# Profitable solutions for oil, climate, and proliferation

AMORY B. LOVINS, CHAIRMAN AND CHIEF SCIENTIST, ROCKY MOUNTAIN INSTITUTE (WWW.RMI.ORG)

*Invited draft for* Bulletin of the Atomic Scientists*, 31 October 2006, updated and slightly expanded for American Academy in Berlin 27 August 2007; 1,543 words + endnotes & biosketch*

Raymond Williams wrote, "To be truly radical is to make hope possible, not despair convincing." Problems like climate change, oil dependence, and nuclear proliferation seem so huge and daunting that energy policy seems like a stupid multiple-choice test: "Would you prefer to die of (a) climate change, (b) oil wars, or (c) nuclear holocaust?" Yet if we take economics and technologies seriously, the right answer is the one usually omitted—(d) none of the above—because all of the conventionally dreadful answers are both unnecessary and uneconomic. To see how, let's start with climate.

Climate protection, like the Hubble Space Telescope's mirror, got spoiled by a sign error: in fact, climate solutions are *not costly but profitable*, because saving fuel costs less than buying fuel. Many leading companies are making billions of dollars' profit by cutting their carbon intensity or emissions at rates of 5–8%/y.[1] When politicians who lament climate protection's supposed costs, burdens, and sacrifices join the parallel universe of practitioners who routinely achieve profits, jobs, and competitive advantage by wasting less fuel, the political obstacles will dissolve faster than any glacier.

Stabilizing carbon emissions requires only increasing energy productivity ($ GDP per GJ) by 2%/y rather than the canonically assumed 1%/y; stabilizing climate needs only ~3%/y. The U.S. has long achieved ~3%/y (it achieved 4%/y in 2006, slightly faster than GDP grew, so its total use of energy, oil, and coal actually declined); California, a point faster; China, a point faster still for >20 y (until 1997, then nearly 8%/y to 2001, then a temporary reversal that should end in 2007). Raising global adoption to ~3%/y will be profitable and not so difficult if we pay careful attention to "barrier-busting"—turning the 60–80 known market failures in buying energy efficiency into business opportunities.[2]

Energy efficiency is not the only, but certainly the main, tool for profitable climate protection, and indeed could suffice if pursued to its full modern potential, typically with expanding rather than diminishing returns (*i.e.*, radical savings at *lower* capital cost, now demonstrated in a couple of dozen sectors but awaiting a revolution in design pedagogy and practice).[3] Detailed assessments show how to save half of U.S. oil and gas at respective average costs of $12/bbl and $0.9/GJ (2000 $),[4] and three-fourths of U.S. electricity at ~$0.01/kWh[5]—all below short-run marginal cost. For example, tripled-efficiency but safer and uncompromised cars[6], trucks, and planes using current technology would respectively repay their extra capital cost in 2, 1, and 4–5 years at current U.S. fuel prices.[4]

Now add alternative supplies. Global fossil-fuel carbon emissions come about 2/5 from burning oil and 2/5 from making electricity (the remaining gas and coal are analogous). Redoubled U.S. oil efficiency at $12/bbl plus substituting saved natural gas and advanced biofuels (together averaging $18/bbl) can eliminate U.S. oil use by the 2040s.[4] Since the average cost of getting

completely off oil is ~$15/bbl—a fifth the recent price—this transition will be led by business for profit. Innovative public policies can support, not distort, the business logic without needing new fuel taxes, subsidies, mandates, or national laws.[4]

Early implementation is encouraging, via "institutional acupuncture"—inserting needles wherever the business logic is congested and not flowing properly. For example:

- Based on our analysis, Wal-Mart in 2005 required its suppliers to provide doubled-efficiency heavy trucks. Its "demand pull," motivated by billions of dollars' expected savings, will soon get those trucks on the road where everyone can buy them, saving 6% of U.S. oil, and more abroad.
- The Pentagon is emerging as the Federal government leader in getting the U.S. off oil so nobody need fight over oil—hence yielding negamissions in the Persian Gulf, Mission Unnecessary.[7] Military science and technology investment in light-and-strong materials, advanced propulsion, etc. will help to transform the civilian vehicle sectors just as military R&D previously created the Internet, the chip and jet industries, and the Global Positioning System.
- Boeing's competitive strategy based on the radically simplified, half-carbon-fiber, 20%-more-efficient, same-price *787 Dreamliner* has yielded the fastest order takeoff of any airplane in history—now sold out into 2014. Its innovations will enter every other Boeing product before Airbus can steer itself out of the ditch, and no doubt Boeing will use its new cashflow and momentum to pursue even more dramatic fuel savings.
- When we suggested in *Winning the Oil Endgame* that this strategy could also work for U.S. automakers, Ford recruited the head of Boeing Commercial Airplanes as its own CEO. This is part of a broader trend that is bringing new leadership and vision to Detroit before U.S. automakers are swept away by a tsunami of Schumpeterian "creative destruction." The competition now underway will change the managers or their minds, whichever comes first. RMI's transformational projects in the industry are providing very encouraging evidence of unprecedented openness to new technologies and business strategies.

In summary, of the six sectors that must shift their behavior to eliminate U.S. oil use, at least three seem lately to have passed their "tipping point," and all six are moving briskly in the right direction.

As for electricity, "micropower"—low-carbon combined-heat-and-power plus carbon-free decentralized renewables—provided[8] 1/6 of the world's electricity and 1/3 of its new electricity in 2005, meeting from 1/6 to over 1/2 of all electrical needs in 13 industrial countries. Micro-power thus added four times the electricity and 11 times the capacity that nuclear power added globally in 2005, now exceeds it in both respects, and is financed by private risk capital (unlike any new nuclear project; they're bought only by central planners). Micropower plus "negawatts," which are probably about as big, now provide upwards of half the world's new electrical services, and their 207 "distributed benefits," when counted, will widen their already decisive economic advantage[9] by about another tenfold.[10]

These dramatic market shifts in technology and scale are largely unnoticed but well underway ("clean energy" got around $71 billion of global investment in 2006). The new technologies for both supply and efficiency, being cheaper and faster (hence doubly lower in financial risk) than traditional competitors, will continue to wallop them in the marketplace—and to buy more climate solution per dollar and per year. Conversely, when central planners continue to buy costlier and slower options, they reduce and retard climate protection—by ~2–10-fold, for example, when new nuclear power is bought instead of micropower and efficiency.[9]

In short, the climate problem is neither necessary nor economic, but is an artifact of not using energy in a way that saves money. Climate change can be prevented by taking markets seriously—letting all ways to save or supply energy compete fairly, at honest prices, no matter which kind they are, what technology they use, where they are, how big they are, or who owns them. Internalizing carbon and other environmental costs will be correct and helpful but not essential. Indeed, a technically very conservative McKinsey study[11] found in 2006 that abating 46% of business-as-usual 2030 global emissions would cost an average of only €2 per tonne of $CO_2$-equivalent. This implies that an efficient carbon market will clear at very low (or, with newer technologies and design integration, negative) prices, sending a relatively weak price signal to emit less carbon. That would make it even more important to use comprehensive "barrier-busting" to enable people to respond to price than to get the price right.

Fair competition can simultaneously solve many other problems. For example, saving electricity needs about 1,000 times less capital, and repays it about 10 times faster, than supplying more electricity.[12] This ~10,000-fold capital leverage can turn the power sector (now gobbling about a fourth of global development capital) into a net funder of other development needs. Profitably eliminating oil use would certainly make the world better and safer. A more efficient, diverse, dispersed, renewable energy system can make major supply failures, whether caused by accident or malice, impossible by design rather than (as now) inevitable by design.[13]

The inevitable demise of nuclear power—already stricken by a fatal attack of market forces—can belatedly stem nuclear proliferation too[14], by removing from ordinary commerce a vast flow of ingredients of do-it-yourself bomb kits and their innocent-looking civilian disguise. That would make those ingredients harder to get, more conspicuous to try to get, and politically far costlier to be caught trying to get, because for the first time, the motive for wanting them would be unmasked as unambiguously military. Focusing intelligence resources on needles, not haystacks, would also improve the odds of timely warning. All this wouldn't make proliferation impossible, but would certainly make it far more difficult for both recipients and suppliers.

Had my analyses of these opportunities been adopted when first published[15], we would not now be worrying about climate change, oil dependence, or Iran and North Korea. But it's not quite too late. As the late Donella Meadows said, "We have exactly enough time—starting now." And now is the time for countries rich in money, technology, and fuels, like the United States and the Federal Republic, to exercise the full energy leadership that the world needs and expects of them.

So what are we waiting for? *We* are the people we have been waiting for. And if any of the solutions suggested here seem too good to be true (and you haven't time to check the references

provided), just remember Marshall McLuhan's remark: "Only puny secrets need protection. Big discoveries are protected by public incredulity."

---

[1] A.B. Lovins, "More Profit with Less Carbon," *Sci. Amer.* **293**(III):74–82, Sep 2005, RMI Publ. #C05-05, www.sciam.com/media/pdf/Lovinsforweb.pdf.

[2] A.B. & L.H. Lovins, "Climate: Making Sense *and* Making Money," Rocky Mountain Institute (Snowmass, CO), 1997, www.rmi.org/images/other/Climate/C97-13_ClimateMSMM.pdf, esp. pp. 11–20.

[3] A.B. Lovins, "Energy End-Use Efficiency," white paper for InterAcademy Council (Amsterdam), 19 Sep 2005, www.rmi.org/images/other/Energy/E05-16_EnergyEndUseEff.pdf; P. Hawken, A.B. & L.H. Lovins, *Natural Capitalism: Creating the Next Industrial Revolution*, Little Brown (NY) and Earthscan (London), 1999, 415 pp., ≥7 translations, 6 in preparation; book and summary article "A Roadmap for Natural Capitalism," *Harv. Bus. Rev.* **77**(3):145–158 (May/Jun 1999), www.natcap.org; see also www.10xE.org for a forthcoming casebook.

[4] A.B. Lovins, E.K. Datta, O.-E. Bustnes, J.G. Koomey, & N.J. Glasgow, *Winning the Oil Endgame*, Rocky Mountain Institute (Snowmass, CO), 2004, free download (or $40 hard-copy order) from www.oilendgame.com with all supporting documentation and calculations.

[5] A.P. Fickett, C.W. Gellings, & A.B. Lovins, "Efficient use of electricity," *Sci. Am.* **263**(3):64–74 (1990), relying on empirical cost and performance of ~1,000 technologies compiled in RMI/COMPETITEK *State of the Art* series, 6 vols., 1986–92, 2,509 pp., 5,135 notes, later summarized in *Technology Atlas* series from E SOURCE, Boulder CO, www.esource.com); A.B. Lovins, "Negawatts: Twelve Transitions, Eight Improvements, and One Distraction," *En. Pol.* **24**(4):331–343 (Apr 1996), www.rmi.org/images/other/Energy/U96-11_Negawatts12-8-1.pdf; for similar European findings, A.B. & L.H. Lovins, "Least-Cost Climatic Stabilization," *Ann. Rev. En. Envt.* **16**:433–531 (1991), www.rmi.org/images/other/Energy/E91-33_LstCostClimateStabli.pdf.

[6] A.B. Lovins & D.R. Cramer, "Hypercars®, Hydrogen, and the Automotive Transition," *Intl. J. Veh. Design* **35**(1/2):50–85 (2004), www.rmi.org/images/other/Trans/T04-01_HypercarH2AutoTrans.pdf.

[7] The Defense Science Board's Task Force on DoD Energy Strategy (www.acq.osd.mil/dsb/taskforces.htm), on which the author serves, is expected to report later in 2007 some important findings on the scope for military leadership in oil displacement.

[8] A.B. Lovins & N.J. Glasgow, www.rmi.org/sitepages/pid256.php#E05-04. Global nuclear capacity actually declined by 0.5 GW in 2006 as retirements outpaced additions—the start of an inexorable long-term trend.

[9] A.B. Lovins, "Mighty Mice," *Nucl. Eng. Intl.* 44–48, Dec 2005, www.rmi.org/images/other/Energy/E05-15_MightyMice.pdf; "Nuclear Power: Economics and Climate-Protection Potential," RMI Publ. #E05-14, 6 Jan 2006, www.rmi.org/images/other/Energy/E05-14_NukePwrEcon.pdf; "Nuclear Power: Competitive Economics and Climate-Protection Potential," Royal Academy of Engineering lecture (London), 13 May 2006, www.rmi.org/images/other/Energy/E06-04_NucPwrEconomics.pdf. These analyses assume the nuclear costs found in a 2003 MIT study; the 2007 real costs are 8–45% higher according to an industry-dominated consensus study (www.keystone.org/spp/documents/FinalReport_NJFF6_12_2007(1).pdf). Another important subsequent study of U.S. windpower (www1.eere.energy.gov/windandhydro/pdfs/41435.pdf)

confirmed that its firmed (dispatchable) delivered cost is less than half the cost found in that Keystone study for a new nuclear plant. Thus the conclusions in "Mighty Mice" continue to strengthen.

[10] A.B. Lovins, E.K. Datta, T. Feiler, K.R. Rábago, J.N. Swisher, A. Lehmann, & K. Wicker, *Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size*, 2002, Rocky Mountain Institute (Snowmass CO), www.smallisprofitable.org.

[11] See www.mckinsey.com/mgi/publications/Global_Energy_Demand/index.asp and www.mckinseyquarterly.com/Energy_Resources_Materials/Strategy_Analysis/Curbing_the_growth_of_global_energy_demand_abstract.

[12] A.J. Gadgil, A.H. Rosenfeld, D. Aresteh, & E. Ward, "Advanced Lighting and Window Technologies for Reducing Electricity Consumption and Peak Demand: Overseas Manufacturing and Marketing Opportunities," LBL-30890 Revised, *Procs. IEA/ENEL Conf. Adv. Technols. El. Demand-Side Mgt*. **3**:6-135–6-152 (Sorrento, 2–5 Apr. 1991), Lawrence Berkeley National Lab.

[13] A.B. & L.H. Lovins, *Brittle Power: Energy Strategy for National Security*, DOD/CEQ/Brick House (Andover, MA), 1981/82, 499 pp., reposted by RMI 2001 in OCR .PDF version at www.rmi.org/sitepages/pid533.php.

[14] A.B. & L.H. Lovins & L. Ross, "Nuclear Power and Nuclear Bombs," *For. Aff.* **58**:1137–77 (Summer 1980), www.foreignaffairs.org/19800601faessay8147/amory-b-lovins-l-hunter-lovins-leonard-ross/nuclear-power-and-nuclear-bombs.html, and **59**:172 (1980).

[15] A.B. Lovins, "Energy Strategy: The Road Not Taken?," *For. Aff.* **55**(1):65–96 (1976), www.foreignaffairs.org/19761001faessay10205/amory-b-lovins/energy-strategy-the-road-not-taken.html; *Soft Energy Paths: Toward a Durable Peace*, Ballinger/FOE (Cambridge/SF), 1977, Pelican (UK), 1977, Harper & Row (NY), 1979, 256 pp., numerous translations; A.B. & L.H. Lovins, F. Krause, & W. Bach, *Least-Cost Energy: Solving the $CO_2$ Problem*, Brick House (Andover MA), 195 pp., 1982, reprinted by Rocky Mountain Institute (Snowmass, CO), 1989, summarized in *Clim. Chg.* **4**:217–220 (1982); A.B. & L.H. Lovins, *Energy/War: Breaking the Nuclear Link*, Friends of the Earth (San Francisco), 1980, Harper & Row (NY), 172 pp., several translations.

*Physicist Amory Lovins, a 2007 lecturer at the American Academy in Berlin, is cofounder, Chairman, and Chief Scientist of Rocky Mountain Institute (www.rmi.org) and cofounder and Chairman Emeritus of Fiberforge, Inc. (www.fiberforge.com). Published in 29 books and hundreds of papers, his work has been recognized by the "Alternative Nobel," Blue Planet, Volvo, Onassis, Nissan, Shingo, and Mitchell Prizes, a MacArthur Fellowship, the Benjamin Franklin and Happold Medals, nine honorary doctorates, honorary membership of the American Institute of Architects, and the Heinz, Lindbergh, Jean Meyer, World Technology, and* Time *"Hero for the Planet" Awards. He advises governments and major firms worldwide on advanced energy and resource efficiency, and has led the technical redesign of $30 billion worth of facilities in 29 sectors to achieve very large energy savings at typically lower capital cost.*