plenty of fuel on the electricity side of the jaws, too. Happily, from a carbon perspective, the developing world loves uranium almost as much as coal. By 2020 or so, a new reactor will be starting up somewhere in the world every five to six days. China alone plans to build another hundred for itself in the next twenty years. A coal grid with 20 percent uranium is as carbon-lean as one that's half gas, and when they can afford to, most countries will also opt to generate another 10 to 20 percent of their power with gas, to take care of peak loads. Or perhaps even more. Now that the world is extracting gas from seemingly solid rock, almost anything is possible. In the right places, after the much lower delivery costs and the exceptionally high efficiency and low cost of gas-fired generators have been taken into account, the very cheapest gas is approaching price parity with coal.

SETTING AN EXAMPLE

It's often suggested that if America just sets the right carbon example, the rest of the world will follow. But most of the rest of the world is still far more interested in saving money. Most of the planet's grids will be lit mostly by coal for most of this century because coal is so abundant and cheap. More uranium —the example that the rest of the world is setting and we are largely ignoring—is the one proven, cost-competitive way to boot a lot of coal, and thus carbon, off the grid. Using gas to beat oil is the best carbon strategy because it costs less, not more, so the 80 percent of the planet that emits more than half of the greenhouse gas can embrace it, too. The developing world is setting the example here too, wherever it pumps natural gas into its heavy iron. For now, the only American example the world's poor are clearly eager to emulate is the one featuring five cars and two trucks for every ten citizens.

By throttling the gas market for so long, bad policy did much to establish oil's lock on our U.S. wheels, and oil might yet lock up much of the rest of the world's, as well. Oil owns our wheels because we got started much earlier, our great-grandparents preferred liquids, the authorities throttled gas when our grandparents and parents were buying cars, and we now have a couple of trillion dollars tied up in liquid wheels. Nobody will deliver gas to gas stations until there are vehicles to buy it, and few will buy the vehicles until there's gas everywhere to buy.

To kick off competition this late in the day, Washington will have to take some affirmative steps to restart the clock. By doing that, we might in fact help the rest of the world get over oil—and some carbon too. Promote private and public investment in new links to connect our vast supplies of stranded gas to our trucks and heavy-duty vehicles. Facilitate diesel-to-gas and gasoline-to-gas vehicle conversions. Accelerate the replacement of old fleets with new gas-powered vehicles. Continue developing the know-how that squeezes gas out of the earth—we already lead the world here, and by improving what we already do so well, we can help kick oil out of hundreds of millions of furnaces and engines worldwide. At home and abroad, the less affluent will be delighted to join the rich in swatting down oil with cheaper gas.

The oil nasties are sitting on a terrifying amount of oil wealth. Someone will eventually buy their oil regardless, but 90 percent of the world will be better off if the nasties get only $10 trillion for it later, not $60 trillion sooner, and Americans will certainly be better off if those trillions aren't ours.

Notes

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Fellows

Peter W. Huber
James Manzi
Max Schulz

The Center for Energy Policy and the Environment advances ideas about the practical application of free-market economic principles to address today's energy issues. It challenges conventional wisdom about energy supplies, production, and consumption, and examines the intersection of energy, the environment, and economic and national security.

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