Return of the Energy Services Model:
How Energy Efficiency, Climate Change, and Smart Grid
Will Transform American Utilities

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Energy efficiency (EE) is the lynchpin of any strong U.S. climate policy. In the power sector, efficiency will provide somewhere between 15 and 40% of our total electricity "supply" between now and 2050, in addition to displacing substantial amounts of other fuels.[1] In the next ten years, efficiency will play an even greater role, as many utilities conclude that there are no other carbon-saving options readily available at comparable costs. Energy efficiency is really the "plug" in our climate strategy – the one resource we can draw on at an increased pace if other key technology solutions fall short. Nothing short of a massive national effort to save energy will allow the U.S. to meet its necessary climate goals.

This reality has profound implications for American energy utilities. Total sales of electricity and gas, which have steadily increased since the industrial revolution, are already flatting out and will soon decline.[2] Under these conditions, the business model on which these industries financed and built America's energy infrastructure will not work anymore.

Yet – at the same time -- utilities and their investors will soon be called upon to rebuild the vast U.S. electric and gas infrastructure with unprecedented speed and great technical risk. Our preliminary estimate for the investment needed to decarbonize the electric sector is $1.5 trillion through 2030, not counting the customer's share of new technology outlays. And that's not counting the risks involved in developing and scaling low-carbon electric generation.[3]

To raise and spend capital on this massive scale, the utility industry must represent a sufficiently investment attractive vehicle. Part of the attraction will come from carbon markets, which will reward investors in low-carbon technologies and utilities that deploy them. But an increasing

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fraction of the industry is rate-regulated, which caps its upside earnings, and is also on the hook for financing many of the EE measures that will drive its own sales growth negative.

Common sense tells us that a business with declining long-term sales is not a good candidate for massive and expensive reinvestment in its production plant. The average prices of its commodities must go up rapidly, further exacerbating the decline in sales. State regulators and governors, who directly or indirectly control most utility prices, are likely to moderate price increases to help consumers. These moderating steps will hurt investor returns. Investors will respond by raising utilities' borrowing costs. All this will hinder utilities' ability to raise capital and further exacerbate the cycle of price increases, only making our climate goals all that much harder to attain.

Fortunately, there is a solution. In the coming era, the commodity utility business must be replaced by an energy services model, where utilities sell specific end uses to customers, such as heat, light, and screen hours, and so on. This change in business models, enabled by the so-called "Smart Grid," will disrupt decades of old thinking, regulatory practices, and dividing lines between industries. It will make utilities a unique hybrid between wireless network providers and regulated public works.

While it is easy to see this logical end state, getting there is going to be a monumental task. It's a little like rebuilding your airplane, changing the interior seating, and reissuing new tickets to everyone on board, all while the plane is in the air.

THE HUNDRED WATT KITCHEN

To understand why energy efficiency may force radical changes in the utility sector, pay a visit the University of California's Lighting Technology Center. Director Michael Siminovich will first tell you that the average American kitchen uses 700 watts for lighting.[4] He'll take you to a handsome new demonstration kitchen inside his tech center with very high levels of attractive light. Then he'll give you the stunning news that this experimental kitchen uses only 100 watts of light energy – one seventh use of today's households.

Siminovich's kitchen is having its impacts. Nationwide, the Electric Power Research Institute now predicts that sales will grow by only 0.7% a year – and that is before factoring in scaled-up efficiency efforts that will accompany U.S. climate policies.[5] One reason why sales are rising very slowly is that power and gas prices have already increased substantially, prompting consumer cutbacks. In addition, a variety of EE policies – building and appliance standards, utility-run EE programs, state and local programs, and others -- are also reducing usage greatly. The natural gas industry is ahead of the power sector, with average residential per-customer use already dropping by at least1% per year.[6] However, electricity isn't far behind. Jan Bennett, a Vice President with the utility serving fast-growing Phoenix recently noted that his sales growth has gone from over 4% per year to dead flat in the past 18 months. "Our customers are cutting back on AC to pay for their gasoline," he reports.

As a result of these trends, many planners are forecasting or advocating for negative growth utility scenarios. ACEEE, an energy efficiency consortium, proposed a negative sales growth goal to Connecticut regulators in a recent long-term power plan.[7] In New York, then-Governor Spitzer recently proposed a "15 by 15" energy strategy in which there would be no statewide power sales growth by 2015.[8] Many internal utility plans already show near-zero future growth. And very few utilities have yet incorporated either the policy or market impacts of strong U.S. climate policies into their forecasts.

CURTAIN CALL FOR THE OLD WAYS

The financial architecture and regulation of utilities was created based on the supposition that the sale of electrical or gas energy units would climb upward forever. Continually higher sales meant that revenues increased even if rates were stable or declining. Higher revenues allowed the industry to service the capital required to supply higher sales. With scale and scope economies, rates might even decline, as they did from the 1950s to 1970s.[9] Even with roughly constant marginal costs, higher sales implied higher absolute earnings and stable rates – still a highly attractive proposition to investors and customers.

But what of an era in which marginal costs are rising rapidly and sales are falling, yet utilities still must spend billions in new capital additions to decarbonize power generation and implement the Smart Grid?

Let's illustrate the dilemma with a simple example. Suppose the costs of operating the current high-carbon system is $10 million – $5 million for the recovery of investment costs and $5 million for fuel and other operating costs. If the utility sells 100 million kilowatt-hours its average customer rate is ten cents ($10 million divided by 100 million). Ten cents a kilowatt-hour (kWh) is roughly what the average American pays for power today.

Now suppose that energy efficiency efforts reduce sales by 10% over the next ten years to 90 million kWh. Meanwhile, reinvestment in low-carbon power plants requires an annual carrying cost of $15 million – a lot more than the $5 million annual cost of the older, dirtier plants. Operating expenses go up as well, partly due to the need to pay for carbon emissions and partly because fuel and commodities are on a long-term upward trend. With operating costs doubled to $10 million, average rates increase to 27 cents – nearly three times the old rates. Want to try a still more ambitious conservation effort? Reduce sales to 80 million kWh and rates increase to 31 cents, not counting the cost of the added efficiency effort.

Electric and gas utilities are still predominately rate-regulated entities. Even where there is retail energy deregulation – fifteen of the largest U.S. states, give or take – there is substantial political control over utility prices, directly or indirectly. In regulated states, of course, the control is explicit. Investors have decades of experience watching the utility regulatory-politico process slow down rapid increases in power or gas rates so as to cushion the impact on consumers. Faced with this likely response, many utility investment experts are looking at the coming demands for large utility investment with an epic sense of dread.

WHY SAVE UTILITIES?

If electric or gas service have become a zero-growth industry, why should we care? Generally speaking, it is a good thing that industries come and go in gales of creative destruction.

Moreover, although they don't arouse much excitement in the pages of the *Wall Street Journal*, some industries go through long periods of zero or gradually declining growth and still deliver good products.

In this case, however, there are at least two reasons why the financial health of the utility industry matters. First, there is a worldwide imperative to change our energy system away from high-carbon fuels and a similar need for greater energy security. Both factors will require someone to invest trillions in U.S. (and other) power systems in the coming decades. While part of this will come from public entities (including publicly owned utilities), a creditworthy private industry will be an irreplaceable investment vehicle for this transformation.

Paradoxically, the second reason has to do with the very energy efficiency investments that will cause sales to decline. These efficiency investments are extremely capital intensive – they require energy consumers to spend a lot of money upfront to get a future stream of cheaper energy services. Real-world experience with getting consumers to make these investments – thereby achieving our ultimate climate and savings goals – shows that utilities have some unique advantages to help finance and install energy efficiency measures. But to do this they must be able to raise and deploy lots of capital – in effect financing the destruction of their own topline!

There are many, many policy levers that increase the overall energy efficiency of the American economy. Higher electricity prices play an essential role in stimulating conservation, including time-varying prices by day and season. The need for better, time-varying price signals is a critical starting point, but one that is likely to be met as overall electricity prices are inevitably driven higher in the next few decades and appliances and grids become controllable or "smart."

Building codes, appliance and auto efficiency standards, and other similar policies also play an enormous role. By some estimates, increased building and efficiency standards have contributed about 70% of efficiency gains during the last decade in California.[10] Educational programs and other state and local government initiatives, including grant and loan programs, are all valuable. R&D, sometimes assisted by state and federal agencies, is also essential.

But electric and gas utilities are likely to play a pivotal role in the coming efficiency transformation. To understand why, start with the reasons why homes and businesses don't readily adopt more efficient technologies:

- Energy efficient devices initially cost more than inefficient ones and pay back the savings over time. Most families and many businesses are strapped for cash and want to use their scarce credit for other uses – if they have any credit capacity at all.
- Even when consumers invest to save energy, they typically use a discount rate much higher than is optimal from society's standpoint, so they under-invest in efficiency;
- It is time-consuming to search for efficient technologies that reliably save energy. Calculating the cost-effectiveness of these investments typically takes economic and technical skills well beyond the reach of typical consumers.
- It is also time-consuming and potentially quite disruptive to retrofit a home or factory with new technologies or to alter initial construction plans. Anyone who has done renovations or construction knows that there is an enormous value to knowing that the engineer or contractor who is going to work on your structure is effective and reliable.

Utilities of have advantages to overcome these well-known efficiency barriers that are second to none. First, regulated or publicly owned utilities are able to *effectively* loan their customers money to make energy efficiency investments without requiring further collateral from them. More accurately, the utilities partially finance these investments on behalf of society at large. These "loans" can be linked closely to consumers installing and maintaining particular energy efficiency measures – a linkage that would be very hard for any other entity (such as a bank or government agency) to police, but one which comes naturally to a utility that reads a customer's meter routinely. Furthermore, utilities can provide financing for these investments at costs of capital that significantly lower than consumers' own interests costs or the costs of standalone energy efficiency companies.

A second set of advantages has to do with transactions costs and reputation. The decision to install unfamiliar energy-saving hardware is vastly simplified if someone you trust vouches for the fact that the technology works well, lasts for a long time, and is worth its cost. But who to trust for this information? In addition to finding the hardware, one needs to find a trusted installer or contractor – and anyone who has ever supervised a remodeling or new construction job knows that this is a daunting task, especially for consumers without a lot of spare time or construction expertise.

While it is common to demonize utilities for a variety of sins, experience shows that most consumers are far more likely to adopt an energy-saving measure if a utility is involved in the process. Consumers understand that a utility risks its enormously valuable goodwill if it does a bad job selecting energy-savings technologies or getting them installed. Whereas the manufacturers of EE devices may be far-distant companies, and installing contractors come and go, the utility is going to be accessible and at least partly accountable indefinitely. The comfort level in choosing to install efficiency measures, and thus the market acceptance rate, is increased immeasurably by a utility's involvement in the value chain – especially when the utility helps finance the measure.

These market barriers also help explain why private-sector (unregulated, profit-making) EE companies have not made large inroads anywhere except the government sector and where utilities facilitate their involvement. Utility EE programs are best understood as creating vehicles for searching out good EE technologies and good private-sector vendor-installers and creating low-cost financing for these measures with a minimum of paperwork, no collateral, and repayment built in to utility rates.

There are certainly alternatives to utility provision of EE, and some of these alternatives clearly work. In some U.S. states government agencies play much of the role that utilities otherwise play – designing programs, paying rebates, and so on. There are many pros and cons of governmental agencies taking the lead in delivering EE. However, the first reality is that for the foreseeable future utilities are going to be in the EE business in a very big way. The other reality is that, if utilities get out of the EE business, only government agencies can realistically pick up

the slack. That means raising and administering billions of dollars of new public funds with all its attendant difficulties.

The other common alternative to greater utility involvement is to assume that better price signals (including carbon prices) will incentivize adequate efficiency and let independent energy service companies (ESCOs) be the industry that drives energy use down. Even if this approach worked best for reducing energy use – which it hasn't – it leaves the traditional utility industry left with the non-viable proposition of rebuilding its supply system financed solely by declining commodity sales. It is as if we told our car companies *not* to make electric vehicles as policies force them away from making gasoline-powered cars, while we made them retool their old factories anyway. Of course, U.S. energy policymakers have done just the opposite, strongly urging Detroit to migrate to new vehicle platforms to save the industry and keep its workers employed.

Keeping utilities out of the energy efficiency business will only make it harder – indeed probably impossible – for them to carry out the job of rebuilding their plants and retooling the grid. The better alternative is to create a utility industry that financially hedges its declining commodity sales with increasing energy services revenues. The industry recreates its supply function while it adds new products and services to its offerings.

NOT YOUR GRANDFATHER'S DEATH SPIRAL

For old-timers in the utility industry, the tension between utility profit goals and energy efficiency is déjà vu all over again. In the 1980s, the industry simultaneously was adding completed nuclear plants into rates, paying record high prices for oil -- though not for natural gas as today -- and trying to reduce bill impacts via energy efficiency programs. These developments led to worries that utilities might enter what became known as a "death spiral."

A death spiral is supposed to work like this: First, a utility raises its rates to cover higher power plant investment costs. Second, the higher rates cause customers to purchase less power, aided by utility EE programs. Third, the lower sales don't change the cost of the power plant that has to be recovered in rates, so rates have to be raised again to cover the lost sales. This causes sales to drop again, rates to be readjusted upward again, and so on into bankruptcy.

As it happened, no utility went into exactly such a spiral. However, several utilities went bankrupt due to their inability to raise rates enough to recover their costs. Much more commonly, regulators chose to spread out utility rate increases, reducing shareholder profits greatly and spreading them out further over time. Most utilities confronting the spiral stayed out of bankruptcy, but their shareholder earnings dropped greatly and so did their ability to invest in new supplies.

Today's situation is similar, with the proviso that the reductions in sales are much, much larger than they were in the 1980s. In that period, sales dropped from five or six percent annual growth down to perhaps two percent a year, which was then thought to be extremely low. In contrast, today's sales growth rates with EE are in the range 1.5% per year to negative 1.5%. Furthermore, the need to make large forward investments and raise prices applies to nearly the entire industry now, as oppose to a relatively contained set of nuclear utility in the 1980s.

In short, the problem is <u>not</u> that average <u>bills</u> will increase to the point where customers will refuse to pay – the old worry. The problem is the basic financial viability of the utility as an investor-financed entity when it faces both a declining sales base and huge investment demands.

THE ENERGY SERVICES MODEL

In the near term, implementing EE incentives inside the framework of traditional utility regulation is an essential start. The industry is at a point where aggressive EE is essential for meeting capacity shortages, moderating bill increases, and making rapid progress towards climate goals. For the next decade or so, the costs of adding supply-side capacity are so high, and the costs of reducing demand so low, that reducing the rate of capital additions through EE is demonstrably accretive to utility shareholders.[11]

The long-term alternative is to change the industry to one that sells units of delivered energy services rather than energy commodities. Energy services such as light, heat, and computer-hours are the real reasons we buy energy. Inside our homes and businesses, we combine energy commodities with energy-using hardware we buy privately to produce the services we desire.

Ironically, the energy services model was the industry's original platform. Thomas Edison sold light by the light-hour to his first customers, not kilowatt-hours.[12] As the number of electric appliances grew, J.P. Morgan decided that the company that sold juice and the company that sold the end-user appliances should be separated. At this moment Edison General Electric became a commodity seller and the appliance division became General Electric. Of course, GE was soon joined by thousands of firms that now make electric and gas "end use" technologies.

Financially, the services model works because the quantity of energy services our economy will use, and can afford to pay for without rate shocks, will continue to grow for the foreseeable future. Because most end use hardware gets continually more efficient, the combined cost of higher commodity prices and more efficient hardware is much less than the rate shocks from high commodity prices alone. It is blending two services with different cost trends to produce a value proposition customers (and the political process) will accept. Better still, this model leverages the forces set in motion by strong climate policies, which will accelerate the introduction of more efficient technologies and thus further offset the steeper rise in commodity prices. In the language of risk management, the industry sells customers an inherently hedged position of commodity and commodity-using products.

To compare the value of commodity energy and combined commodity-hardware energy services, look at the services in simple electric lighting. A lumen-hour is a well-accepted unit of lighting energy service. One kWh of power pumped through a conventional incandescent bulb produces about 13,300 lumen-hours of energy service. If we were modern-day Thomas Edisons, we'd charge a power customer about 7.5×10^{-4} cents for each hour of this service. But if we sold our customer that same lumen-hour using a much more efficient compact fluorescent, the cost would

be only about 1.7×10^{-4} cents on a life cycle basis. The cost of commodity power can quadruple and the lumen-hours from the CFL are still cheaper.

From the customer's standpoint, how exactly would this work? The customer's bill would look nothing like today's relatively simple power bill. Instead, the detail of charges on the bill will include charges for each of these services:

- Lumen-hours of interior light
- Lumen-hours of exterior light
- Heating-degree hours of heat supplied
- Cooling-degree hours of cooling supplied
- Cooking and other kitchen energy
- Water heat supplied
- Other miscellaneous commodity load

Each of these services would have its own price; only the latter would continue to be sold on a per-kWh basis.

The energy services model will necessitate great changes in the industry. Utilities will get back into the business of deeply influencing, and if not sometimes leasing or owning, the end use hardware in homes and businesses. An industry that has been largely out of the hardware business will have to coexist with thousands of unregulated hardware manufacturers.

While this may sound unacceptably intrusive, the product and technology mix is very similar to that of today's wireless communications providers. These providers sell bundles of specially-developed hardware (locked cell phones that work only on their networks) and wireless network services. Although the underlying commodity on their network is really bits per second, they don't sell this commodity. Instead, they separately price and sell talk minutes, text messages, video downloads, internet minutes, and a plethora of other services. All these services use the same underlying commodity, but they convert the commodity to a useful (and priceable) service using an end use appliance they select and market to the customer.

DÉJÀ VU AND THE SMART GRID

In 1980 a former Ford Administration energy official named Roger Sant wrote an article for the Harvard Business Review called "The Coming Market for Energy Services."[13] Noting Thomas Edison's original use of the services model, Sant wrote:

> "Most managers have learned from experience, as Edison did, that a product should be packaged in a form which people can easily relate to, such as protection instead of life insurance. Most people cannot understand typical energy terms like kilowatts, kilowatt-hours, cubic feet, barrels, or Btu's. They can relate to a heated room and a lighted desk. But until recently, the costs of these various fuel units were so small that no one cared about the terms in which they were sold.

Sant then suggested that utilities start selling these services, in competition with "Honeywell, General Electric, IBM, Carrier, General Motors, and many others, large and small." The energy services model was also suggested by Amory Lovins and other leading energy policy thinkers of this era.[14]

Sant, Lovins, and their contemporaries were ahead of their time, and the sale of energy services did not take root in the utility industry. A few utilities and non-utilities started energy services companies ("ESCOs"), but these have not flourished outside the military and government customer segment, where customers are able to meet the special business terms these companies require to remain competitive. Meanwhile, federal and state policymakers reacted to the electric and gas price shocks of this era by adopting new planning processes that tried to mesh least-cost service calculations with new expansion plans and the first utility-administered EE programs. These changes marked an important transition, but every utilities' financial performance and rates remained denominated in commodity units – kilowatt hours or therms.

Today, changes in industry economics and technology make the energy services model not merely possible but compelling. In the 1980s, the industry certainly faced tough times, and a number of utilities became bankrupt or insolvent. Nonetheless, electricity sales continued to go up in this era nearly every year, they just went up at a lower growth rate. Furthermore, natural gas prices fell during this period, allowing producers to make commodity power at constant or

declining real prices. Both factors took the pressure off the traditional model. This time around, there are no rapidly declining sources of commodity power and few scenarios for continued sales growth.

The second major change from the prior era involves a key set of breakthrough enabling technologies known as the "Smart Grid." During the 1970s it was flatly unworkable for utility providers to measure and keep track of the many types of energy services demanded by nearly 200 million different customers across the nation. Sensors and energy measurement gear were primitive and expensive and there were no wide-area communications or data management systems remotely capable of gathering and processing the data needed for monitoring, managing, or billing.

The Smart Grid will remove all of these barriers. There are now low-power wireless energy sensors, such as those developed by the Lawrence Berkeley National Laboratory, that transmit energy use data continuously to building monitor systems. Many utilities are already installing electric meters with advanced two-way communications features and WANs capable of collecting boatloads of customer data. Energy management software, which automatically manages the major energy hardware and collects all the data needed by utilities, is already standard in every new commercial and industrial building and will soon be standard in homes. And appliance manufacturers are starting to sell appliances pre-equipped to send precisely the information utilities need for services model billing. In a nutshell, the Smart Grid is the key enabling technology for the energy services model. It didn't exist in the 1980s, but utilities are steadily increasing their smart grid investments and government policies are starting to accelerate the process.

REGULATING ENERGY SERVICES

Most prior visions of the energy services model assumed that the power industry would be fully deregulated. Service providers would compete to sell light and heat to customers at the lowest possible price, much like the largely deregulated wireless carriers compete with largely price-unregulated service plans today.

For the next few decades, however, the U.S. power industry will remain predominantly regulated or publicly-owned. This raises the question of how state regulation, which is also built firmly on the commodity model of electric services, can cope with this enormous business transition.

There are many possibilities and no firm answers. For each end use and customer segment, regulators could likely set a cost-based maximum price and allow utilities to charge any price below this if they can beat it. Many other forms of performance-based ratemaking could be used to give utilities similar incentives to maximize service without using more commodity. The terms of utilities' financial stake in customers' end use appliances would have to be factored in to any ratemaking scheme.

While it may sound farfetched to imagine that state regulators would ever set maximum prices for lumen-hours or cooling-degree days, the seeds of such changes are sprouting throughout the industry already. Duke Power has proposed a new ratemaking scheme in which it installs energy-saving hardware at its customers and keeps the difference in costs between the older, more expensive energy services package and the new one it helps create. Separately, many utilities are doing experiments with Smart Grid prototypes in which customers choose different levels of energy services by choosing how hot or cold to make their homes during the day and other service selections. Several consortiums of manufacturers, utilities, and information companies are deep into the design of appliances that communicate with are controlled by the electric network.

These actions will make the transition to a full services business model much easier. So far, utilities continue to speak to their customer in the language of commodity use and bills – the language of kilowatt-hours and dollars. The next step will be to teach the customer to think about particular types of energy services, and to get more involved in the combination of hardware and commodity needed to provide each one. Overall, regulating energy services is not a task beyond the reach of state regulators or the managers of public-owned utilities – but it will be a the largest revolution in utility regulation since its inception.

CONCLUSION

For almost a century, utilities have supplied electricity to a power-hungry American economy. Most of this supply came from investor-owned companies whose prices were set to equal their costs plus a fair return on invested capital. The more they invested, the larger the supply and the greater their earnings.

This approach to regulation created an industry whose regulatory processes, financial well-being, and business culture was tied directly to continuing growth in both sales and invested capital. Long-lasting economies of scale ensured a virtuous circle in which utilities expanded their supplies, regulated prices diminished, and utility earnings on invested capital rose steadily. Households and businesses loved cheap and abundant supplies of energy and Wall Street loved stocks whose dividends rose steadily year after year after year.

For a variety of truly historic reasons, this era is coming to an end. Climate policies and rising prices will end the era of commodity sales growth, while massive supply and grid investments are nonetheless necessary. The industry must fashion a new regulatory compact, and a new business model, if it is to survive.

Under today's business model, the only way to finance all these capital additions is to charge current customers more and more for their gradually declining levels of use. This is a terrible value proposition for customers and public policymakers alike. It is reminiscent of our healthcare system, where our insurance premiums continue to go up as our levels of coverage (and too often the overall quality of care) simultaneously decline.

Utilities are extraordinarily well-suited to carry out the difficult work of saving electricity and gas. The problem is that the financial foundations of this industry are built on steady growth, not declining sales. The regulatory fixes being used to treat this conflict are not up to the task. Without dramatic changes in the very core of the utility industry's financial and business model we may be setting ourselves up for a costly and dangerous failure.

There is no smooth and seamless path from an industry whose financial success depends on selling progressively more units to one rewarded for selling progressively fewer. Regulators, investors, and utility managers have spent a lifetime thinking like every other company that is rewarded for growing sales and increasing profits. And Wall Street hardly likes it when the business model underlying a company's stock valuation is transformed – with abundant economic and regulatory uncertainties – right before its eyes.

But we are in an era that demands new thinking and massive changes in our energy production and use. We are in a race to rapidly reinvent a global energy system that is deeply dependent on high-carbon fuels. The solution will require new industries, business models, and government institutions everywhere in the world, starting with a trillion-dollar market for carbon emission permits that does not even exist yet. At the same time, disruptive technologies such as the Smart Grid will change the industry as well. New modes of working with our local utilities, new core competencies within these firms, and greater control over our end use purchases may simply be one of the inevitable changes needed to manage the American portion of world's all-too-pressing carbon budget.

Endnotes

[1] "Realizing the Potential for Energy Efficiency," The United Nations Foundation, (2007); "2008 Annual Energy Outlook," The U.S. Energy Information Administration, (2008), http://www.eia.doe.gov/oiaf/aeo/; Ahmad Faruqui, "Rediscovering the Demand-Side of the Equation," (presented before the Indiana Energy Association, September 21, 2007).

[2] Energy Information Administration Report "Annual Energy Review 2007," U.S. Department of Energy, http://www.eia.doe.gov/aer/.

[3] Peter Fox-Penner *et al.*, "Transforming America's Power Industry: The Investment Challenge," (Report forthcoming for The Edison Electric Foundation, 2008).

[4] See http://cltc.ucdavis.edu/ for more information on the Technology Lighting Center.

[5] Jonathan Koomey, *et al*., "Residential Sector End-Use Forecasting with EPRI-REEPS," Lawrence Berkeley Laboratory, (1995).

[6] Frederick Joutz and Robert R. Trost, "An Economic Analysis of Consumer Response to Natural Gas Prices", American Gas Association, (2007).

[7] Jeff Schlegel, "Energy Efficiency and Global Warming: What Must Be Done," (presented at the ACEEE Conference: Energy Efficiency as a Resource, October 2, 2007).

[8] Eliot Spitzer, "15 by 15 A Clean Energy Strategy for New York," (Crains Business Breakfast Forum, New York, NY, April 19, 2007).

[9] Energy Information Administration Report "Annual Energy Review 2007," U.S. Department of Energy, http://www.eia.doe.gov/aer/.

[10] Ahmad Faruqui and Sanem Sergici, "Energy Efficiency Through the Long Lens of History." (presented before to EPRI/EEI, February 16, 2008).

[11] The same thing is true, in approximate terms, for the customer-owners of cooperatives and others in this segment of the industry, as well as for ratepayer-taxpayers of government-owned utilities. The underlying economic fact that new supplies are much more expensive than reductions in demand means that average rates will go up more rapidly with higher rates of supply growth and concurrent demand. In all segments of the industry, reductions in demand reduce bill increases as help meet climate goals.

[12] Roger Cullis, "Technological Roulette- A Multidisciplinary Study of the Dynamics of Innovation," The Queen Mary Intellectual Property Research Institute, (2004) http://www.qmipri.org/Cullis.htm

[13] Roger W. Sant. "Thinking Ahead (The Coming Market for Energy Services)", The Harvard Business Review, (1980).

[14] Theodore Levitt's seminal piece "Marketing Myopia" raised the question of "What Business Are You In?" in 1960 and soon after economists began to use this question to analyze the energy industry and its future. Amory Lovin's first introduced the phrase "soft energy paths" in 1976. A "soft energy path" is one that replaces fossil/nuclear fuels entirely with efficiency and renewables to meet total demand. To successfully structure this path, Lovins stressed that utilities would be wise not to view energy as the end product itself, but the means to a social end. In his 1989 Keynote Address at CCR Green Energy Conference in Montreal, "The Negawatt Revolution: Solving the CO2 Problem," Lovins describes "soft energy" as an "end-use, least cost" approach similar to Sant's energy service model in "The Coming Market for Energy Services". Later, in 1984 Sant collaborated with Dennis Blake, Roger F. Nail, and James Bishop to publish "Creating Abundance: America's Least-Cost Energy Strategy."