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Climate

Making Sense *and* Making Money

Amory B. Lovins, VP/Dir. of Research
Rocky Mountain Institute
1739 Snowmass Ck. Rd., Snowmass CO 81654, USA
www.rmi.org (see downloadable study of same title)
++ 1 970 + 927-3128, fax -4178, *ablovins@rmi.org*

The climate debate: old view

- To protect climate we must use far less energy
  - Achieved only by ruinously high energy prices...
  - …which will depress the economy, lose jobs and industries, constrain lifestyles, and erode freedoms
- That's painful, so take no action until you're completely sure; focus on debating the science
- Going first is a handicap, so wait for consensus
- How can the world fairly share the sacrifices?

The climate debate: new view

- Saving energy saves money. Enough can be quickly saved at a profit to protect the climate at today's prices if we remove barriers
- This strengthens the economy -- and incidentally solves the climate problem if it's real
- The scientific uncertainties don't matter
- Going first is advantageous
- What sacrifices? Share the *profits!*

Two views, different consequences

- Price, pain, and penury *vs.* profits, markets, innovation, enterprise, competitive advantage, and economic opportunity
- Indefinite delay *vs.* immediate action
- Economic theory *vs.* engineering practice
- Public *vs.* private sector in the vanguard
- Divisive *vs.* uniting; anti- *vs.* pro-development
- Wringing out energy *vs.* fossil-fuel carbon

Three principles of profitable climate protection

- Displacing carbon and using energy efficiently are *not costly but profitable*, because *saving fossil fuel costs less than buying it* (ignoring any environmental benefits of not burning it)
- Huge opportunities for profitable energy efficiency remain unbought because of 30+ specific barriers that keep the market from working
- Turning each of those obstacles into a business opportunity can save vast amounts of energy very quickly even at *today's* energy prices

Decarbonizing the economy

- IPPC (×3-4) C-emission reductions over the next half-century are feasible and profitable for countries in all stages of development
- Encouraging precedents: Pb, CFCs, SO_x
- Economics offers limited insight into how
- Technologies *and* implementation matter; neither can do much without the other
- Many feasible points of intervention, but we'll conservatively consider only a few

Saving carbon: six ways, three tools

goods, though not services, also reflect a term representing throughput per unit stock; it's considered here as part of industrial end-use efficiency

$$C_{energy} = \frac{population \times affluence\ per\ capita \times carbon\ intensity}{conversion\ efficiency \times end\text{-}use\ eff. \times hedonic\ eff.}$$

how well delivered energy services enhance human satisfaction

We'll consider here only carbon intensity, conversion efficiency, and end-use efficiency. The other three terms are equally important. All provide important and flexible choices. All need three tools: technology, implementation, policy.

TECHNOLOGY

1. Reducing carbon intensity (fossil-fuel carbon per unit primary energy) ×
2. Improving conversion efficiency (primary energy to delivered form) ×
3. Improving end-use efficiency (delivered energy to final service) = ...

1. Reducing carbon intensity

- Natural gas is widespread, abundant, and relatively benign: ~1/2 coal's C intensity, or ~0 with nearly costless sequestration
- Renewables are increasingly competitive for high/low-temp. heat, electricity, & fluid fuels
- A Shell-style least-cost scenario (2050 global primary energy 52% renewable, 12% natural gas) cuts C intensity ~2,3× (~11× by 2100)
- New ways to commercialize H_2 very rapidly could do even better, sooner, and cheaper

Renewables are coming of age

- Conservative U.S. National Labs studies:
  - 1990: renewables could cost-effectively expand to 3/5 of current U.S. energy use (6/5 for el.)
  - 1997: efficiency + low-carbon options could hold 2010 emissions to 1990 levels at zero cost
- The world's fastest-growing source is wind (+26% 1995-96); soon <3¢/kWh @ 5,6 m/s
- 75 "distributed benefits" make photovoltaics cost-effective *now* in many applications
- Renewables could cut a big CA utility's C ~97% with unchanged reliability and cost

2. Improving conversion efficiency

- U.S. power plants' waste heat equals Japan's *total* energy use, converting only 34% of fuel to useful work; Danish av. is 61%, Trigen 90-91% (which could cut U.S. CO_2 by 23%)
- Advanced U.S. industrial-cogeneration gas turbines yield 1/3 the carbon, and combined-cycle gas *vs.* coal, 1/4 the carbon, both at 1/2 the cost
- Cascading process heat could save ~30% of U.S. and 45% of Japanese industrial energy
- Rapidly emerging "distributed utilities" favor the most efficient and lowest-carbon options

3. The biggest prize of all: end-use efficiency

- After cutting its energy bills $150-200b/y (and C emissions 1/4) since 1973, the U.S. still wastes ~*$300b*/y worth of energy, based on 1997 prices and technologies
- Technical efficiency is better in Japan and W. Europe, but they too have huge potential
- Inefficiency is worst in developing and transitional economies -- hobbling their development, because new energy supply can take up to 10 000× more capital than efficiency

Headline news: “tunneling through the cost barrier”

- Big savings often cost *less* than small savings
- Example: U.S. carpetmaker Interface cut pumping energy in 1997 Shanghai factory from “optimized” 70,8 to 5,3 kW (-92%), *cut first cost too*
  - big pipes, small pumps, not small pipes, big pumps
  - lay out pipes first so they’re short and straight (also allowed more insulation, saving 70 kW of heat too)
  - nothing exotic: just good *whole-syste*m engineering
- Shown in buildings, motor & lighting systems, hot-water systems, computer & car design,….

End-use efficiency: U.S. examples

- Electricity (1/3 of CO_2, in bldgs. & ind.): save 1/4 in motor systems, 1/4 lighting, 1/4 other
- Buildings (1/3 of CO_2): save 65+% in cost-effective retrofits, ~75-90% in new construct'n
  - 19k-m^2 Chicago curtainwall office-retrofit design saves 75%, same cost as normal renovation
  - 97% cooling/fan saving in California office retrofit
  - New houses comfortable at -44 to +46°C, no heating/cooling equipment, lower capital cost
  - New Bangkok house: 90% less a/c, same cost
  - *Better* comfort, amenity, market/fin. performance

U.S. end-use examples (cont'd.)

- Industry (1/3 of CO_2): savings keep growing
  - Dow/Louisiana averaged >200%/y ROI, adding $110M/y profits, but kept on finding even more
  - Southwire cut el./kg 40%, gas/kg 60%, in 6 y, then kept saving even more, still w/2-y payback
  - pinch + catalysts can often save chemical firms ~70% (ROI > 70%/y) *after* ~50% already saved
  - 3/4 of ind'l. el. goes to motors, which use their own capital cost's worth of el. every few *weeks* and typically save ~50% w/system retrofit; *one* efficient 75-kW motor costs same, saves ~$20k

U.S. end-use examples (cont'd.)

- A clean-sheet chemical-plant redesign offered ~75% el. saving, ~10% lower construction cost
- Semiconductor fabrication-plant redesign can save 4× or more, *e.g.*, 7-20× in cleanrooms, 4-10+× in tools; >$100b plants planned globally
- Competitive key: $7 *vs.* $0,11 el. per hard drive
- Vast frontier: dematerialization from long product life, service leasing, minimum-materials design & manufacturing, recovery of scrap not eliminated, repair, reuse, remfg., recycling

U.S. end-use examples (cont'd.)

- Transportation (1/3 of CO_2): also a goldmine
  - Toyota Prius hybrid, on Japanese market 12/97, saves 50% of fuel; 1/3 world market share 2005?
  - Combine with ultralight, ultra-low-drag body and save 70-80% of fuel, w/fuel cells (<2005) up to 90%; such "hypercars" are rapidly emerging (~$2,5b committed by private sector)
  - 2-3× savings available in heavy trucks & aircraft
  - make negatrips (sound land-use), virtual mobility, and all modes of physical mobility compete fairly

What can already energy-efficient countries do?

- Even in Sweden -- efficient, cold, cloudy, far north, heavily industrialized -- the State Power Board, using mid-1980s technologies, found 50% el. savings cost 78% less than producing more. These savings, fuel-switching, & environmental dispatch could:
  - achieve 54% forecast GDP growth 1987-2010
  - phase out the nuclear half of the power supply
  - reduce utilities' carbon emissions by one-third
  - *reduce* the cost of electrical services by $1b/y

Already efficient countries (cont'd.)

- Late-1980s technologies could save 3/4 of Danish electricity at ~1,6¢/kWh, 4/5 of German home energy with ~40%/y aftertax ROI
- Similar results found worldwide 1979-97
- Houses in Germany, and buildings in Japan, are less thermally efficient than U.S. ones
- 4× savings in Japan's offices can cost *less*
- Av. new German and Japanese sedans are no more efficient than U.S., maybe less so

Developing countries have even more need & opportunity

- China halved energy/GDP growth ratio, yet is 2× less efficient than U.S., 3× than Japan
- The South is ~3× less efficient than OECD
- Faster pop./ec. growth means more things to build right the first time -- *and* more need to
- Least-cost options could boost Karnataka's development more, with 2/5 less el., 2/3 lower cost, and 95% less fossil-fuel CO_2, than official plans (which were rejected)
- Efficiency can turn the power sector into a net *source* of capital for development needs

Physics confirms astonishing levels of waste

- Modern 12 km/L (28 mi/USgal) cars use only 1% of their fuel energy to move the driver
- Converting power-plant fuel into incandescent light is only ~3% efficient
- OECD economies are at best only ~2-3% energy-efficient (*vs*. their theoretical potential)
- Materials efficiency -- massflow that gets into products and is still there six weeks after sale -- is ~1% in U.S., perhaps ~2-3% in Japan

IMPLEMENTATION

- So why haven't these big, profitable savings all been bought already?
  (Hint: not mainly price)
- Eight specific classes of big market failures now inhibit buying profitable efficiency
- Every obstacle can be a business opportunity
- Most economic models *assume* essentially perfect markets in buying energy efficiency
  (There are no such markets)

Obstacles that prevent buying energy efficiency

- Over 30 specific market failures of 8 types
  - Capital misallocation, value-chain risks
  - Organizational & informational failures
  - Regulatory failures, perverse incentives
  - False or absent price signals, absent markets
- Proven methods can turn each of these obstacles into lucrative business opportunities
- Barrier-busting should top the policy agenda

1. Capital misallocation

- Energy, a small factor cost, gets little attention
- Most purchases are based on first cost only
  - For example, thicker office wiring (169%/y after-tax ROI) isn't bought because it's not low-bid
- Only 1/5 of the U.S. firms that do look beyond first cost use discounted cashflow methods
  - The rest seek a 1,9-y median *simple payback* -- a *71%/y* aftertax return, ~6× the cost of capital
- U.S. has misallocated $1 trillion to a/c alone

2. Organizational failures

- Force of habit rules: why make waves?
- Schedule dominates: “infectitious repetitis”
- Little measurement, hence no improvement
- Departments can’t or won’t cooperate
- Cut energy costs, lose budget; no rewards
- Energy managers got laid off long ago
- Firms “satisfice”, not optimize: as anyone knows who works in a large organization, we live in a Dilbert world, not a perfect one

3. Regulatory failures

- Almost every utility in the world is rewarded for selling more energy and penalized for cutting your bill; British-style restructuring further destroys any market incentives to save
- Just “meeting code” wastes money
- Transport sector is the most centrally planned and underpriced (L.A./Bangkok *vs.* Singapore)
- Obsolete rules (Singapore/HK “OTTV” std.)
- Dispersed land-use mandated by old zoning

4. Informational failures

- Do *you* know exactly what to buy & where? your electric tariff? your refrigerator's kWh/y?
- Inattention to detail: U.S. uses 5 GW to run household appliances that are *turned off* (same convenience available w/90-95% less, no cost)
- Information is viscous; it sticks to those who have it, but seldom gets to those who need it
- Cheap, powerful information is missing (a plant that labeled light-switches saved $30k/y)

5. Value-chain risks

- Why should manufacturers take the risk of new products without knowing they'll sell?
- If they don't make it, how can you buy it?
- Distributors seldom stock the most efficient devices, so you can't buy them right away when you need an immediate replacement
- Litigation risks (esp. U.S.) lead to inefficient defensive behavior and can inhibit innovation

6. Perverse incentives

- Architects and engineers get paid according to what they *spend*, not what they save
- All 20+ other parties in the real-estate value chain are also systematically rewarded for inefficiency and penalized for efficiency
- Split incentives -- one person choosing the technology, another buying the energy -- are ubiquitous (landlord/tenant, builder/buyer,…)
- Wasteful old equipment is resold, not scrapped

7. False or absent price signals

- Distorting subsidies (~$250-300b/y worldwide)
- Unpriced externalities -- not just environmental (U.S. spends >$50b/y on military forces for Persian Gulf, making that oil cost >$100/bbl)
- Dilution by other costs (U.S. gasoline, cheaper than bottled water, is ~1/8 the cost of driving)
- Poor tracking of energy costs to profit centers
- Appraisers seldom value energy efficiency
- Tax asymmetries (fuel is expensed, but investments in efficiency must be capitalized)

8. Incomplete markets and property rights

- There's no market in saved energy
- You can't bounty-hunt for wasted energy
- You can't trade negawatt futures and options nor, usually, bid them against megawatts
- Few tradeable property rights in reduced or avoided depletion/pollution or reduced uncer-tainty of energy demand, so can't express value
- Standard measurement protocols for savings are now available, but only for buildings

Each obstacle offers a major business opportunity

- Each of these 30+ obstacles to using energy in a way that saves money corresponds to a known and proven *profit opportunity* (see RMI study)
- Most of those opportunities have been grasped in only a few exemplary cases, because most businesspeople aren't paying close attention
- Competition and emulation can quickly make them do so, making climate a boon to business

Economic models *assume* essentially perfect markets

- Don't pick up that ¥10,000 note -- it's not real
- *Economic* models of the cost of protecting the climate are far less sophisticated (1960s-style) than modern *physical* climate models -- as if the latter omitted clouds, oceans, and atmosphere, and only correlated historic CO_2 w/temperature
- Mainstream economic models nonetheless show small costs or even benefits from climate protection, *without* counting its environmental values, because proper pricing removes distortions and improves economic efficiency

Other-worldly models (cont'd.)

- Extreme models find high costs by *assuming* them, *i.e.* requiring stupid, inflexible responses
- Most models don't make renewables cheaper at high volumes, let technologies improve at high prices, recognize price-capping "backstop" technologies, recycle revenues efficiently, trade emissions, note that some major countries lack market economies, take any explicit account of on-the-market efficiency techniques, etc, etc
- *No* model includes the whole-system designs that can "tunnel through the cost barrier"

Other-worldly models (cont'd.)

- A World Resources Institute meta-analysis of 162 predictions by the 16 top climate-economy models found 80% of the spread in their results explained by just seven assumptions
- For (say) a 60% carbon reduction in 2020, these seven assumptions alone can predetermine whether the model predicts by then a 7% fall or a 5% rise in GDP
- Models showing economic gains simply assume the flexibility that markets exhibit

POLICY

- Rapid energy savings don't require high prices
- Price is relevant, but its importance has been much exaggerated by most economists*
- High prices are not necessary nor sufficient
- Job-loss concerns are unfounded
- Markets do work -- if allowed to
- Time to dump the myths
- Ambitious climate goals are profitable

*Efficiency will increasingly be bought to get superior service quality, and distributed supply resources to get distributed benefits -- decoupling both from traditional energy-cost competition

Even cheap energy can be saved very quickly

- U.S. in 1979-86: GDP +19%, energy -6%
  - High and rising prices, sense of urgency
- Now we can substitute high and rising *skill and attention*, focused by any combination of:
  - current or expected price signals (trading,…)
  - political leadership
  - public concern
  - competitive pressures
- Private-sector leadership can shift fashions and transform big systems quickly

Price isn't the only or even the main driver of action

- *Ability to respond* to price is *more* important
  - In 1990s, Seattle, with el. prices half Chicago's, is saving el. load 12× and el. energy 3640× as fast
  - Why? Utility helps in Seattle, not Chicago, to make an informed, effective, efficient market in savings
- Prices without barrier-busting save little, slowly
  - DuPont's European factories are as inefficient as U.S. ones despite long exposure to prices 2× as high
- High prices aren't necessary -- nor sufficient
- Barrier-busting makes big savings profitable *now*

Price signals helpfully supplement barrier-busting

- Early trading changes expectations by putting a price on emitting carbon (the right price isn't known but also isn't zero, and it's better to be approximately right than precisely wrong)
- Carbon taxes should be seen in the wider context of shifting taxation from jobs and income to consumption and resource depletion -- correctly signaling new relative scarcities and increasing overall economic efficiency
- But correcting market failures is *more* vital

Job-loss concerns are unfounded, even backwards

- No evidence for “pollution havens” exists
- If modest changes in energy prices (a small factor cost -- av. U.S. mfg.: 1,3%) mattered, all Japanese factories (paying ~3× U.S. el. prices) would’ve fled to U.S., but they just got efficient
- Industry hasn’t even migrated much in search of *big* reductions in its *biggest* cost -- labor
- Main threat to ~100k U.S. coal-mining jobs is mining companies, which cut 8000 jobs a year
- A just transition for miners is easily affordable

Markets work -- if allowed to

- Ironically, some who favor competitive markets for other uses scorn them for saving C, predicting gloom-and-doom -- from markets
- Yet much experience suggests that until we reward people for saving something (or even for thinking about how), they have no reason to become clever about it, so initial cost projections will be grossly exaggerated
- The phaseouts of leaded gasoline and CFCs were predicted to be catastrophic, but turned out to cost little (or nothing) and work fine

Markets can work (cont'd.)

- Before SO_x trading was approved in 1990, environmentalists predicted that saving a ton of sulfur would cost $250-350, government $500-750, industry $1000-1500; yet the market opened in 1992 at ~$250 and in 1996 cleared at $66; the U.S. is 2/5^{ths} *ahead* of its SO_x target, at astonishingly low cost
- Wringing out the carbon should be even more successful because it's *known to be profitable: efficiency costs less than fuel*

Time to dump the myths

- Climate-science uncertainties don't matter: profits dictate the same actions anyhow
- Whoever goes first will gain the most benefit, so why wait? (That's why the South is saving carbon so fast -- for *economic* reasons)
- Don't argue about sharing pain: this is about who gets the *profits*
- Since government should steer, not row, we need not command-and-control, but many small "trimtab" actions, in both public and private sectors, to help markets work properly

By 2050, an affluent world could meet or beat a 3-4× C reduction goal

$$C_{energy} = \frac{\underset{\times 2}{population} \times \underset{\times 3\text{-}4}{affluence\ per\ capita} \times \underset{\div 2\text{-}4}{carbon\ intensity}}{\underset{\times 1{,}5}{conversion\ eff.} \times \underset{\times 4\text{-}6}{end\text{-}use\ eff.} \times \underset{\times 1\text{-}2?}{hedonic\ eff.}}$$

or ~1,5-12× *lower* emissions despite assumed 6-8× growth in GWP. (A 1993 UN study* found 1,35× and 8× respectively, 1985-2050.) Great flexibility is thus available. *The future is not fate but choice*.

*Johansson, Kelly, Reddy, Williams, & Burnham, *Renewable Energy*, 1177 pp., Island Press, Washington DC. This analysis, though mostly excellent on the supply side, assumed relatively weak end-use efficiency opportunities.

We could live even better by choosing sounder social goals

- "Natural capitalism"*: put Earth on the balance sheet; protect and restore its vital capital
- Count what really counts, not what's merely countable; "vanity" *vs.* how much is enough
- Meet nonmaterial needs by nonmaterial means
- Care for the poorest, emphasize fairness
- Live by the principles of all main religions
- Make growth a considered tool, not a mantra

*von Weizsäcker, Lovins, & Lovins, *Factor Four*, numerous languages, 1995-97; Hawken, Lovins, & Lovins, *Natural Capitalism*, Little Brown (NY), 1998

The good news about climate

- Climate-protecting energy efficiency and carbon displacement are highly profitable now, even at very low U.S. prices (most countries with higher equipment/labor costs and efficiencies have offsetting higher energy prices too)
- Adoption is blocked by 30+ specific barriers
- Savings can be rapidly captured by removing those barriers, even at present prices
- This requires business-gov't partnership, and *attention* to turning obstacles into opportunities

"The lesson here is simple: Environmental initiatives, if sensibly designed, flexibly implemented, cost less than expected and provide unforeseen economic opportunities….If we do it right, protecting the climate will yield not costs, but profits; not burdens, but benefits; not sacrifice, but a higher standard of living. There is a huge body of business evidence now showing that energy savings give better service at lower cost with higher profit. We have to tear down barriers to successful markets and we have to create incentives to enter them."

-- President Bill Clinton, National Geographic Society
speech enunciating national climate policy, 22 October 1997