The Impact of E-Commerce On Energy and the Environment

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Editor's Note: Readers, who are responsible for improving energy efficiencies in all sectors, should note that the authors attribute two-thirds of the improvements in energy intensity which have taken place to the traditional activities of energy engineers and professionals. Further, that improvements in traditional energy efficiency will likely accelerate.

This article explores the impact of the growing Internet economy on current and future trends in energy consumption.

The world is only beginning to come to grips with the complex consequences of the exploding growth of e-commerce and the Internet economy. To be sure, the impacts on the way we live, work and consume will be historic, both positively and negatively. We need to understand the potential created for environmental gains and structural reductions in energy and resource use, as well as the need for certain industries to adapt to very large strategic challenges and opportunities.

This article reflects an analysis of currently available but incomplete data, and begins to construct some rough scenarios. Hopefully these scenarios begin the process of identifying opportunities and challenges for business leaders and policy makers and suggesting the directions of future research and initiatives. These dynamics will fundamentally shape the path to sustainability in the US and around the world.

Our key points and conclusions:

- The nation experienced remarkable economic growth in 1997 and 1998, about 4% per year, driven to a significant extent by industries that produce information technology (IT). The resulting increase in electronic business transactions also played a role. The overall productivity of the economy appears to have increased substantially, driven by the IT sector.

- During those same two years, the nation's energy consumption—the principal source of air pollution and the gases linked to global warming—hardly grew at all. In the previous 10 years, U.S. *energy intensity*, measured in energy consumed per dollar of gross domestic product declined (i.e., improved) by under 1 % per year. In both 1997 and 1998, it improved by more than 3%—an unprecedented change during a time of low energy prices. In 1998, U.S. emissions of greenhouse gases rose only 0.2%, the smallest rise since 1991 (which was a recession year).

- Preliminary analysis by EPA and Argonne National Laboratory suggests that roughly one third of the recent improvements in energy intensity are "structural." Structural gains traditionally occur when economic growth comes in sectors of the economy that are not particularly energy intensive, such as the IT-producing sector, which includes computer manufacturing and software (as opposed to more energy-intensive sectors, including chemical manufacture, the pulp and paper industry, and construction).

- The remaining two-thirds improvement comes from gains in the energy efficiency of all sectors. In traditional energy efficiency, a computer factory would use more efficient motors, a software company might using more efficient lighting in its buildings, or a chemical manufacturer might redesign a process for making a chemical to cut the energy used per pound of product.

- Traditional structural gains will likely continue, since the IT-producing industries continue to show high growth rates. The EPA has performed a preliminary analysis of the potential impact of structural changes driven by rapid growth of the IT-producing industries. The analysis suggests that mainstream forecasts may be overestimating U.S. energy and carbon dioxide emissions in the year

2010 by up to 5%—while significantly *underestimating* overall U.S. economic growth.

- Traditional energy efficiency will also likely accelerate for two reasons. First, more and more companies are developing and implementing strategies to reduce their greenhouse gas (GHG) emissions and these strategies include investing in energy efficiency. Second, major energy service companies are increasingly offering "energy outsourcing" deals in which they take over corporate energy management for Fortune 1000 companies and invest in energy efficiency to a much higher degree than those companies had. These deals eliminate many of the barriers that have slowed more widespread adoption of energy efficiency technologies and strategies in the past decade.

- Equally important (and a primary focus of this article), the Internet economy itself seems to be generating both structural gains and efficiency gains. Internet structural gains will occur, for instance, if the manufacturing of software on disks and CDs (delivered by plane and/or truck) continues to shift toward purely electronic files delivered over the Internet. If companies put their stores on the Internet using software, rather than constructing new retail buildings, that would also represent an Internet structural gain. Dematerialization saves energy. The Internet makes possible what might be called *e-materialization*. By 2003, e-materialization of paper alone holds the prospect of cutting energy consumption by about 0.25% of total industrial energy use and net GHG emissions by a similar percentage. By 2008, the reductions are likely to be more than twice as great. We also believe the Internet Economy could *render unnecessary as much as 3 billion square feet of buildings*—some 5% of U.S. commercial floor space—which would likely save a considerable amount of construction-related energy. By 2010, e-materialization of paper, construction, and other activities could reduce U.S. industrial energy and GHG emissions by more than 1.5%.

- Internet energy efficiency gains potentially cover a broad spectrum of activity. In business-to-consumer e-commerce, for instance, a warehouse can contain far more products like books per square foot than a retail store. Warehouses themselves also typically use far less

energy per square foot than a retail store. So books and other products sold over the Internet would likely consume less energy per book then traditional retail-based sales.

- More important is business-to-business e-commerce, which is estimated at 5 to 10 times the size of business-to-consumer e-commerce. As traditional manufacturing and commercial companies put their supply chain on the Internet, and reduce inventories, overproduction, unnecessary capital purchases, paper transactions, mistaken orders, and the like, they achieve greater output with less energy consumption. Federal Reserve Board Chairman Alan Greenspan told Congress in June "Newer technologies and foreshortened lead-times have, thus, apparently made capital investment distinctly more profitable, *enabling firms to substitute capital for labor and other inputs far more productively than they could have a decade or two ago*." Imagine the Internet energy efficiency gains if electronic commerce leads "to a reduction in overall inventories of $250-$350 billion, or about a 20% to 25% reduction in current U.S. inventory levels." Few things have a larger environmental benefit than pollution prevention, especially in the energy-intensive manufacturing sector. Not making products that wouldn't have been sold or not building manufacturing plants that aren't needed is pure prevention.

- Another important effect is that the Internet appears to be promoting greater use of home offices, allowing telecommuters to spend less time at the office and also spawning many purely home-based businesses. The Internet provides home-based workers more access to more useful information and increasingly high-speed connections to coworkers and/or customers. And as e-commerce itself grows, both business-to-consumer and business-to-business, more jobs will involve spending a considerable amount of time on the Internet, jobs that can perhaps be done as easily from home as from traditional workplaces. This shift will increase energy consumption in homes, but will likely save far greater energy in avoided office building construction and utility bills, as well as reduced commuting energy.

- The Internet is growing so quickly, and data on it remain so inadequate, that it is certainly not possible to draw more than tentative

conclusions at this point (particularly in areas as difficult to analyze as the possible substitution of Internet use for transportation). That is why we have labeled this analysis a scenario, and not a prediction. We believe the Internet may already be reducing the energy intensity of the industrial sector, and that it holds the potential to have its most significant impact in this area. If so, this would be the Internet's biggest impact on the environment, since this sector is responsible for a third of the nation's air pollution and the vast majority of its hazardous waste and other pollutants. We believe the Internet could significantly reduce the contribution of the commercial building sector to the nation's energy intensity and that gains in this sector will likely outweigh increases in electricity use in residential buildings. We suspect the Internet economy will be no worse than neutral in the transportation sector, but could well have a large positive impact. In general, we believe one label commonly used for e-commerce, "frictionless," has a useful analogy here. Friction causes energy to be lost. Frictionless commerce saves energy.

- If, indeed, the Internet is already reducing energy intensity, then it is likely to have a very big impact in the years to come. The Internet economy is projected to grow more than ten-fold—from its current level of tens of billions of dollars today to more than $1 trillion in a few years. Moreover, while the Internet economy remains a small share of the total U.S. economy, it represents a much higher fraction of the *growth* in the economy. That is the essential point for this article, which explores the likely impact of the Internet on the relationship between the growth in the economy and the growth in energy use.

- We believe the combination of trends described above makes it likely that the years 1997 to 2007 (and probably beyond), will not see the same low level of energy intensity gains that the previous 10 years saw, which were under 1 % per year. *We expect annual improvements in energy intensity of 1.5%—and perhaps 2.0% or more*. If this comes to pass, most major economic models used in the country will need to be modified. For instance, the government's main energy forecasting arm, the Energy Information Administration, uses a figure of 1.0% or less for its projection of annual energy intensity improvements. If the actual number is closer to 1.5% to

2%, then a number of related forecasts may need to be changed, such as the number of power plants the United States will need to build in the next decade, and the cost to the nation of achieving greenhouse gas reductions.

- It may be that many other factors widely used in economic models—building construction per GDP, paper use per GDP, and the like—also need to be changed. This might in turn affect the impact of GDP growth on the inflation rate. The Internet economy could well allow a very different type of growth than we have seen in the past. In other words, the scenario we are presenting is that if there is a so-called "New Economy," as many apparently now believe, there is also a "New Energy Economy," which would have profound impacts on energy, environmental, and economic forecasting.

- At the level of the firm, one company has already integrated traditional energy efficiency with Internet efficiency to achieve remarkable improvements in energy intensity. IBM is one of the leaders in corporate energy management, with major successes using technologies like efficient lights and motors in its office buildings and factories. At the same time, it has had one of the most ambitious programs in corporate America to use laptop computers and other information technologies to allow a significant fraction of its sales and service organizations to work outside IBM's buildings (i.e. to telework). In addition, the company has been using its electronic network to improve inventory management and production planning, which has allowed it to better utilize existing manufacturing capacity and thereby lower investment and operating costs. Together, all of these efforts have allowed IBM to reduce corporate energy consumption by 4% per year throughout most of the 1990s. Moreover, IBM projects that it will be able to continue reducing energy consumption for the foreseeable future, even as it continues to experience significant growth.

ABOUT THE AUTHORS

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Dr. Art Rosenfeld is one of the foremost experts in energy efficiency in buildings and appliances, as well as climate mitigation and analysis. He is the author of 360 scientific or technical papers and three best-selling books on energy. He is the founder and former director of the Center for Building Science, Lawrence Berkeley National Laboratory (1975-1994).

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ABOUT THE CENTER FOR ENERGY AND CLIMATE SOLUTIONS

CECS works with corporations, governments, and organizations to supply practical strategies and tools for reducing energy costs and GHG emissions. CECS services include:

- Helping companies design and implement strategies to cut costs and boost productivity while cutting GHGs;
- Spreading best practices for GHG reduction;
- Providing neutral and credible verification of GHG emissions baselines and reductions;
- Partnering with energy service companies to spread the opportunity for energy efficiency and GHG reductions;
- Partnering with Information Technology companies and Internet companies to promote economic growth while increasing energy efficiency and reducing environmental impact, what we call “eee-commerce”; and
- Communicating and educating the public on GHG emission mitigation efforts through public speaking, publications and the CECS website (www.cool -companies. org).