The Future of Commercial Buildings: The Major Trends, Influences, and Factors Driving Change in the Commercial Buildings Market

Katherine Johnson, KJ Consulting
John H. Reed and Jeff Riggert, Innovologie, LLC
Jerry Dion, U.S. Department of Energy

ABSTRACT

Commercial buildings are continuously changing and evolving to meet the needs of their users. The structure, operation, and use of buildings of the past differ from today. Commercial buildings in the next several decades will continue to evolve to meet these changing needs. This paper, based on a study commissioned by the Department of Energy, will examine the ways in which commercial buildings are expected to change.

Introduction

The Department of Energy, Building Technologies Program, contracted with Innovologie, LLC, to characterize the commercial new construction market in order to better understand the needs and operation of this market, to more effectively identify technologies needed by the market, and to suggest ways to improve the effectiveness with which technologies are diffused to it. This paper describes some of the ways that commercial buildings are expected to evolve and change within the next two decades.

Sources of Information

Much of the information for this study was gathered from secondary sources on the Internet. This information came from surveys and studies compiled by trade associations and industry-specific publications. Many information sources have been in printed format for a number of years but have not been readily available outside of the disciplines for which they were produced. Within the last three to five years this information has been placed on the Internet where current search engine technology has made it easy to locate and retrieve it. Examples of the diversity of sources are the *National Real-estate Investor* and SIOR Comparative Statistics of Industrial and Office Real Estate Market*s* for the commercial office submarket; *Shopping Center World* and *Chain Store Age* for the retail submarket, *Restaurants USA*, National Association of Convenience Stores, and Census of Manufacturers for the food sales and services submarkets; American Senior Housing Association, *AHA Hospital Statistics*, Health Industry Market Intelligence Database for the health care submarket; the American Hotel and Lodging Association and Smith Travel Research for the lodging submarket, the US Department of Education, National Center for Education Statistics Common Core of Data Survey and *School Management and Planning* Annual Construction Reports for the education submarket; and Reed Business Information, a Division of Reed Elsevier, Inc. for the warehouse submarket.[1] We mention these sources because they are not sources that energy efficiency researchers use yet they provide a wealth of data and articles about trends in the various

[1] For more information about sources see Reed (2004).

submarkets, trends in construction, and not infrequently articles and data about energy use and energy efficiency.

There are some limitations. Many of the databases from these sources are based on surveys conducted by trade associations and rely on voluntary response and self-reported information. In some instances they capture nearly the entire population, especially of the large players in a submarket. It appears that the largest firms tend to respond to requests by trade organizations while smaller firms are less apt to respond or are not polled. Nonetheless, the data provide some of the best information available on the state of these markets.

The information is collected for use by the trade association and its members. It tends to focus on issues of importance to them to the exclusion of other concerns. Thus, it does not always contain the level of detail about buildings or decision-making that we might like.

The data reported on the Internet are a selected subset of the available information. Much more information is collected than is reported publicly in the publications and by the trade associations. Thus, there is potential to learn much more than is evident on the Internet if access to the main data sources can be purchased or arranged. These are potentially rich sources for understanding these markets and energy use in them.

Commercial Buildings in Perspective

In simplest terms, commercial buildings are those not used for industrial, residential, or agricultural purposes.[2] It is not possible to engage in an extensive discussion of historical trends in commercial buildings but it is useful to highlight a few key facts.[3] The number of commercial buildings in the United States has increased steadily for the past two decades. In 1979, CBECS estimated that there were 3.8 million commercial buildings in the United States. By 1992, that number had increased 27 percent to 4.8 million, an average annual increase of 1.8 percent. During this same 20-year span, the amount of floor space went from approximately 51 billion to 67 billion square feet. The number of new buildings probably increased between 1.5 and 2.0 percent annually although there are periods in which the increase is more rapid than in other periods. For example, the rate of new construction was lower in the early 1990s than in other periods due to the economy (CBECS Survey, 1999).

When we think of commercial buildings, we tend to think of large buildings such as high-rise buildings in center cities or big box stores. However, most commercial buildings in the United States (74 percent) are less than 10,000 square feet (CBECS Survey, 1999). That is the area of a very modest residential lot in a suburb. Fully one-half of all commercial buildings (50 percent) are between 1,000 and 5,000 square feet, while another 24 percent are between 5,001 and 10,000 square feet. The size of buildings is important because the technologies that are used in buildings change with size. In terms of the number of pieces of equipment, the market for small commercial buildings is much larger than that for large commercial buildings.

Energy use in commercial buildings has not quite quadrupled in the last half-century trending in a more or less linear pattern (EIA 1999). Consumption has increased since 1949 with an intermediate peak in 1973 around the time of the first oil price shock. Consumption in the commercial sector briefly fell and then rose again until 1978-1979 at the time of the second oil

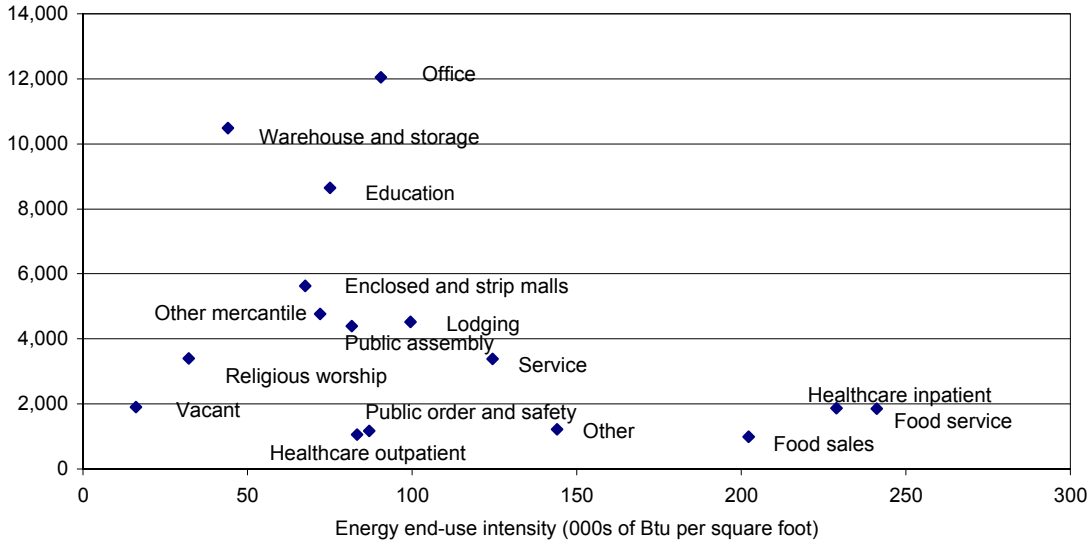
[2] The Commercial Buildings Energy Consumption Survey (CBECS) defines commercial spaces as those structures or part of structures that are used for offices, food sales, retail/service, lodging, healthcare, religious worship, public assembly, food service, public order and safety, and warehouse and storage.

[3] For a more extensive treatment of historical trends, see Reed (2004).

price shock. Through the early 1980s, consumption in the commercial sector increased more slowly than in the 1960s and 1970s. There was a slight decrease in the early 1990s and then a take off as building consumption increased in the late 1990s probably due to the rapid increase in new construction in that period. EIA predicts that this upward trend will continue until 2010 as the commercial building market increases by 19 billion square feet. However, that prediction is likely dated due to the economy in the early years of the 21st Century and because of societal changes that may change the need patterns for commercial buildings.

Finally, in thinking about commercial sector energy efficiency it is useful to analyze these building types by square footage and energy efficiency (Figure 1). Sub-markets with low energy intensities and lesser amounts of floor space may be of less interest in policy terms than sub-markets with high energy intensities and/or large amounts of floor space.

Figure 1. Sub-Markets by Floor Space and Energy Intensity



Source: EIA, CBECS 1995, Table C-3

Healthcare, food services and food sales have high intensities but relatively small amounts of floor space. The office and education sub-markets have moderate energy intensities but large numbers of buildings. Enclosed and strip malls, other mercantile, public assembly, lodging, and services are characterized by moderate energy intensities and modest amounts of floor space. The healthcare outpatient sector is characterized by moderate energy intensities but small amounts of floor space. This is mostly office space where patients visit doctors and receive additional services. The energy intensity of this space corresponds to that of office space. Warehouse and storage, religious worship, and vacant spaces have low energy intensities. However, the square-footage of space devoted to warehouses is among the largest amounts. The energy intensity of refrigerated warehouses is somewhat higher than for warehouses in general. Furthermore, the warehousing industry is changing in ways that may change the patterns of energy use.

Commercial Buildings of the Future

In our study, we identified six drivers of socio-cultural change that we believe will change the nature of buildings: communications/electronics, energy, transportation/logistics, biotechnology/nanotechnology, manufacturing, and materials. Communication is changing how buildings function, how users use buildings, and the need for buildings. Wiring and optical cabling will be replaced by high-speed constantly "on" wireless technologies. Moreover, these wireless technologies will increase the potential for building monitoring and operational controls. Users will have greater control over building environments and buildings will have enough intelligence to sense who the users may be and tailor the environment to the user in real time. Communication will lead to changes in work patterns through telecommuting and conferencing that is likely to reduce energy consumption from travel and shift energy use from office buildings to residential and other structures.

We are likely to see an increase in distributed energy production in buildings. This will have impacts for the utility distribution systems and for the distribution systems within the buildings themselves.

The Internet and transportation/logistics are changing the way we shop, which in turn will change the demands for retail space and the need for travel. The functions of warehouses will change and become less oriented to storing goods and more oriented to post-manufacturing services and expediting the flow of goods.

Bio- and nanotechnologies will lead to changes in the size and energy consumption of many of the cultural objects we use on a daily basis. These technologies will have profound effects on medicine and medical treatment that will likely result in much of in-patient care becoming out-patient care, thus changing the requirements for space, the need for acute care institutions, and the high energy intensities associated with in-patient care.

One of the newest trends in building practices is the assembly of subcomponents into components and then the assembly of the components into whole products. Automobiles are built this way. Ships are built this way. Airplanes are built this way. Steve Kieran and James Timberlake argue that soon buildings will be built this way (Hart, 2002). Kieran and Timberlake contend that this "componentiation" will result in mass customized, high quality, but standardized building blocks. This will speed construction. It will also fundamentally change the way buildings are designed because design will be done from the core out in 3-D rather than from the façade to the core in 2-D. The shift from 2-D to 3-D speeds design, reduces error, and increases quality. Computer-aided design will be linked to computer-aided engineering programs that are linked to computer-aided manufacturing equipment that is highly flexible (Kellog, 2003). More importantly, this trend could result in higher quality buildings and buildings that are more energy efficient.

A variety of new materials are appearing on the horizon that will have far-ranging impacts on both the types of technologies available and the way in which they are used. These materials will affect the ways that buildings are built, operate, communicate, and function in the next century. Trends in new materials include the development of catalytic materials, opto-electronic materials, magnetic materials, and "intelligent textiles." Examples of these new materials are found in structures designed by Kieran and Timberlake (2003 that were displayed at the Cooper-Hewitt National Design Museum. These structures used a material called "SmartWrap"-- a composite material that integrates conventional functions of the wall such as shelter and insulation. A polyester mixture film (PET) provides protection from the elements

and acts as a substrate for other layers. There is a layer of phase change materials that absorb, store, or release heat to moderate temperature. An active layer of organic light emitting diodes (OLED) is used to provide lighting and information display. Thin film batteries and thin film silicon cells are used to power the OLED display and to store energy. Conductive ink is used to interconnect the active elements. If such materials prove practical, they offer opportunities to control light, thermal radiation, comfort and to produce energy. The result may be buildings that are lighter, stronger, more efficient, less costly to erect, and perhaps energy self-sufficient.

In the sections that follow we explore trends in the office, retail, food sales, lodging, and warehouse sectors in more detail. More detailed treatments of these and other sub-markets can be found in Reed (2004).

The Office of the Future

The commercial office as we know it will change as it is adapted to an increasingly mobile and flexible workforce in the 21st century. The rise of computers, the acceptance of alternative working arrangements such as telecommuting and flextime, and the proliferation of wireless and Internet capabilities have changed the ways in which office workers communicate with each other daily.

This increased use of computers means that commercial office space must offer more flexible configurations that can adapt to differing staffing needs. These changing patterns directly affect the ways that energy is used in the work place. Occupancy sensors, zoned heating and cooling, and more flexible and user-controlled lighting will better meet the environmental needs of a mobile workforce.

Several leading futurists predict that the Internet will change commercial offices in other ways. For example (Centron & Davis, 2001):

- High-speed communication allows companies to focus on their core competencies, spinning off secondary functions and support services, such as delivery and customer support, to third parties.
- By 2020, most large companies will be globally networked, highly decentralized entities that operate around-the-clock. Their virtual teams of freelance and on-contract personnel will be coordinated through a digital nervous system over the Internet.
- Companies will range from mini to mega in size. There will be perhaps 100 mega corporations worldwide, perhaps a million niche companies, plus a billion family-operated "webpreneurial" firms, with very few large-to-mid-sized firms still surviving (Feather, 2002).

Telecommuting and the Rise of Home Offices

While offices have become increasingly “wired,” so have alternative worksites. Although many office workers take work home with them, they are not necessarily telecommuting. The Bureau of Labor Statistics (BLS) defines telecommuting as “an employee receiving pay for work done at an alternative site.” Alternative sites include the home, satellite offices, telecenters, or any other place. Definitions of what constitutes telecommuting and telework vary but when differences in definition are taken into account there is rough agreement

on the number of telecommuters. According to the BLS, about 3.3 percent of the workforce were telecommuters in 1997.

It is estimated that in 2001, 24 percent of the US workforce, or about 32 million workers telecommuted sometime during the workweek (Cahers In-Stat Database, 2002). This trend is expected to increase to 28 percent of the workforce, or 40 million telecommuters (Cahers In-Stat Database, 2002). Seventy percent of all US organizations with 5,000 employees or more offer workers telecommuting options (G. Lovelace, 2000).

Table 1. Estimates of Telecommuters and Home-Based Business Employees

Year	2001 (millions)	2004 (millions)
Estimated number of telecommuters in the US	32.0	40.0
Estimated number of telecommuters at home at least one day per week	6.4	8.0
Estimated number of home-based business employees	6.0	8.0
Estimated number of home-based business employees working at home at least one day per week	6.0	8.0
Total at home workers per day	**12.3**	**16.0**

Source: International Data Corporation, 2001; US Census Bureau, December 2001.

Although the definitions differ from the Cahers In-Stat Database (2002), a 2003 survey suggests that the number of workers who are telecommuting has increased by 40 percent since 2001 (ITAC, 2003).

Telecommuters rely heavily on the fax, telephone, the email, and the Internet to coordinate work and stay in touch. However, telecommuting provides definite economic benefits to employers that outweigh any additional costs. Employers report increased worker satisfaction and productivity among teleworkers. Telecommuting is also used as a recruiting tool to attract and retain qualified workers. Finally, telework has implications for space and travel costs (ITAC, 2002).

According to US Teleworking Database (2004), telework yields annual savings of $12,000 per teleworker annually. The Institute for the Study of Distributed Work (2004) estimates that "companies save $2 for every $1 invested in remote equipment and extra phone lines." AT&T says that 24 percent of its 75,000 managers worldwide work from home at least one day a week. Since teleworking began, AT&T estimates savings of approximately $550 million by eliminating or consolidating office space that was no longer needed (AT&T Survey, 2003). IBM estimates savings of $100 million annually through improvements in productivity and employee effectiveness (US Telework, 2004). One study reports that workers reduce their travel by 32 miles per telework day. That represents a significant reduction in worker time and travel related energy consumption (Lovelace 2003).

Closely aligned with the rise of telecommuting is the rise of the small office/home office segment (SOHO). This is now the fastest growing segment of the US economy accounting for $454 billion in annual sales. In 1997, there were 6.3 million individuals who worked in full-time

home-based businesses and it is estimated that 44 percent of US households have income generating or after-hours home offices (BIS Strategic Business Decisions, 2002).

The Corporate Headquarters of the Future

Just as employees migrate toward "virtual offices," so too will corporate headquarters. A virtual headquarters will be the option of choice for business leaders looking to reduce organizational costs and improve management focus. These "virtual headquarters" will consist of a laptop, cellular phone, and a calendar with designated blocks of days identifying in which city of the world the management team is to gather to concentrate their activities, plotting the future and leading the company. Companies like Bacardi, Foundation Health Systems, and U.S. Industries already conceptually follow this model.

These future headquarters will mostly occupy 20,000 square feet or less in a Class A facility offering flexible offices and technologically advanced communications systems. The space, if not at an international airport, will certainly be located with access to one nearby. These flexible offices will displace the monolithic corporate structures that currently dominate many city and suburban skylines (Schriner, 2001).

Future Trends in the Retail Market

"Time is becoming the world's most precious commodity" according to *The Futurist Magazine* (Cetron & Davis, 2001). This statement has widespread implications for retail establishments. According to this publication, single workers and two-income couples are so pressed for time that they will purchase any product that promises either to "simplify their lives or grant them a taste of luxury-and they can afford to buy it." For retailers, this means that as time for shopping continues to evaporate, Internet and mail order options will have a growing advantage over traditional stores.

Microsegmentation

The next decade also marks the movement toward "micro-segmentation" within the retail market. This means that chain department stores and giant discounters will succeed because of their ability to offer anything and everything to a potential customer. Meanwhile, smaller specialty boutiques will become even more prevalent, offering products and services from customized kitchens to custom-built surfboards. These smaller niche stores will also succeed as customers search, most likely online, for the best products they can find for their time-compressed lives. It is the nondescript, non-adaptive, and off-brand retailer that fails to take advantage of the Internet who is less likely to survive.

Industry Consolidation

The retail marketplace is facing increasing consolidation as the larger retailers, the "power players" in the industry, expand their operations even more. This trend has forced the traditional "Mom and Pop" stores out of business or required them to develop new and innovative ways to serve their customers. Moreover, the blurring of the lines between the

traditional retail segments and the rise of superstores suggest that customers are increasingly looking for "one-stop-shopping" (Libman, 2001).

Online Shopping

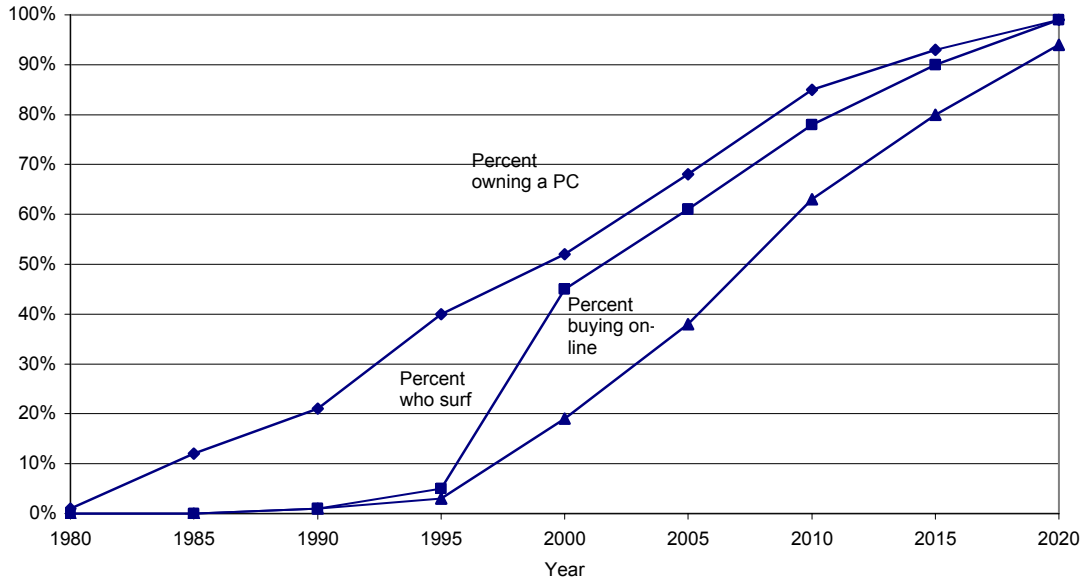
Futurist Frank Feather predicts that by 2010, 83% of all North American households will have at least one personal computer, 79% will be online, and 66% or approximately 76 million households, will shop and buy regularly online (Feather 2002). Figure 1 illustrates how the growth of online shopping is linked to increasingly high ownership levels of personal computers (PCs), which leads to Internet surfing, and online shopping.

From an energy perspective, we may see a decline in the number of retail outlets or a slowing of the increase in the number of such establishments. There is likely to be an increase in energy use in the largest establishments. An increasing amount of retail will be conducted electronically reducing visits to retail establishments and increasing the importance of logistics and delivery services. This may result in a reduction in energy use from travel that may more than offset any increases associated with delivery.

Future Trends for the Food Industry

The restaurant industry will also face a number of challenges from customers, as they demand convenience, variety, and higher quality meals while expecting fast service and innovative delivery choices. Some these emerging trends, as described by restaurant specialist Susan Mills (1999) include:

Figure 2. Estimates of PC Ownership, Web Access and Shopping in North American Households



Source: Innovologie reconstruction of data from F. Feather, *FutureConsumer.com: The Webolution of Shopping to 2010*. 2nd ed. Toronto: Warwick Publications, 2002, p. 123.

- Convenience will continue to dominate customer needs.
- Chains will continue to increase their share of the market while diversifying their offerings through multiple concepts and brands.
- Concepts such as takeout and delivery, casual dining, ethnic, family-style, and theme restaurants will proliferate.
- The proportion of the food dollar spent away from home will increase.
- To satisfy the needs of aging baby-boomers as well as generations X and Y, casual and comfortable will reign as prominent design themes.
- Marketing will become more targeted, as restaurateurs make greater use of consumer and customer databases.
- There will be greater demand for authentic items and flavor profiles.

The "Restaurant of the Future"

According to Beth Panitz (2000), by 2010 successful restaurateurs will also find ways to incorporate high-tech applications into their restaurant operations. Restaurant owners will use new technologies to control and improve management efficiency. One trend is the development of the "smart kitchen," already a reality in Europe. For example, the kitchen will have a central "dashboard" computer that can send, and receive, information to all equipment.

This interconnectivity could also led to improvements in energy management. The central computer could monitor and control the energy usage of each piece of equipment, scheduling high-energy tasks for off-peak times. It could scatter peak-usage intervals, such as when a refrigerator's compressor runs, to avoid a system peaks and or demand charges.

Future Trends in Food Sales

Smart appliances and web-based grocery stores will be linked increasing the services available to the customer. The smart appliances will read product bar codes and build grocery lists for the placement of orders automatically over the Internet. These groceries will be delivered from the local supermarket at a convenient time for the shopper. The back-end of this arrangement is already in place since Web-based grocers already retain shopping lists so that the customer has only to modify the list for the next delivery (Windsor Marketing Group, 1998).

The future of supermarkets will involve managing the consumer's expectation of the grocery store. Supermarkets will become providers of information not just products. They will offer pamphlets, brochures and signs to help consumers filter out choices and educate them about the best purchases for their individual needs, as a way to enhance the overall shopping experience (Windsor Marketing Group, 1998).

Future Trends in the Lodging Market

Issues affecting the larger tourism market, specifically an aging population, new technology, increased safety concerns, and airfares, drive the lodging market.

Electronic devices for interpersonal communications are impacting the travel and lodging industry. The reduced cost of interactive Web conferencing (IWC) and the potential for improving the fidelity of the web conference experience will lead to its increased use. The

increasing hassles of all travel, but especially air travel, is likely to reduce or at least slow the growth of business travel (Tarlow, 2002).

Another emerging trend is the interest in virtual travel technology that simulates the visual experience of various destinations. Discretionary dollars that could have been spent on travel may be used for electronic equipment that promotes virtual travel.

While business travel may grow less rapidly there appears to be a greater interest in recreational travel. Within the lodging market, there may be an upswing in the creation of more spas and health resorts. There is also a rise in demand for all-inclusive family-oriented resorts and more "urban playgrounds" that feature full-service resorts, shopping, and entertainment facilities in a 24-hour environment. Perhaps the most popular "urban playgrounds" are the themed resorts dominating Las Vegas and other entertainment oriented areas.

From an energy standpoint, resorts are more energy intensive than business hotels. Thus, while we may see slow growth over even decline in energy use related to business travel those gains may be offset by leisure travel. This may increase the important of targeting energy efficiency to the leisure industry. The resort industry tends to have more independent operators and fewer chains, a fact that has implications for marketing energy efficiency to the leisure industry.

Trends in the Warehouse Segment

The warehouse of the future will change from a storage facility to a facility that provides value-added services in the supply chain. Equally important is the fact that warehouse operators are under pressure to increase the velocity of inventory. As a result, the designs of warehouses are evolving to flow-through or cross-docking facilities. In this configuration, goods enter one side of the building, are reconfigured to customer/shipment requirements, and immediately move out the other side of the building. According to a recent survey conducted by the University of Arizona in Tempe and cited in the industry trade publication, *Warehousing Management*, high-performance warehouses cross-dock 50 percent or more of incoming goods and set targets of 25 to 50 turns per year (Harrington, 2002).

In the future, the warehouse may be responsible for processing of goods not completely compatible with in-place manufacturing capacity. Post-production quality testing, specialized packaging, display assembly, and returned goods processing will be assigned to the warehouse. The result is likely to be reduced activities at manufacturing facilities and increased activities at warehouses resulting reductions in energy use at manufacturing facilities and an increase in energy use in logistics facilities. Because of the built-in ability to reconfigure logistics operations at the new warehouses, the ability to flexibly handle many unrelated jobs rather one or two packing or shipping operations, automation, and coordination of shipments, there is likely to be a substantial increase in productivity and a decline in the energy use associated with the transportation of goods.

Energy Implications of These Trends

These trends will have far-reaching impacts on every sector of society, fundamentally changing the ways in which Americans work and play. The implications of particular interest to energy analysis are the ways in which energy consumption and usage will change as a result of these trends.

The changes in the process building construction and changes in the materials used in buildings have the potential to increase the quality of buildings, reduce energy use, and produce energy on-site to reduce the net consumption of buildings.

The changes in working patterns will affect the ways in energy is used both at home and in commercial buildings. For example, the rise of telecommuting and small businesses/home based businesses may result in a residential load curve that is flatter and less peaked. There may a general increase in the overall plug load throughout the day as home-based workers blur the lines between "work time" and "home time."

The trend toward small and smarter office buildings may reduce consumption in urban and suburban locations and result in smaller increases or perhaps declining energy demand in the commercial sub-market. Transportation energy use is likely to decline or at least see reduced rates of increase. Other effects may be improved air-quality, improved travel times or travel times that are deteriorating less rapidly, and reductions in the need for highways or reductions in the rate of increase in the demand for highways.

As the retail and service sectors continue to compete for the attention of a busy consumer with multiple alternatives, some stores will tend to become larger and more entertaining, and perhaps require more energy. With the growth of niche markets, the decline of traditional retail, and the increased delivery of retail goods, the overall demand for energy in the retail submarket may be reduced or increase less rapidly.

Changes in eating patterns in the form of eating out and take-out may lead to reduced energy consumption for cooking in residences but perhaps increased gas consumption from picking up and delivering meals as the weekly shopping trip or grocery delivery is displaced by numerous food foraging trips.

Changes in the reasons for travel brought about by information technology are likely to result in reduced business travel but perhaps increases in leisure travel. This has implications for energy use because energy intensities are higher in the leisure segment than the business segment. It also has implications for promoting energy efficiency because the ownership in the leisure segment is less concentrated that it is in the business segment. Given the high operating costs and thin margins, energy expenses represent a significant potential opportunity in the lodging sector. Energy accounts for four to 10 percent of revenues, according to a study conducted by Ernst & Young. Increasing installations of energy efficient technologies, such as improved lighting and space heating systems could lower energy costs by 10 to 25 percent annually (Ernst & Young, 2004).

With the growth of electronic commerce through the Internet and logistics, warehouses have become more central to the supply chain. As the warehousing industry focuses more intensely on accelerating their operations and increasing the services they offer, energy use will increase. This rise in energy use is likely to be more than offset by reductions in energy use associated with assembly and testing at manufacturing sites increases in productivity. This market may well be the market most willing to embrace energy efficient technologies as it looks to expand operations while controlling costs.

Conclusions

Although no one has a crystal ball that allows a perfect forecast of the future of commercial buildings, this paper provides a snapshot of some possible changes. Some changes may never occur. There is a complex web of interactions that will result in significant changes in

energy usage. At the beginning of the paper we described the linear trend in commercial building energy use in the last 50 years. That trend line undoubtedly masks equally complex interactions. Hopefully this paper increases our awareness and provides insights that will allow us to more rationally pursue efficiency technologies that will make sense in the future and to identify policies and strategies that have potential to cause substantial reductions in energy use.

References

AT&T Survey July, 2003. Cited in US Telework Scene, Stats & Facts, http://www.ivc.ca/studies/attstudy.htm. Accessed March 2003, April 2004.

Bureau of Labor Statistics, Current Population Survey 1997, http://www.bls.gov/bls/.

BIS Strategic Business Decisions as cited in "Work at Home-2001," Bureau of Labor Statistics Report, March 2002. http://www.bls.gov/cps.

Cahers In-Stat Database, April, 2002, Cited in US Telework Scene, Stats & Facts, http://www.ivc.ca/studies/attstudy.htm. Accessed March 2003, April 2004.

Cetron, M. and Davies, O. "Trends now changing the world: Technology, the workplace, management, and institutions", The Futurist, Mar/Apr 2001.

Cooper-Hewitt National Design Museum, "Cooper-Hewitt National Design Museum Premieres Solos Exhibition Series To Showcase Contemporary Architecture and Design — Inaugural Exhibition Solos: SmartWrap Features Building Skin of the Future," Press Release, August 4, 2003.

Energy Information Administration, "1999 Commercial Buildings Energy Consumption Survey" Department of Energy, http://www.eia.doe.gov/emeu/cbecs/. Accessed March 2003, April 2004.

Ernst & Young, "Hospitality Industry, Top Thoughts for 2004," Hotel Online Special Report, http://www.hotel-online.com/News/PR2004_1st/Jan04_TenKeyIssues.html.

Feather, F., Biznets: In Search of Online Excellence, 2002.

The Futures Project: Policy for Higher Education in a Changing World April 2000, Briefing on New Providers.

Harrington, L. "Digital Age Warehousing," *Industry Week*, on-line article.

Hart, S. "New Ways to Build Better, Faster, Cheaper," Architectural Record, January, 2002, p. 131.

ITAC, "Anytime, Anyplace, Anywhere Report," July 2002. As cited in US Telework Scene, Stats & Facts, http://www.ivc.ca/studies/attstudy.htm. Accessed March 2003, April 2004.

ITAC, "Home-based Telework by U.S. Employees Grows Nearly 40% Since 2001." 2003. http://www.workingfromanywhere.org/news/pr090403.htm, accessed May 18, 2004.

Institute for the Study of Distributed Work, May 2004. As cited in US Telework Scene, Stats & Facts, http://www.ivc.ca/studies/attstudy.htm. Accessed March 2003, April 2004.

Kellog, C. "Again, Architecture Discovers Prefab," New York Times, May 29, 2003.

Libman, W. 'The Consumer Paradox: The Threat to Loyalty in the New Millennium," WSL's Survey: How America Shops, WSL Strategic Retail, 2001, p. 6. http://www.wslstrategicretail.com/publications/edge/prev/.

Lovelace, G. Telework and the New 21st Century, Washington: DC. US Department of Labor. http://www.dol.gov/asp/telework/p1_2.htm#three.

Mills, S. "Guide to Success in 2010," Restaurants USA, September 1999.

Panitz, P. "Smart Kitchens: Science Fiction or High-Tech Reality?", Restaurants USA, October 2000.

Reed, John H., Katherine Johnson, Jeff Riggert, and Andrew Oh, "Who Plays and Who Decides," Rockville, MD: Innovologie, 2004.

Sage Research, "Opportunities in Telecommuting: A Quantitative Analysis of Drivers, Deterrents and Deployment Patterns" Sage Research, January 2000, p. 6. as cited in Lovelace, G. Telework and the New 21st Century, Washington: DC. US Department of Labor. http://www.dol.gov/asp/telework/p1_2.htm#three.

Schriner, J. "What the Future Holds for Corporate Headquarters?", Fantus Consulting, a division of Deloitte & Touche LLP. http://www.facilitycity.com/busfac/bf_99_07cover1.asp

Staff, "How third-party logistics providers are using IT to improve performance," Warehousing Management, October 1, 2002.

Tarlow, P. "Tourism in the twenty-first century," The Futurist; Washington; Sep/Oct 2002.

US Telework Scene, Stats & Facts, http://www.ivc.ca/studies/attstudy.htm, Accessed March 2003, April 2004.

Windsor Marketing Group, 1998. http://www.windsormarketing.com/.