How innovative technologies, business strategies, and policies can dramatically enhance energy security and prosperity

Invited Testimony to United States Senate Committee on Energy and Natural Resources
Hearing on Energy Independence, SD-366, 0930–1130 Tuesday 7 March 2006

AMORY B. LOVINS[1], CHIEF EXECUTIVE OFFICER
ROCKY MOUNTAIN INSTITUTE[2]

Both energy independence and its purpose, energy security, rest on three pillars:

1. Making domestic energy infrastructure, notably electric and gas grids, resilient.
2. Phasing out, not expanding, vulnerable facilities and unreliable fuel sources.
3. Ultimately eliminating reliance on oil from any source.[3]

Listing them in this order emphasizes that achieving the third goal without the first two creates only an illusion of security. Hurricane Katrina might as well have read my 1981 finding[4] for DoD that a handful of people could cut off three-fourths of the Eastern states' oil and gas supplies in one evening without leaving Louisiana. We should worry not only about already-attacked Saudi oil chokepoints like Abqaiq and Ras Tanura, but also about the all-American Strait of Hormuz proposed in Alaska.[5] DOE policy that didn't undercut DoD's mission would:

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[1] Published in 29 books and hundreds of papers, Mr. Lovins's work has been recognized by the "Alternative Nobel," Onassis, Nissan, Shingo, and Mitchell Prizes, a MacArthur Fellowship, the Benjamin Franklin and Happold Medals, nine honorary doctorates, and the World Technology, Heinz, Lindbergh, Jean Meyer, and *Time* "Hero for the Planet" Awards. He's a longtime advisor to the Departments of Energy and Defense and major energy firms worldwide.

[2] RMI is an independent, nonpartisan, entrepreneurial, nonprofit applied research center that creates abundance by design. Working mainly with the private sector, it fosters the efficient and restorative use of resources to make the world secure, just, prosperous, and life-sustaining. In recent years, RMI's consulting team has redesigned $20 billion worth of facilities for advanced energy efficiency and has served or been asked to serve over 80 *Fortune* 500 firms.

[3] Since oil is a fungible commodity in a global market, national energy policy correctly recognizes that the problem is oil use, not imports: see n. 13, p. 14. For example, even if the U.S. imported no oil, it would still be a price-taker in the world market, so its economy, like its trading partners', would still be buffeted by oil-price volatility. Oil infrastructure is also inherently vulnerable even if it is domestic (n. 4).

[4] A.B. & L.H. Lovins, *Brittle Power: Energy Strategy for National Security*, Brick House (Andover MA), 1981, and Rocky Mountain Institute, 1989; OCR scan reposted at www.rmi.org/sitepages/pid1011.php; summarized in A.B. & L.H. Lovins, "The Fragility of Domestic Energy," *Atlantic*, pp. 118–126, Nov. 1983 (**Attachment One hereto**).

[5] Former Director of Central Intelligence R. James Woolsey, an Oklahoman not *per se* hostile to petroleum, testified against Arctic National Wildlife Refuge drilling on national-security grounds (Energy Subcommittee of USHR Science Committee, 1 Nov. 2001), and wrote that such drilling's "real show-stopper is national security. Delivering that oil by its only route, the 800-mile-long Trans-Alaska Pipeline System (TAPS), would make TAPS the fattest energy-terrorist target in the country—Uncle Sam's 'Kick Me' sign. / TAPS is frighteningly insecure. It's largely accessible to attackers, but often unrepairable in winter. If key pumping stations or facilities at either end were

- shift from brittle energy architecture that makes major failure inevitable to more efficient, resilient, diverse, dispersed systems that make it impossible;[6]
- avoid electricity investments that are meant to prevent blackouts but instead make them bigger and more frequent;[7]
- stop creating attractive nuisances for terrorists, from vulnerable LNG and nuclear facilities to overcentralized U.S. and Iraqi electric infrastructure;[8]
- acknowledge that nuclear proliferation, correctly identified by the President as the gravest threat to national security, is driven largely by nuclear power.[9]

Each of these self-inflicted security threats can be reversed by cheaper, faster, more abundant, and security-enhancing alternatives, available both from comprehensive energy efficiency and from decentralized supply. For example,

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disabled, at least the above-ground half of 9 million barrels of hot oil could congeal in one winter week into the world's biggest ChapStick®. / The Army has found TAPS indefensible. It has already been sabotaged, incompetently bombed twice, and shot at more than 50 times. Last Oct. 4 [2001], a drunk shut it down with one rifle shot. / In 1999, a disgruntled engineer's sophisticated plot to blow up three critical points with 14 bombs, then profit from oil futures trading, was thwarted by luck. He was an amiable bungler compared with the Sept. 11 attackers. Connect the dots: Doubling and prolonging dependence on TAPS hardly seems a prudent centerpiece for what advocates whimsically called the Homeland Energy Security Bill. / Reliance both on Mideast oil and on vulnerable domestic energy infrastructure such as TAPS imperils the security of the US and its friends." (R.J. Woolsey, A.B. & L.H. Lovins, "Energy security: It takes more than drilling," *Chr. Sci. Mon.*, 29 Mar. 2002, www.rmi.org/images/other/EnergySecurity/S02-05_TakesMoreThanDrill.pdf. For documentation, see hyperlinks to p. 73 in A.B. & L.H. Lovins, *For. Aff.*, pp. 72–85, July/Aug. 2001, www.rmi.org/images/other/Energy/E01-04_FoolsGoldAnnot.pdf, and later supplementary references at www.rmi.org/sitepages/pid171.php#E01-04.)

[6] N. 4; "Surprises and Resilience," *RMI Solutions*, pp. 1ff, spring 2006, www.rmi.org/sitepages/pid1200.php.

[7] Bigger power plants sending bigger bulk power flows through longer transmission lines tend to make the grid less stable (*id.*). Leading engineering analysts of electric-grid theory are reaching similar conclusions, *e.g.*, http://eceserv0.ece.wisc.edu/~dobson/PAPERS/carrerasHICSS03.pdf. FERC doesn't let resilient options compete.

[8] See n. 4 for discreet details. Since the invasion of Iraq, private recommendations that its electricity infrastructure be rebuilt in decentralized form, virtually invulnerable to insurgent attack, have been repeatedly rejected.

[9] A.B. & L.H. Lovins and L. Ross, "Nuclear Power and Nuclear Bombs," *For. Aff.* **58**(5):1137–1177, Summer 1980. Had that article's recommendations been adopted, we would not today be worrying about Iran and North Korea. In brief, nuclear power makes widely and innocently available the key ingredients—fissile materials, equipment, technologies, skills—needed to make bombs by any of the ~20 known methods (other than stealing military bombs or parts). (New reactor types and the proposed reversal of the Ford-Cheney non-reprocessing policy greatly intensify these perilous links.) But in a world that took economics seriously, nuclear power would gracefully complete its demise, due to an incurable attack of market forces (n. 10), so these ingredients of do-it-yourself bomb kits would no longer be items of commerce. This would make them 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 reason for wanting them would be *unambiguously* military. This would not make proliferation impossible, but would make it far more difficult and much easier to detect timely: intelligence resources could focus on needles, not haystacks. The U.S. example is critical because if a country with such wealth, technical skill, and fuel resources claims it cannot meet its energy needs without nuclear energy and reprocessing, then it invites every other less fortunate country to make the same spurious claim. Yet the U.S. could still offer to meet the intent of the Non-Proliferation Treaty's Article IV bargain by sharing today's cheaper, faster, more effective energy technologies (n. 10) to boost global development. The NPT's specifically nuclear bargain was written by nuclear experts, in a nuclear context, around 1969–70, when nuclear energy was widely believed to be cheap and indispensable. Now that the market has decided otherwise, Article IV should be reinterpreted to achieve the same electricity-for-development goal by more modern, speedy, and affordable means, starting immediately with U.S./Indian energy cooperation: improving the non-nuclear 97% of India's electricity system could produce enormously greater, wider, faster, and cheaper development benefits.

nuclear power has already been eclipsed in the global marketplace by resilient, inherently peaceful, lower-cost, and lower-risk micropower.[10] That's a big win for national security and profitable climate protection,[11] and a vindication of competitive markets over central planning.

Energy independence is not only about oil. Many sources of LNG raise similar concerns of security, dependence, site vulnerability, and cost: Iran and Russia won't be more reliable long-run sources of gas than Persian Gulf states are of oil. Fortunately, half of U.S. natural gas can be saved by end-use efficiency and electric demand response with average costs below $1 per million BTU—four times cheaper than LNG[12]—making LNG needless and uncompetitive.

America's oil problem is equally unnecessary and uneconomic. Seventy-seven weeks ago, my team published *Winning the Oil Endgame*—an independent, peer-reviewed, detailed, transparent, and uncontested study cosponsored by the Office of the Secretary of Defense and the Chief of Naval Research.[13] It shows how to

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[10] Low-carbon cogeneration plus decentralized no-carbon renewables surpassed nuclear power's global capacity in 2002 and its annual electricity output in 2005, and they are far outcompeting central stations despite typically lower subsidies and bigger obstacles. In 2004, micropower worldwide added ~2.9 times as much output and ~5.9 times as much capacity as nuclear power did (or at least ten times if electric efficiency were also included). Industry projects that in 2010, micropower will add ~160 times as much capacity as nuclear power adds. Micropower comprises cogeneration (combined-heat-and-power using 1–120 MWe gas turbines, 1–30 MWe engines, and steam turbines only if in China), plus renewables excluding big hydro (>10 MWe). Electricity *savings* are probably even bigger than micropower additions but are not being well tracked. See A.B. Lovins, "Mighty Mice," *Nucl. Eng. Intl.*, pp. 44–48, Dec. 2005 (**Attachment Two**), www.rmi.org/sitepages/pid171.php#E05-15, and for details, "Nuclear power: economics and climate-protection potential," 11 Sep. 2005 / 6 Jan. 2006, www.rmi.org/sitepages/pid171.php#E05-14. Statistics at www.rmi.org/sitepages/pid171.php#E05-04 and www.ren21.net/globalstatusreport/issueGroup.asp.

[11] Choosing the best buys first could relieve climate concerns not at a cost but at a profit, because efficiency generally costs less than the energy it saves: A.B. Lovins, "More Profit With Less Carbon," *Sci. Amer.*, pp. 74–82, Sept. 2005, www.sciam.com/media/pdf/Lovinsforweb.pdf (**Attachment Three**), and its extended bibliography, www.rmi.org/images/other/Climate/C05-05a_MoreProfitBib.pdf. Reducing global energy intensity not by the normally assumed 1%/y but by 2%/y would eliminate CO_2 growth; slightly faster improvement would stabilize climate. Both the U.S. and certain states have sustained intensity reductions well over 2%/y, and attentive companies around *6*%/y, all at a handsome profit. Yet climate politics focus on cost, burden, and sacrifice rather than on profit, jobs, and competitive advantage. Fixing this sign error is the key to crafting a profitable climate solution. Of course, buying carbon-free resources judiciously, not indiscriminately, yields the most climate solution per dollar and per year. Expanding nuclear power would reduce and retard climate protection, simply because it's costlier and slower than its key competitors— cogeneration, certain renewables, and efficient end-use. See Lovins papers in n. 10.

[12] Saving 1% of U.S. electricity, including peak hours, can save 2% of total U.S. natural gas consumption and cut the gas price by 3–4% (see n. 13, pp. 112–116, 219–220). In this decade, such straightforward efficiencies could cut $50 billion off the Nation's annual gas and power bills and relieve many gas and electricity constraints without costly, controversial, and vulnerable supply-side investments. The main obstacles are that gas efficiency isn't on the federal policy agenda, and that 48 states reward utilities for selling more electricity and gas while penalizing them for cutting customers' bills. Scores of other barriers, too, block wider purchases of energy efficiency in all sectors (see pp. 11–20 in www.rmi.org/images/other/Climate/C97-13_ClimateMSMM.pdf), but each obstacle can be turned into a business opportunity if policy focuses systematically on "barrier-busting."

[13] *Winning the Oil Endgame: Innovation for Profits, Jobs, and Security*, RMI, 20 Sep. 2004, by A.B. Lovins, E.K. Datta, O.-E. Bustnes, J.G. Koomey, & N.J. Glasgow; Forewords by George Shultz and Sir Mark Moody-Stuart;

eliminate U.S. oil use by the 2040s and revitalize the economy, led by business for profit. Welcomed by business and military leaders, our analysis is based on competitive strategy for cars, trucks, planes, and oil, and on military requirements.

Our study shows how the U.S. can redouble the efficiency of using oil at an average cost[14] of $12 per saved barrel, and can substitute saved natural gas and advanced biofuels (chiefly cellulosic ethanol) for the remaining oil at an average cost of $18 per barrel. Thus *eliminating* oil would cost just one-fourth its current market price, conservatively assuming that its externalities are worth zero. Side-benefits would include a free 26% reduction in CO_2 emissions, a million new jobs (three-fourths in rural and small-town America), and the opportunity to save a million jobs now at risk. America can either continue importing efficient cars to displace oil, or *make* efficient cars and import neither the cars nor the oil. A million jobs hang in the balance.

The key to wringing twice the work from our oil is tripled-efficiency cars, trucks, and planes. Integrating the best 2004 technologies for ultralight steels or composites, better aerodynamics and tires, and advanced propulsion can do this with two-year paybacks.[15] For example, new low-cost carbon-composite manufacturing techniques can halve cars' weight and fuel use, improving safety, comfort, and performance without raising manufacturing cost.[16]

Oil elimination's compelling business logic would drive its eventual adoption. But supportive public policy could accelerate it without requiring new taxes, subsidies, mandates, or federal laws; this could be done administratively or by the states.

.PDF download free at www.oilendgame.com. That site also posts the Executive Summary (**Attachment Four**), 24 Technical Annexes, lay summaries from *Ripon Forum* (www.rmi.org/sitepages/pid171.php#OilDependence) and *Fortune* (www.rmi.org/images/other/Energy/E04-21_FreeFromOil.pdf), Robert C. McFarlane's *Wall Street Journal* op-ed (http://online.wsj.com/public/page/0,,public_home_search,00.html#SB110350663319704480), and many other articles and reviews, and offers the 331-page hard-copy book for $40.

[14] Refiner's acquisition cost on the short-run margin, 2000 $, 5%/y real discount rate.

[15] Compared with EIA 1/04 Reference Case vehicle characteristics and fleet mix, fuel economy could be improved by 69% for cars at a levelized Cost of Saved Energy of 57¢/gal, by 65% for Class 8 trucks at 25¢/gal, and by ~65% for planes at ≤46¢/gal. The first 25% of truck and 20% of airplane fuel savings are free. Please see n. 13 and its Technical Annexes 4–6 and 12 for full analytic details and documentation.

[16] Because the advanced composites' higher cost is offset by simpler automaking and smaller powertrains. See n. 13, pp. 44–73, Tech. Annex 5 (www.oilendgame.com/TechAnnex.html), and *Intl. J. Veh. Des.* **35**(1/2):50–85 (2004), www.rmi.org/images/other/Trans/T04-01_HypercarH2AutoTrans.pdf. One cost-competitive carbon-composite structural manufacturing process, being commercialized by a small firm, Fiberforge®, of which (full disclosure) I'm Chairman and a small shareholder, is described at www.fiberforge.com/DOWNLOADS/FiberforgeACCE05.pdf and in trade press articles at www.fiberforge.com/PAGES/DETAIL_PAGES/inthenews.html.

Many innovative policies could also transcend gridlock. Size- and revenue-neutral feebates[17] could speed the adoption of superefficient cars far more effectively than gasoline taxes or efficiency standards, and would make money for both consumers and automakers.[18] Novel policies could also support automotive retooling and re-training, superefficient planes, advanced biofuels, low-income access to affordable personal mobility, and other key policy goals, all at zero net cost to the Treasury.[19]

Early implementation steps are encouraging. Our analysis led Wal-Mart to launch a plan to double its heavy truck fleet's efficiency and to consider tripled efficiency a realistic goal.[20] The Department of Defense is also recognizing fuel-efficient platforms as a key to military transformation. Military needs for ultralight, strong, cheap materials can transform the civilian car, truck, and plane industries—much as DARPA created the Internet, GPS, and the chip and jet-engine industries—and thus lead the Nation off oil so we needn't fight over oil: negamissions in the Persian Gulf, Mission Unnecessary.[21]

The surest path to an energy policy that enhances security and prosperity is free-market economics: letting all ways to save or produce 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. That would make the energy security, oil, climate, and most proliferation problems fade away, and would make our economy and democracy far stronger.[22]

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[17] Such feebates (= fee + rebate) would broaden the price spread within each size class by charging fees on less efficient vehicles and using the revenue to pay rebates on more efficient vehicles. Whether you pay a fee or receive a rebate depends on your efficiency choice within the size class you prefer. A typical feebate slope—$1,000 per 0.01 gallon/mile difference from the "pivot point" efficiency level set within each size class—would arbitrage the spread in discount rate between consumers and society, so a car buyer would consider full lifecycle fuel savings (nominally ~14 years) rather than just the first 2–3 years. DOE/ORNL modeling, closely matching RMI's, shows that such feebates yield both producer and consumer surplus. See n. 13, pp. 186–190.

[18] See n. 13, pp. 169–190.

[19] See n. 13, pp. 178–226. The 2005 Energy Policy Act's 3–5-year biofuel credits are too brief for investment horizons; any serious incentive, especially in an area fraught with investment uncertainties, should last at least a decade. However, I generally prefer abolishing energy subsidies to adding new ones, and I fear that the same broad policy conditions that created the energy market collapse of 1984–85 are now being repeated.

[20] L. Scott, "Twenty First Century Leadership," 24 Oct. 2005, www.walmartstores.com/Files/21st%20Century%20Leadership.pdf.

[21] Fuel-efficient platforms offer huge benefits in force protection, tens of billions of dollars' annual savings in fuel logistics, and multi-divisional realignments from tail to tooth: n. 13, pp. 84–93, 221, and 261–262; Defense Science Board, *More Capable Warfighting Through Reduced Fuel Burden*, 2001, www.acq.osd.mil/dsb/reports/fuel.pdf.

[22] Both a quick low-budget experiment (www.nepinitiative.org) and the National Commission on Energy Policy (www.energycommission.org) revealed a broad ground for trans-ideological consensus on these general lines. The former effort found that a bipartisan group of private- and public-sector energy leaders could readily agree on a comprehensive, visionary, but practical framework for national energy policy by focusing on what they already agreed about—thus making what they disagreed about largely superfluous.