3.4 DOD'S ENERGY CHALLENGE AS STRATEGIC OPPORTUNITY

Mr. John Simpson

The first thing we are going to talk about is exposing DoD's soft underbelly and revealing how that is actually a source for strategic advantage.

As summarized in Figure 1, the Department of Defense's mission is at risk and huge costs are being paid both in terms of treasure and in terms of loss of combat effectiveness due to pervasive waste of energy in the battle space and at fixed facilities that are

---

Mr. John Simpson has more than 25 years of practical experience and proficiency inside and outside of government in the technical areas of sustainable design, engineering, construction, operation, maintenance, management, contracting, and evaluation. He has led multidisciplined, multinational teams of professionals working with clients, cities, campuses, and military bases across the globe to provide analysis of their resource flows to reduce costs, gain competitive advantage, create wealth, and strengthen environmental performance through the application of a whole-systems approach that not only recognizes the underlying causal linkages but sees places to turn challenges into opportunities. Mr. Simpson developed significant experience at the internationally recognized "Think and Do Tank" at the Rocky Mountain Institute (RMI). While at RMI, he presented the Institute's guiding principles and project examples as a keynote speaker at events across the United States and internationally. Also, as a Principal, he was in charge of numerous high-level projects working with collaborative teams of public and private stakeholders. Mr. Simpson joined GSA's Office of Federal High Performance Green Buildings (OFHPGB) to apply his experience, knowledge, and skills in every aspect of sustainable design and program implementation. Mr. Simpson is a Registered Professional Engineer and a LEED Accredited Professional. He holds a master's degree from Stanford University and a bachelor's degree from the University of South Carolina, both in civil and environmental engineering.

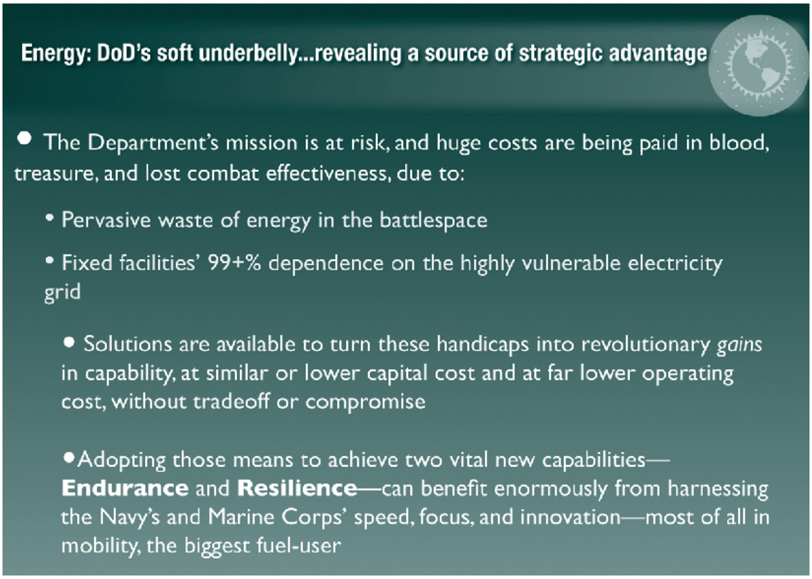

Figure 1. Energy: DoD's Soft Underbelly

almost totally reliant on our nation's highly vulnerable and really shaky electric grid. If you have read "Brittle Power," you know what I mean. [1] Solutions are available to turn these handicaps into revolutionary gains in capacity at lower capital costs and at far lower operating costs, without tradeoffs or compromise. We propose that DoD solve this problem by focusing on endurance and resilience.

When we talk about endurance, what we mean is how do we improve energy efficiency and autonomous energy supply (I'll quote Amory here because I want to be precise) while "recognizing the need for affordable dominance requiring little or no fuel logistics in persistent, dispersed and remote operations while enhancing overmatch in more traditional operations"? We're trying to give the war fighter the ability to spend more time on station with less vulnerable fuel supplies, to be more combat effective, and to be less at risk.

By resilience, we mean: "During the loss of critical emissions from energy supply failures by accident or malice, from inevitable to nearly impossible." That particular quotation is also from the Defense Science Board (DSB) 2008 Briefing. [2] An excellent overview of DoD's energy challenge and strategic opportunity can be found in a recent issue of the *Joint Forces Quarterly*. [3] The article can also be found on the RMI website, **www.rmi.org**.

In Afghanistan, our forces use 5-ton air conditioning units that are powered by generators that consume a gallon of fuel each hour. Cooling 120 tents for one day consumes 68 barrels of fuel that must be delivered by truck over the Khyber Pass. Those trucks are typically organized into convoys that stretch for 3 miles and are extremely vulnerable to being attacked by the Taliban.

With that in mind, the ideal expeditionary force (and, again, this is Amory's take on it) is "like a Manx cat" (Figure 2). If you are familiar with the Manx cat, you know that it has no tail, which would make it the ideal expeditionary force. In our case, we will need to have a stretch goal because we cannot get to "no tail." We want to use efficient and passive or renewable technologies that take care of tasks such as cooling tents, powering up chow halls—doing what we need to do by using the energy in the passive and

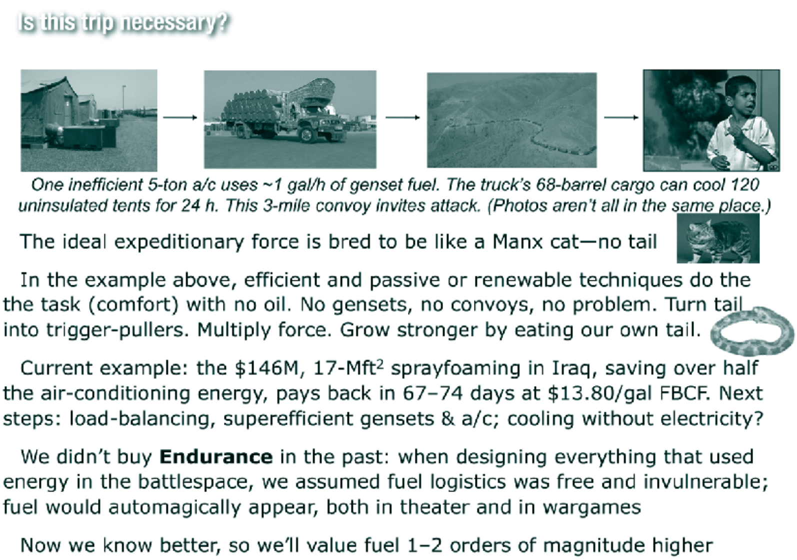

Figure 2. Manx Cat Analogy

most efficient ways. We want to be able to do without generator sets and fuel convoys. We want to be able to turn the tail into trigger pullers and thereby multiply our force. In a sense, we grow stronger by eating our own tail.

As an example of this approach, DoD's Energy Surety Task Force recently spent $140 million for 17 million square feet of spray-on insulating foam for use in Iraq. The foam was sprayed onto the uninsulated tents used by our military so that our troops could be comfortable without needing to set their air conditioners at full throttle. Given a (nearly) fully burdened cost of fuel of some $13.08 per gallon, the resulting savings in fuel use paid off the cost of the insulating foam in about 70 days.

Unfortunately, we do not usually buy endurance. When we designed most of our military systems, we assumed that energy on the battlefield would be free, that it would just appear there, and that it would be invulnerable. Now that we know better, we need to value that fuel at 1–2 orders of magnitude over what we already have.

So what are the hidden costs of fuel in the logistics? If you start at the beginning, about half of DoD's personnel and a third of DoD's budget goes toward procuring, storing, and delivering fuel. Fifty percent of the tonnage moved when the Army deploys is fuel. The annual increase in fuel cost has risen by 2.6% per year on average for each on the past 40 years. The cost is expected to grow 1.5% per year up through 2017.

So that's where we come to the concept of fully burdened cost of fuel (Figure 3). We want to get at the fact that fuel does not just appear where you want it or need it. It has to get there through some means. Our aim is to count all the assets, the activities that would not be needed or could be reassigned to other tasks if a given gallon need no longer be delivered in theater.

According to the recent DSB study, improvements in military energy efficiency provide benefits in five areas. Improvements can reduce the need for force protection because we'll need to protect fewer fuel trucks. Improved efficiency serves as a force multiplier by freeing up convoy guards to become combat operators.

Fully Burdened Cost of Fuel—though often 1–2 *orders of magnitude* higher than *un*burdened cost—is not only incomplete but understated

Initial OSD guidance, though improving, still appears to omit:
- full support pyramids
- multipliers from in-theater to full rotational force strength
- actual (not book) depreciation lives
- full headcounts including borrowed and ?contractors
- full Air Force and Navy lift costs to/from theater
- possibly recursions on FBCF of the fuel that delivers fuel

Some treat garrison costs as dilutive, not additive, to FBCF

Some analysts average peacetime with wartime costs, or even assume a peacetime OPTEMPO

DSB 08: "FBCF is a wartime capability planning factor, not a peacetime cost estimate."

Aim: fully count all assets and activities that won't be needed, or can be realigned, if a given gallon need no longer be delivered

Figure 3. Fully Burdened Cost of Fuel

The bottom line for DoD is fewer casualties, more effective forces, and a safer world.

So, where do we look when prospecting for energy savings? Let's start with DoD's biggest fuel consumer—military aircraft. They use about 73% of DoD's petroleum. Reducing aircraft fuel use by 37% would equal the total fuel used by all the land forces and the maritime forces. Is that practical? We think it is very simple because 60% of the Air Force's fixed wing aircraft are based on designs that are 50 to 60 years old. Nearly all of the vertical lift aircraft are based on designs that are 30 to 50 years old. Replacing these with more modern designs could yield savings of 50 to 80%. The greatest gains in combat effectiveness will come from fuel-efficient ground forces, land and vertical lift platforms, land warriors, and forward operating bases.

The farther downstream we can improve efficiency, the greater will be the overall benefit. For every gallon of fuel that the Army uses, for example, they spend another 1.4 gallons getting it to the front line forces. The British army says that they consume

7 gallons of fuel to deliver each gallon to their operational forces. See Figure 4 for a summary of these points.

What I am doing at GSA is trying to be a catalyst to leapfrog fuel savings into the civilian sector. The civilian sector uses 50 times more fuel energy than does DoD, which is the government's largest single customer. The civilian sector has still been driven in the past to GPS, the Internet, and other aspects that started within DoD. If we can do the same for fuel energy savings and fully burden cost of fuel, that will drive the actual biggest fuel user in our economy, which is the civilian sector.

We need to come from radical clean-sheet design initiatives rather than an incremental approach. That is what Amory emphasizes again and again. For too long we have gone after incremental savings, optimizing things as a single system versus optimizing the system. When you optimize the mechanical system and the electrical system and the fuel system and the propulsion system, you invariably fail to recognize that a little less efficiency in one portion can breed 10 times the efficiency in a more energy-saving capable system.

We do not want to assume diminishing returns or tradeoffs. They are generally signals of poorly stated design problems. None of the briefs presented to Amory and the DSB included discussion of the tradeoff between design efficiency and force protection.

The most *total fuel* can be saved in aircraft: they use 73% of DoD's oil

- Savings in aerially refueled aircraft and forward-deployed ground forces save the most *delivery cost and thus realignable support assets*
- The greatest gains in *combat effectiveness* will come from fuel-efficient ground forces (land and vertical-lift platforms, land warriors, FOBs)

Savings *downstream*, near the speartip, save more fuel, because delivering 1 liter to Army speartip consumes ~1.4 *extra* liters in logistics; in expeditionary Afghanistan, that number may be ~7 (British Army est.)

So these are all worthy objectives—for different reasons—and they're not mutually exclusive

Figure 4. Energy Savers: Where Do We Look?

To look at that, you can go, again, to RMI's website. You can go to *Winning the Oil End Game*, a Pentagon- and Office of Naval Research (ONR)-funded report, which is discussed below.[4]

Now let's turn to oil. Winning the Oil End Game, as I said, was a 2004 road map to getting the United States off imported energy by the 2040s, led by Business for Profit. You can download it at the website. It was an ONR and Office of the Secretary of Defense (OSD)-funded, peer-reviewed work that Amory completed and has been giving away. Figure 5, from *Winning the Oil End Game*, shows that through concentrating on efficiency first you are going to save half of the oil that we use right now. Then, by substituting advanced biofuels or natural gas, you get the other half of what we currently use. It is in the road map. Download it for free. The projected savings are actually a conservative estimate because they assume the hidden costs are zero and that the cost per barrel of oil is only $26, which is a fifth of what we are paying per barrel right now.

The last two presentations stated that 70% of our oil is used in vehicles. By making vehicles lightweight, slippery along the road and through the air, and giving them an advanced propulsion system, they can get 94 miles per gallon. If you look at how your vehicle uses fuel while you are driving down the road, 87% of the fuel energy never reaches the wheels because of engine losses right away. Conventional combustion engines are very

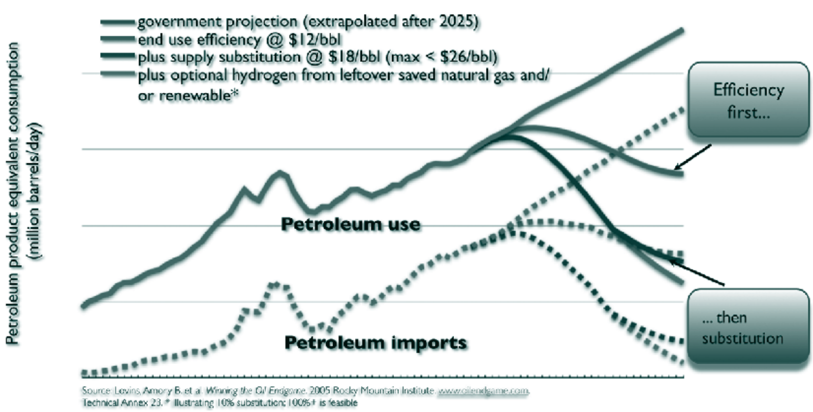

Figure 5. U.S. Oil Use and Import, 1950–2035 [4]

inefficient. You have idle losses, drive train losses, and accessory losses. Then you have aerodynamic drag and rolling resistance. Accelerating and braking resistance make up the last portion. Only 13% of the energy is used to move the tractive load. After more than 100 years of designing motor vehicles, only 6% of the energy goes into accelerating your car. Of that, only 0.3% is moving you. At least two thirds of the fuel use is caused by the weight of the car (Figure 6).

Each unit of that energy saved at the wheel saves 7 to 8 units of fuel in the tank, 3 to 4 with a hybrid. So the first thing we have to do is make the cars radically lightweight and then decompound their mass. The way RMI goes about this is through something we call institutional acupuncture. RMI spent $4 million over 3 years leading the consolidated shifts in these six sectors. Boeing did it with the Dreamliner. Walmart reduced the fuel used by its heavy trucks by 25% in 2008 and is looking at saving 50% this year just through the redesign of their trailer system and adding aerodynamic

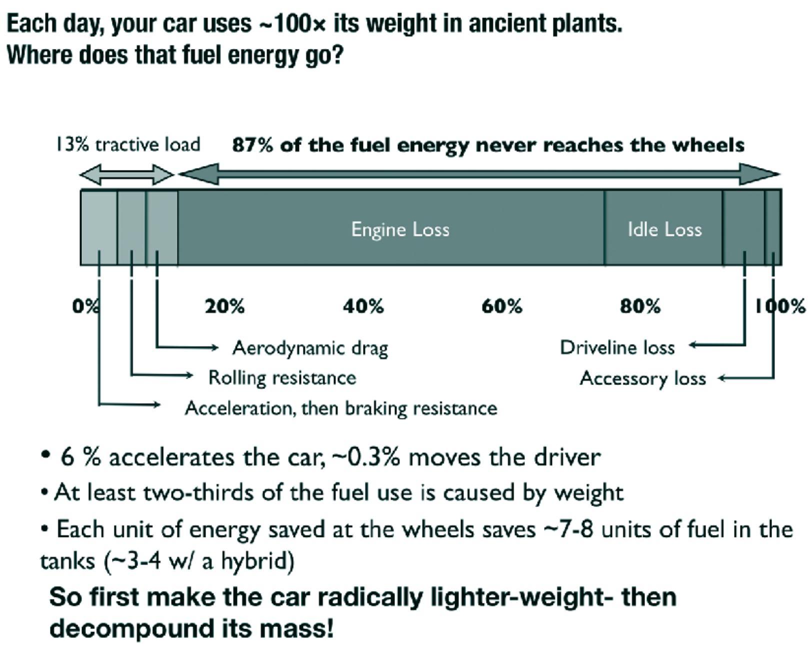

Figure 6. Fuel Energy Used by Vehicles

features to all of their trucks. In 2008, the military emerged as a leader in getting the United States off of fossil fuels.

Cars and light trucks are the slowest in terms of achieving energy efficiencies, but they are finally changing. The American automobile manufacturers are now implementing the lessons they have learned. To reduce car weight, Ford is using some of the carbon technology created by Boeing.

So RMI, with its partners from Ford to Walmart, from Boeing to the Pentagon, has looked at all six sectors. As it turns out, three or four of those six sectors have already passed the tipping point, which means that there is a lot of hard work to be done but it is going to get easier from here on out.

To see that evidence, you should look at the *Wall Street Journal*'s recent reporting on Exxon-Mobil's agreement with many of the private government forecasts predicting that gasoline use will have peaked in 2007. [5] We may have reached peak oil not in supply, but on the demand side—a very positive indicator. Look at world oil, which is projected to peak in 2016 and then fall by 2030 to 8% below today's level and 40% below the consensus forecast.

We are now going to move into the next sector of "reinventing fire," which is the electric sector. We know that 70% of U.S. electricity is used in buildings, which leaves 30% being used by industry. Over 20 years ago, RMI assessed over 1000 energy-using technologies and found that three quarters of the electricity used in these technologies was wasted. Since that time, the efficiency of technologies using electricity has increased greatly and it continues to increase, but its rollout and use still lag behind its increases in efficiency.

The most important thing that RMI found in this study was that the integrated design philosophy was the biggest factor lacking in achieving the efficiencies that we need to lead us into the future. Amory's house in Snowmass, Colorado, was built in 1984. It is a very unique building, but it was a test concept back then for building a home at 7200 feet elevation where annual temperature readings vary from –47°F to over 100°F. He has no heating or air conditioning system, just a heat exchanger with a small fan that moves air through the building. Thanks to solar panels, the house produces more energy than it consumes. The house also includes a greenhouse, where, in the middle of the winter with no heating or air conditioning, Avory has grown bananas for 32 consecutive years. There is really nothing within the home that does not have at least three functions; one important structural component provides 12 different capabilities.

Using that proof of concept and the theories of integrated design, RMI recently worked with Jones, Lang, LaSalle, JCI, and the majority owner of the Empire State Building to do the business case analyses for a retrofit of the Empire State Building. That retrofit is underway. It is projected to reduce energy use by 38% to 40% with a 3-year payback. It has some really unique ideas within the system. There was some out-of-the-box thinking. They actually went across the street, shot the building from outside with thermal imaging, and found that every steam radiator within the building had a heat signature outside the building. Using a 38-cent ($0.38) piece of reflective material behind each one of those radiators erased that signature and greatly increased the efficiency of the building.

Another out-of-the-box concept was to take a floor of the Empire State Building and turn it into a window manufacturing facility for Super Windows. They are now in the process of replacing 6500 windows in the building. All of the replacements will be operable. When we looked at putting that together with better lights and better office equipment to cut the peak load by almost a third, we found that we tunneled through the cost barrier that had been the original concept of what it was going to cost for this retrofit. We started by doing the windows, placing thermal barriers behind the radiators, and installing a number of other packaged retrofits. These improvements reduced the energy demand so much that when it came time to replace the chiller plant, we found that we did not need to tear up 5th Avenue. We did a simple retrofit in place. Doing that led to the $4.4 million in annual savings and operating expenses. These savings, as well as others, are illustrated in Figure 7. But this case is not unique. The Empire State Building is a great example, but we have done other similar things. There is a

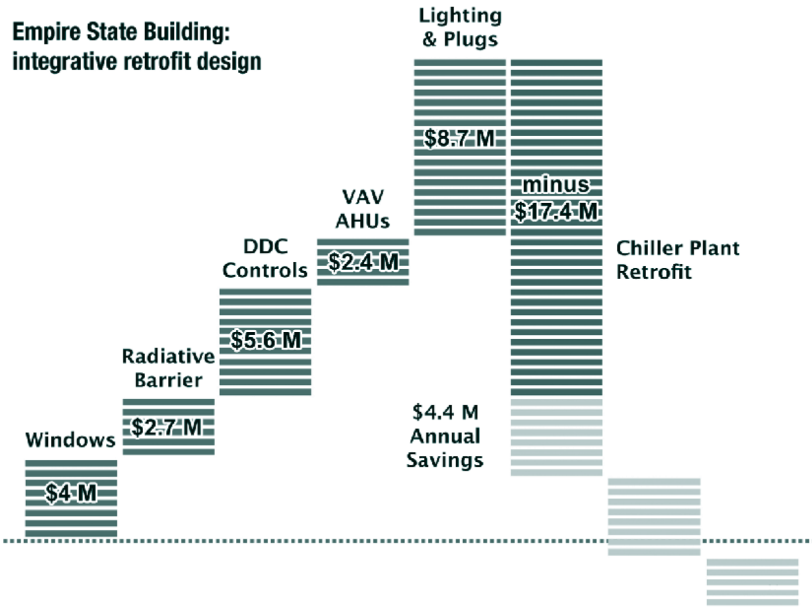

Figure 7. Empire State Building Retrofit Savings

building outside of Chicago that was doing a 20-year curtain wall replacement and we saved 75% of its operational energy, which made the payback for this retrofit negative 5 months.

What invariably happens when people start to look at efficiency improvements is that they reach a cost-effectiveness point above which they are not willing to go. However, if you use integrated design principles and look at the things that you can start leaving out by going beyond that—by super-insulating; changing out Super Windows; examining whether you can downsize your chillers or eliminate a back-up; determining whether you can get rid of pumps, pipes, fuel delivery systems—then you actually end up tunneling through the cost barrier to get to a point at which you do have that negative 5-month payback (Figure 8).

It is interesting that about 60% of the world's electricity is used in motors and about 30% of those motors drive pumps and fans. A normal, typical layout of an industrial plant has pipes that seem to bend every which way. Why is it laid out like this? It's tradition.

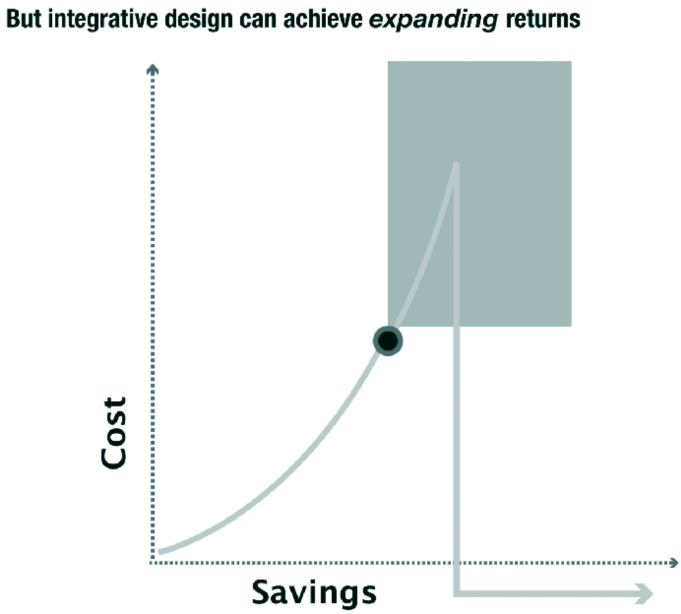

Figure 8. Integrative Design Returns

People lay out their equipment first, then they tell the pipefitters, "Come on in and connect it up," and you end up with a spaghetti mess. RMI has found that by doing the piping layout first and then adding the equipment intelligently saves 69% over the base case with lower capital costs by having short, fat, straight pumps and smaller pumps.

As another example, let's look at transmission losses (Figure 9). If a coal-fired power plant produces 100 units of power, fully 90% of that is lost along the transmission lines by the time it reaches end

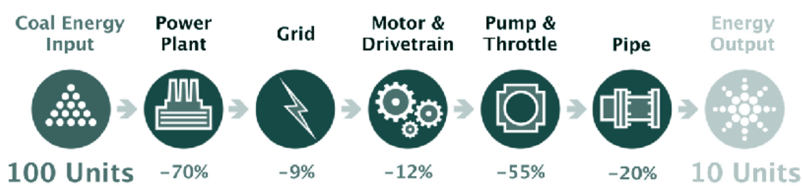

Figure 9. Energy Efficiency: Start Downstream

users. They are able to use only 10% of the 100 units of power generated at the plant. Saving a single unit of power through conservation, efficiency, or reduction of load will yield a 10-fold reduction in the amount of power that needs to be generated. If we can save 5 units of power, then we will need to generate only 50 rather than 100. That is the whole concept behind 10× engineering.

Figure 10 is an example of Amory's typical graph out of *Winning the Oil End Game*. What Figure 10 is really about is how the world is moving away from big, central plants to smaller combined heat and power and distributed renewables. In this study we found that about 16% (or one sixth) of the world's electricity right now is being generated by combining power plants and renewables, whereas nuclear reactors produce only 13%.

Our goal should be to apply these concepts across the grid, especially as part of DoD's net zero initiatives. We should move to distributed generation and advanced renewables. By doing so, DoD and the U.S. government, including GSA, will create the market pull to make photovoltaics come online. Those devices are currently only 13% efficient, but if we can get closer to the current theoretical maximum of 35% (or perhaps higher) over the next 10 years, our nation can get off oil and imported energy

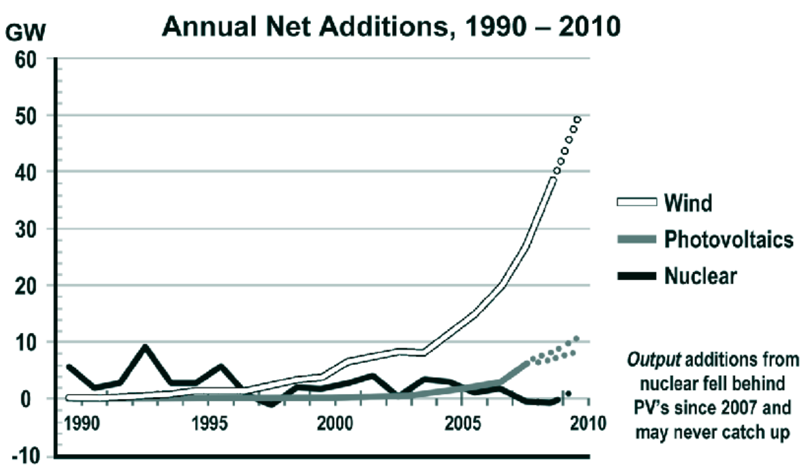

Figure 10. Global Generating Capacity

through the use of distributed renewables and an intelligent, smart grid.

Figure 11 is an example of the antinuclear graph that Amory uses. It shows distributed renewables. It has 100 billion dollars of private capital last year and added 40 billion watts, whereas nuclear has zero. In fact, electricity output growth from nuclear power may never catch up to photovoltaics. The micro-power revolution is increasingly being led by China.

If we want to turn the pyramid on its head, RMI's vision is that, through use of efficiency, renewables, and distributed generation, we can take our traditional energy pyramid, which has the majority coming from coal, nuclear, natural gas, and oil, and make it look a lot more like that (Figure 12). Two key policy changes that can help us do that are "feebates" and the decoupling of shared savings (Figure 13). Feebates are a combination of a fee plus a rebate for energy-efficient cars, thereby creating a revenue-neutral, size-neutral, more profitable system for automakers. They make more effective use of fuel taxes and efficiency standards. This approach is already being used very successfully in France.

- Buy $2–20^{+}\times$ more climate protection per \$, $20–40\times$ per year
- Frees up money and attention for superior alternatives — $\sim 10^{4}\times$ macroeconomic leverage to fund other devel't. needs
- Inhibits spread of nuclear bombs (Iran, N. Korea,…) by removing ambiguity and smoking out proliferators (see *Foreign Policy*, 21 Jan 2010, publ. #2010-03 at www.rmi.org
- How? Just let all ways to save or produce energy compete fairly—no matter which they are, what technology they use, where they are, how big they are, or who owns them
- Key to a richer, fairer, cooler, and safer world

Figure 11. Nuclear Power's Market Collapse Is Good for Climate and Security

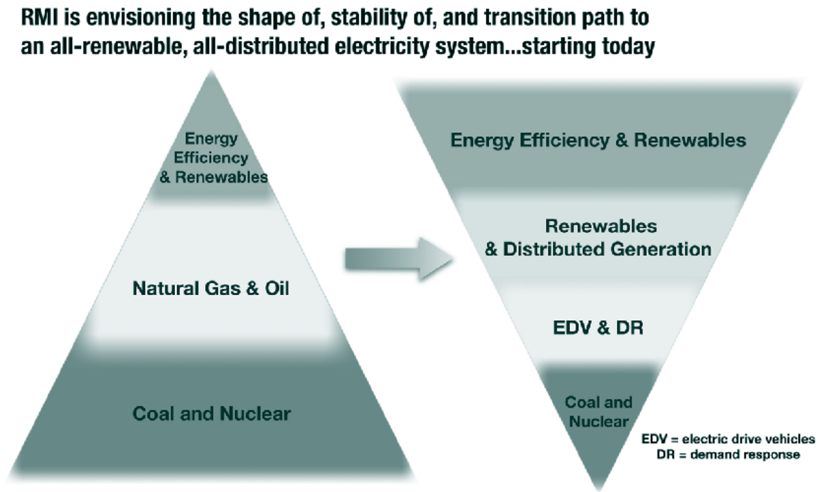

Figure 12. RMI's Vision

The idea behind decoupling and shared savings is to provide an incentive for energy suppliers such as the electric grid to benefit if we use less rather than more energy. Currently, the electric grid is set up so that it is paid more if it provides you with more energy. There is no incentive for them to help you save energy. Thanks to

- **Feebates** (fee + rebate) for efficient cars
  - Revenue-neutral, size-neutral, more profitable for automakers
  - More effective than fuel taxes or efficiency standards
  - Highly successful in France, now proposed for 20 other products; could be applied to new buildings
- **Decoupling and shared savings** for electricity and gas
  - Aligns utility's interests with customers' interests
  - Long successful in 2 U.S. states; spreading: adopted for electricity (gas) in 8 (18) states, pending in 11 (5)

Figure 13. Key Policy Changes

the rebate, manufacturers are going to give you for a better refrigerator or a better car. To similarly incentivize energy providers, we propose a bonus system that pays them more for saving more energy, kind of like performance contracting. One of the big myths is that this is not happening. Well, it actually is. If you look at the United States, use of coal and oil fell in 2006. If we paid more attention to it, we could make it fall even more. The requirement that solutions must await global agreement is simply not true. It is China's number one priority.

Some argue that increasing the price of carbon fuels is an essential first step. Yes, it would be helpful and desirable but it is not essential. What we really need is the price effect. We have to be able to bust those barriers. The ability to respond to price matters more. Tax subsidies and mandates and other instruments such as the car feebates, decoupling, and savings that I just described are more effective and attractive.

Public policy is not the only or even the strongest key. The best approach is to rely on innovative, competitive strategy, technology and design—all from businesses co-evolving with civil society and a more dynamic system. We know that currently we tend to rely on design pull for innovation. What we are advocating is a new design concept that is integrated to push and pull. We want to define the end point, develop the targets, and do some risk management. The GSA, where I now work, is serving as a green proving ground for the government. We intend to bleed a little bit to get the technologies over the tipping point, provide the economic insight, and build customer relationships.

I'll close with one of Amory's favorite quotes from Marshal McLuhan, who said: "Only puny secrets need protection. Big discoveries are protected by public incredulity."

REFERENCES

1. Amory B. Lovins, L. Hunter Lovins, *Brittle Power: Energy Strategy for National Security*, Brick House Publishing Company, 1982.

2. Defense Science Board Task Force, *More Fight—Less Fuel: Report of the Defense Science Board Task Force on DoD Energy Strategy*, Feb 2008, **www.acq.osd.mil/dsb/reports/ADA477619.pdf**.
3. Amory B. Lovins, "DOD's Energy Challenge as Strategic Opportunity," *Joint Forces Quarterly*, **57**:33–42, 2nd Quarter 2010.
4. Amory B. Lovins, E. Kyle Datta, Odd-Even Bustnes, Jonathan G. Koomey, Nathan J. Glasgow, *Winning the Oil End Game: Innovation for Profits, Jobs, and Security*, Rocky Mountain Institute, 2004.
5. Keith Johnson, "Green Ink: Forget Peak Oil; Peak Gasoline is Already Here," *The Wall Street Journal*, 13 Apr 2009, **http://blogs.wsj.com/environmentalcapital/2009/04/13/green-ink-forget-peak-oil-peak-gasoline-is-already-here/**.