CONTRIBUTORS' PROOFCHECKING INSTRUCTIONS FOR ENCYCLOPEDIA OF ENERGY

PROOFREADING

The text content and layout of your article is in final form when you receive proofs. Read proofs for accuracy and clarity, as well as for typographical errors, but DO NOT REWRITE.

Check titles and headings for spelling and capitalization. Ensure that the right typeface and size have been used to indicate the proper level of each heading. Review numbered items such as figures, tables, and lists for proper order. Proofread the captions and credit lines for illustrations and tables. Ensure that any permissioned material has the required credit line. Artwork appears in its final size and placement, but may not match the image quality of the final printed publication and is for content checking only.

Any questions from the copy editor will be listed following the article proof. Please address these questions as necessary. While it is appreciated that some articles may require updating/revising, please try to keep alterations to a minimum. Excessive alterations may be charged to the contributors.

Please keep a copy of any corrections you make.

RETURNING PROOFS

Proofs should be returned to Joanna Dinsmore at Elsevier by 01 Dec 2003 by one of the following methods:

1. If corrections are minor, they should be sent in an e-mail to j.dinsmore@elsevier.com. This e-mail should state the encyclopedia title and article title and ID number. Each correction listed should clearly identify the page number, paragraph number, line number within that paragraph, and the correction itself.

2. If corrections are more substantial, the amended hard copy should be mailed by express courier or faxed (only if marked very clearly) to:

Joanna Dinsmore
MRW Production Department
Academic Press/Elsevier
525 B Street, Suite 1900
San Diego, CA 92101-4495

619-699-6749 (tel)
619-699-6305 (fax)

3. If the proofs are OK as is, please inform Joanna Dinsmore via either email (j.dinsmore@elsevier.com) or fax (619-699-6305); be sure to list the article ID number and title.

Please note that your corrections should be returned as quickly as possible. Scheduling is crucial at this stage of production, and a delay in the return of the proofs could mean missing the press date, resulting in delayed publication.

CHECKLIST

Author name(s) and affiliation(s) checked? ☐

Figures and tables checked? ☐

Further Reading section checked and completed? ☐

Outstanding permissions letters returned to Elsevier? ☐

Author's mailing address checked and updated? ☐
[Note: this information will be used only to update our records; this section will not be printed in the final article.]

Manuscript queries addressed/answered? ☐

Reprint order form faxed to 619-699-6305? ☐

If you have any questions regarding your proofs, contact Joanna Dinsmore at j.dinsmore@elsevier.com.

Article Number: NRGY : 00498

A0005 *City Planning and Energy Use*

HYUNSOO PARK and CLINTON ANDREWS
Rutgers University New Brunswick
New Jersey, United States

Glossary

G0005 **alternative dispute resolution (ADR)** Any techniques, such as arbitration, mediation, early neutral evaluation, and conciliation, for the purpose of consensus building before litigation.

G0010 **combined heat and power (CHP)** Systems that generate electricity and thermal energy simultaneously in an integrated manner, so as to capture wasted energy.

G0015 **distributed energy resources (DER)** A variety of small, modular electric generation units located near the end user; used to improve the operation of the electricity delivery by complementing central power.

G0020 **smart growth** A development strategy emphasizing mixed land uses with convenient transportation choices in existing communities, thereby alleviating sprawl and preserving open spaces.

P0005 City planning is a future-oriented activity that shapes land use and the built environment by means of designs, regulations, and persuasion. The scope of city planning includes a range of interdependent decisions at the nexus of the private and public spheres: transportation and utility infrastructure investments, allowable land uses, and the locations and characteristics of housing, retail stores, offices, schools, hospitals, factories, and even energy-producing facilities. Although planners rarely focus explicitly on energy issues, planning decisions influence energy use and production in profound, long-lasting ways. This article focuses mostly on the U.S. case.

1. SCOPE OF CITY PLANNING S0005

Although urban design has deep historical roots, P0010
modern city planning began with the Industrial Revolution and the associated rapid urbanization that led to a degradation of the local quality of life. City planning was a response to the growing ugliness and unhealthfulness of cities, and it became a movement to reform an old paradigm of cities, which in many countries had been based on laissez-faire principles. In the Anglo-American world, which paced the rest of northern Europe, early signs of the city planning impetus in the late 19th and early 20th centuries were the English Garden City movement led by Ebenezer Howard, the U.S. City Beautiful movement that started in Chicago, and the zoning movement that attempted to separate residential and industrial land uses. Decentralization advocate Frank Lloyd Wright, and "tower in a park" advocate Le Corbusier, utopians of very different stripes, provided intellectual fodder to planning debates.

After World War II, the agenda of United States P0015
city planners changed periodically in accordance with evolving economic, political, and ideological forces. Scientific planning, emphasizing optimization and rationalistic analysis, dominated during the 1950s and has never disappeared. Advocacy planning, emphasizing empowerment of disenfranchised slum dwellers, gained modest influence in the 1960s and 1970s. Equity planning, with a focus on improved fairness in land use decisions, became a central tenet of planning from the late 1960s onward. In the 1970s, environmental planning became an important component of city planning. Starting in the late 1980s, city planning increasingly emphasized participatory and communicative planning processes.

Article Number: NRGY : 00498

Collaboration, community visioning, smarter growth, and sustainable development are the watchwords of the planning profession at the beginning of the 21st century.

P0020 Planning practice begins with how to regulate land use in urban areas. Zoning and subdivision regulations are basic tools in determining land use patterns. Land use planning is inextricably related to transportation planning, which analyzes the travel behavior of individuals and aggregates on current and prospective networks. Urban designers apply these tools to give cities unity and coherence, with clear and legible structures and hierarchies of centers. In the United States, however, low-density development in suburban areas during the post-World War II period created “sprawl.” Planners devised growth management strategies to control sprawl, and starting in the 1990s, a “smart growth” movement advocated an integrated form of regional growth management to restore the community vitality of center cities and older suburbs. City planners increasingly rely on public decision-making processes to organize the built environment, and recent efforts at communicative planning encourage citizens’ direct participation in policy-making processes, implementation, and monitoring of policies, so as to minimize conflicts and negative externalities.

P0025 The city planning profession, however, has paid little attention to energy use, even though most cities experienced significant energy crises in the 1970s. Most planners assume that cities are, above all, places to consume energy rather than produce it. They are increasingly being shown to be wrong.

S0010 2. *SITING ENERGY FACILITIES*

S0015 2.1 Regulations and Institutions

P0030 In the United States context, most land use and facility siting decisions take place at the local level. The federal government has reserved siting authority for only a few types of energy facilities: pipelines and nuclear waste dumps are the chief examples. Most states delegate facility siting tasks to municipalities, although statewide bodies have been created in a few states. Statewide decisions about siting facilities are made by a siting board, an energy facility siting council, or an energy commission. The members of the siting institutions vary from state to state; for instance, the members of the Energy Commission in California consist of four professionals and one citizen, and the members of the Energy Facility Siting Council in Oregon consist of seven geographically representative citizens appointed by the governor. These institutions issue a certification for the construction and operation of energy facilities.

The siting certification processes also vary from state to state. Generally, in the beginning of the process, these siting institutions or subcommittees oversee the submission of plans by the utilities. Then a potential applicant submits a notice of intent, which describes the proposed facilities and which allows the office to collect public inputs through public hearings and to identify laws, regulations, and ordinances. At the next stage, the applicants submit the application to the office and then the siting institution decides whether to issue a site certification. P0035

General criteria for siting facilities are based on standards determined by each state. The environmental standards include considerations of noise, wetlands, water pollution, and water rights; soil erosion and environmentally sensitive areas are also considered. Structural standards consider public health and facility safety. The siting institutions consider the applicant’s organizational, managerial, and technical expertise; the applicants are required to have financial assurance. Siting institutions must also evaluate socioeconomic effects such as expected population increases, housing, traffic safety, and so on. However, deciding where to site facilities is not easy due to the divergent interests of multiple stakeholders, and the process of siting facilities therefore often brings about locational conflicts. P0040

2.2 Locational Conflicts S0020

Siting facilities can be understood as an exercise in siting locally undesirable land uses (LULUs), many of which cause locational conflicts and thereby place government officials and policy makers in opposition to grassroots “not in my back yard” (NIMBY) groups. Locational conflicts can escalate from local disputes into broad protests against structural inequities. Major issues driving locational conflicts include health and safety concerns as well as environmental impacts. In addition, facilities may be sited in neighborhoods whose residents are poor or people of color, becoming an issue of environmental justice. Opponents of constructing facilities sometimes adopt grassroots techniques, such as protests, civil disobedience, and initiatives. Many conflicts lead to judicial review, promoting high transaction costs. P0045

New approaches to the resolution of locational conflicts have emerged since the 1970s to reduce P0050 the high transaction costs. Alternative dispute resolution (ADR) is a method based on consensus building; this is also called principled negotiation or consensus-based negotiation. In their 1981 book, *Getting to Yes*, Roger Fisher and William Ury emphasize the importance of principled negotiation that applies scientific merit and objectivity to the problem in question. Planners engaged in siting facilities now routinely consider both efficiency and equity/fairness criteria.

S0025 2.3 Balancing Efficiency and Equity/ Fairness Considerations

P0055 By and large, the criteria to evaluate the benefits and costs of siting energy facilities will be determined by three factors: risk from the facilities, fairness in siting facilities, and productivity or efficiency of the facilities after the decision on siting the facility. It is desirable to reduce risks related to health and safety issues. There is a fairness issue behind the risk issue. The NIMBY syndrome usually results from an unequal distribution of costs and benefits. Sites of energy facilities are correlated to a variety of economic factors, such as natural resources, land prices, and urban infrastructures. In his 1992 piece in the *Virginia Environmental Law Journal*, Robert Collin argues that generally racial and ethnic minorities and low-income groups are more likely to be exposed to hazardous waste and pollution because they are more likely to live near those treatment facilities. Thus, the balancing of efficiency and fairness becomes a major argument in siting energy facilities. Participation by the affected parties and negotiation are standard components of most current United States energy facility siting processes. During the negotiation process, each party reviews the plan to site facilities and pays close attention to the type and amount of compensation awarded to the community and the criteria used for siting facilities. If the compensation is not sufficient, renegotiation may be necessary.

S0030 3. *FINANCING ENERGY INFRASTRUCTURE*

S0035 3.1 Public or Private Ownership

P0060 Energy infrastructures include many components: generation, transmission, and distribution of electricity; physical networks of oil and natural gas pipelines; oil refineries; and other transportation elements such as marine and rail transportation. Historically, industrialized countries have financed the energy sector privately. Wood, coal, oil, natural gas, and electricity were produced and transported mostly by private firms well into the first decades of the 20th century. Thereafter, as network energy utilities became ubiquitous, public involvement increased. The new Soviet Union made electrification a national project; financially unstable private utilities of the United States begged for and received government regulation following World War I, and New Deal regional and rural policies made access to electricity a public goal justifying public investment and ownership. Before the Great Depression of the early 1930s, several holding companies controlled more than 75% of all U.S. generation. After the Great Depression, holding companies proved to be financially unstable and caused the price of electricity to increase, so support grew for government ownership of utilities, especially hydroelectric power facilities. Since the energy crisis in the early and late 1970s, the structure of electricity industry has changed; nonutilities have been added in the electricity market and the vertical structure has been unbundled. Because of the uncertainty over the future structure of the industry and recovery of investment costs in electricity infrastructures, financing electricity infrastructure has been in difficulty. In the United States as of 1999, federally owned utilities controlled 10.6% of the total generation, cooperatives controlled 5.2%, publicly owned utilities controlled 13.5%, investor-owned utilities controlled 70.7%, and nonutilities controlled 18.9%. The combination of private and public ownership differs from region to region. There are about 5000 power plants in the United States.

As electricity was transformed from a novelty to a P0065 necessity during the mid-20th century, many countries worldwide nationalized their electricity sectors. Only since the 1980s have privatization and liberalization reversed this trend. In the developing world, lack of public funds has forced many countries to turn to private, often transnational, financiers for energy sector investments.

In the oil and natural gas sectors, historically, P0070 major energy companies have possessed a vertically integrated oil and natural gas infrastructure, involving oil and natural gas exploration, development, and production operations and petroleum refining and motor gasoline marketing. Also, independent oil and natural gas companies take part in segments of vertically integrated structures as producers, petroleum refiners, and providers of transmission pipelines. Oil and natural gas pipelines may run across state boundaries or federal lands in order to link supply locations to market areas in cities. In the natural gas industry, there has been a structural change since the issue of Order 636 by the Federal Energy Regulatory Commission (FERC), which no longer permitted gas pipeline companies to engage in the sale of natural gas. Thus, several pipeline companies have been consolidated under single corporate umbrellas, such as El Paso Merchant Energy Company, the Williams Company, Duke Energy Corporation, and the notorious Enron Corporation. Several of these companies have acquired interstate pipeline companies.

S0040 3.2 Vertical Disintegration

P0075 In the United States electricity sector, the industry structure throughout the 20th century consisted of three vertical components: generation, transmission, and distribution. With increasing demand, robust transmission networks, availability of new generating technologies, and an ideological shift, restructuring in electricity and natural gas industries has become significant. In the electricity sector, regulatory reform has changed the structure of the electricity industry; according to Order 888 issued by FERC, all utilities can have access to the U.S. transmission systems; in addition, as already mentioned, nonutilities can provide electricity through the transmission system. To reduce the costs resulting from constructing new power plants, the federal government is trying to remove the transmission constraints between regions, some of which are traceable to the 1935 Public Utility Holding Company Act (PUHCA) limiting interstate utility operations. Horizontal market power is replacing vertical integration as the dominant utility business strategy.

P0080 In the natural gas sector, business operations are going in a direction parallel to that of the electricity industry. In his 2001 report, *Natural Gas Transportation—Infrastructure Issues and Operational Trends*, James Tobin discusses that, to take a better position to handle the large growth in natural gas demand, natural gas companies have consolidated operations through major mergers.

S0045 3.3 Municipalization

P0085 In the early 20th century, local governments in the United States played key roles by awarding competing bidders electric service franchises. In fact, however, some local officials received bribes in return for granting franchises to utilities, and franchise holders imputed this burden to citizens. Citizens rebuked utility companies for causing the rates to be high, and called for local governments to take over some local electricity systems. Today, a significant minority of municipalities control electricity distribution to their residents, and a smaller number also generate and transmit power. In parallel, in the 20th century, strong state regulations were introduced to prevent corruption and guarantee the fair pricing among investor-owned utilities. From historical experience, municipalization has both strengths and weaknesses.

Nevertheless, the recent restructuring of the electricity sector might open new opportunities for public financial involvement. Municipal governments can serve as aggregators and use their market power to buy reasonably priced electricity on the open market. They can reduce rates for their residential customers or meet expectations of clean air and water by offering clean energy options. They can also use various renewable energy sources to meet their citizens' demand (this will be further discussed in Section 6). P0090

4. INFLUENCE OF LAND USE PATTERNS ON ENERGY S0050

4.1 Effects of Density, Grain, and Connectivity S0055

Land use patterns can be parsimoniously characterized in four dimensions: degree of centralization or decentralization (urban form), ratio of population or jobs to area (density), diversity of functional land uses such as residential and industrial (grain), and extent of interrelation and availability of multiple modes of circulation for people and goods among local destinations (connectivity). The use of resources per capita diminishes as urban form becomes more centralized, density goes up, grain becomes finer, and connectivity shrinks. Metropolitan land use patterns in the United States after World War II show increased energy use due to increasing regional populations, decentralization, decreasing density, rougher grain, and increased connectivity. P0095

Throughout the 19th century, most people in the United States lived in small towns and villages. With the advent of the 20th century, many people moved to industrial cities for jobs, a trend that peaked in the 1920s and was compounded by overseas immigration. Following the interruptions of the Great Depression and World War II, the pent-up demand for housing was met by a conscious process of P0100

T0005 *TABLE I*

Intensity of Land Use in Global Cities, 1990[a]

City	Metropolitan density		Central city density[b]		Inner-area density		Outer-area density	
	Pop.[c]	Jobs	Pop.	Jobs	Pop.	Jobs	Pop.	Jobs
American average[d]	14.2	8.1	50.0	429.9	35.6	27.2	11.8	6.2
Australian average[e]	12.2	5.3	14.0	363.6	21.7	26.2	11.6	3.6
Canadian average[f]	28.5	14.4	37.9	354.6	43.6	44.6	25.9	9.6
European average[g]	49.9	31.5	77.5	345.1	86.9	84.5	39.3	16.6
Asian average[h]	161.9	72.6	216.8	480.1	291.2	203.5	133.3	43.5

AU:6 [a] Adapted from Newman and Kenworthy (1999). Density expressed in millions.
[b] Central business district.
[c] Population.
[d] Average of Sacramento, Houston, San Diego, Phoenix, San Francisco, Portland, Denver, Los Angeles, Detroit, Boston, Washington, Chicago, and New York.
[e] Average of Canberra, Perth, Brisbane, Melbourne, Adelaide, and Sydney.
[f] Average of Winnipeg, Edmonton, Vancouver, Toronto, Montreal, and Ottawa.
[g] Average of Frankfurt, Brussels, Hamburg, Zurich, Stockholm, Vienna, Copenhagen, Paris, Munich, Amsterdam, and London.
[h] Average of Kuala Lumpur, Singapore, Tokyo, Bangkok, Seoul, Jakarta, Manila, Surabaya, and Hong Kong.

suburbanization. Achieving the dream of home ownership became feasible for many Americans as new federal mortgage guarantee policies removed financial barriers to home ownership, as developers such as William Levitt perfected mass production of affordable housing units on greenfield sites, and as federal dollars poured into road building. Discrimination in lending and housing markets prevented most black Americans from participating in this exodus. Yet, by 1960, the suburban lifestyle was the conventional land use practice in the United States.

P0105 Suburban lifestyle has brought about sprawling, low-density suburban communities; according to the 1990 census, from 1970 to 1990, the density of urban population in the United States decreased by 23%. From 1970 to 1990, more than 30,000 square miles (19 million acres) of once-rural lands in the United States became urban areas, an area equal to one-third of Oregon's total land area. From 1969 to 1989, the population of the United States increased by 22.5%, and the number of miles traveled by that population ("vehicle miles traveled") increased by 98.4%.

P0110 Anthony Downs defines the term "sprawl" as (1) unlimited outward extension, (2) low-density residential and commercial settlements, (3) leapfrog development, (4) fragmentation of powers over land use among many small localities, (5) dominance of transportation by private automotive vehicles, (6) no centralized planning or control of land use, (7) widespread strip commercial development, (8) great fiscal disparities among localities, (9) segregation of types of land use in different zones, and (10) reliance mainly on the trickle-down, or filtering, process to promote housing to low-income households. The impacts of urban sprawl have caused increasing traffic congestion and commute times, air pollution, inefficient energy consumption and greater reliance on foreign oil, inability to provide adequate urban infrastructures, loss of open space and habitat, inequitable distribution of economic resources, and the loss of a sense of community.

When land use patterns in the United States are compared to other countries, they show significant differences. In comparisons of metropolitan density, U.S. cities are of low density in residential and business areas whereas European cities are three to four times denser. Asian cities are 12 times denser compared to American cities (Table I). P0115

The average energy use for urban transportation in American cities is 64.3 gigajoules (GJ) of fuel per capita compared to 39.5 GJ in Australia, 39.2 GJ in Canada, 25.7 GJ in Europe, and 12.9 GJ in Asia. Energy use in American cities is five times more than in Asian cities. In addition, European cities consume two times more energy compared to Asian cities. This shows that energy use in transportation is closely related to land use patterns and income levels (Table II). P0120

4.2 Environmental and Public Health Implications S0060

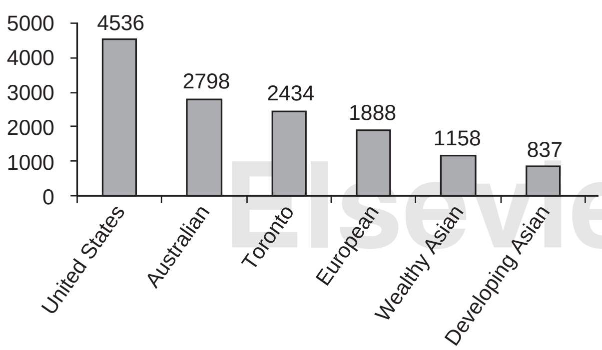
Low-density development and urban sprawl are correlated with high-level air pollutant emissions P0125

T0010 *TABLE II*

Transportation Energy Use per Capita in Global Regions, 1990[a]

City	Private transportation: Gasoline (MJ)	Private transportation: Diesel (MJ)	Private transportation: Private % (of total)	Public transportation: Diesel (MJ)	Public transportation: Electricity (MJ)	Public transportation: Public % (of total)	Total transportation energy (MJ)	Total Transpotation energy/$ of GRP[b] (MJ/$)
American average[c]	55,807	7764	99%	650	129	1%	64,351	2.38
Australian average[d]	33,562	4970	98%	764	159	2%	39,456	1.96
Canadian average[e]	30,893	6538	97%	1057	163	3%	39,173	?
European average[f]	17,218	7216	95%	604	653	5%	25,692	0.83
Asian average[g]	6311	5202	89%	1202	148	11%	12,862	3.81

[a] Adapted from Newman and Kenworthy (1999). Use expressed in megajoules.
AU:7 [b] GRP, gross regional product.
[c] Average of Sacramento, Houston, San Diego, Phoenix, San Francisco, Portland, Denver, Los Angeles, Detroit, Boston, Washington, Chicago, and New York.
[d] Average of Canberra, Perth, Brisbane, Melbourne, Adelaide, and Sydney.
[e] Average of Winnipeg, Edmonton, Vancouver, Toronto, Montreal, and Ottawa.
[f] Average of Frankfurt, Brussels, Hamburg, Zurich, Stockholm, Vienna, Copenhagen, Paris, Munich, Amsterdam, and London.
[g] Average of Kuala Lumpur, Singapore, Tokyo, Bangkok, Seoul, Jakarta, Manila, Surabaya, and Hong Kong.



F0005 *FIGURE 1* According to 1990 statistics, rates of annual CO_2 emissions (shaded bars, in kilograms/person) in the United States are 2.4 and 5.4 times higher than those of European cities and developing Asian cities, respectively. Modified from Newman and Kenworthy (1999). AU:3

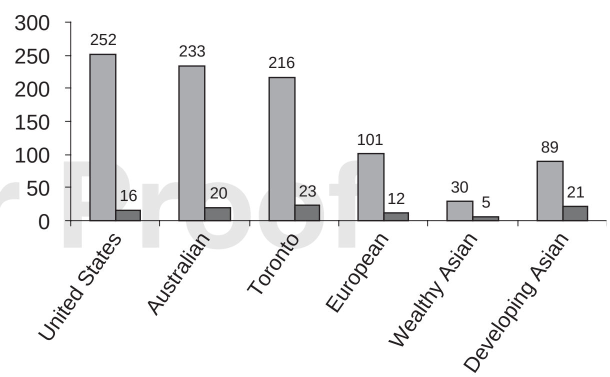


FIGURE 2 Rates of annual NO_x, SO_2, CO, and volatile hydrocarbon smog-related emissions (light shaded bars, in kilograms/person) in the United States are 2.5 and 2.8 times higher than those of European and Asian cities, respectively, in 1990. Volatile particulates are also shown (dark shaded bars, in grams/passenger-kilometers). Modified from Newman and Kenworthy (1999). F0010 AU:4

from transportation. Emission rates of the greenhouse gas carbon dioxide in U.S. cities are higher than those of other cities (Fig. 1). Health problems are caused by smog-related emissions, involving nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), volatile hydrocarbons (VHCs), and volatile particulates (VPs). Per capita emission rates in the United States and Australia are higher than those in European and Asian cities (Fig. 2).

P0130 Los Angeles (LA) is famous for its smog caused by automobile emissions. The analysis in the 1996 report of the LA Air Quality Management District is that average ozone levels in LA, the South Coast Region, are twice the federal health standard. Ozone concentrations have exceeded standards on as many as 98 days per year. Because of the frequency of occurrence, the smog in this region is especially harmful to aged people and children. The symptoms caused by smog are usually aching lungs, wheezing, coughing, and headache. Ozone also hurts the respiratory system's ability to fight infection. Other cities have similar air pollution problems; LA is no longer exceptional, especially among the growing cities of the American sunbelt.

S0065 4.3 Can Technological Innovations in Transportation Offset Impacts of Sprawling Land Use Patterns?

P0135 Optimists hope that innovations in transportation technology will solve the problems associated with sprawling land use patterns. Traffic congestion, air pollution, and burgeoning energy consumption are each the target of specific research initiatives. The U.S. government supports research to develop vehicles, such as hybrid electric and fuel cell cars, that will use energy sources (i.e., compressed natural gas, biodiesel fuel, ethanol, and hydrodiesel electricity) less harmful, compared to fossil fuels, to the environment. the government also promotes fuel efficiency through the Corporate Average Fuel Economy (CAFE) standards. In addition, with federal funds, some cities are introducing Intelligent Transportation Systems (ITSs), which increase the effectiveness of existing roadways by giving drivers real-time information about the best travel routes. However, many analysts argue that transportation energy efficiency and ITSs will not reduce the number of vehicles in use and air pollution emissions. Thus, technological innovations should be accompanied by nontechnological solutions. The Department of Energy suggests new land use planning strategies that will improve energy efficiency and will protect natural corridors and open space. These include transit-oriented design, mixed-use strategies, urban growth boundaries, infill development, greenways, brownfields redevelopment, transfer of development rights, open-space protection, urban forestry, land trusts, agricultural land protection, and solar access protection.

S0070 *5. INFLUENCE OF URBAN/ ARCHITECTURAL DESIGN ON ENERGY POLICIES AND PRACTICES*

P0140 Urban form at the metropolitan scale strongly affects transportation-related energy consumption, but smaller scale urban and architectural design decisions also influence energy use. Site layouts and building material choices affect microclimate and can create heat island effects.

P0145 Heat island effects arise from multiple sources. First, urbanized areas have residential, commercial, and industrial zones that displace trees and shrubs to varying extents. Trees and shrubs have the capacity to control their own temperature by releasing moisture, resulting in a natural cooling effect known as evapotranspiration. The displacement of trees and shrubs in the most built-up areas removes beneficial natural cooling. In addition, impervious surfaces, dumping excess heat from air-conditioning systems, and air pollution cause the ambient temperatures to rise, increasing energy use due to the large demand for air conditioning.

Site layouts and physical features of buildings and other impervious materials in a city have an influence on microclimate changes such as sunlight access, wind speed, temperature, and noise. Sunlight striking dark, impervious surfaces becomes sensible heat, causing the temperatures to rise. Building locations influence wind speed, sometimes impeding and other times redirecting the flow of wind on a site. Solar access, prevailing winds, tree location, and topographic modifications change microclimate. Wind facilitates good air circulation, thereby reducing build-up of heat. Effectively narrowing a street with street trees can reduce summer temperatures by 10°F. A modified site layout (street orientation, building placement, location on slope, and landscaping) can reduce the energy consumption of an ordinary residence by 20%. P0150

Architects and, to a lesser extent, planners can influence building design and materials choices at the micro level. Energy efficiency in building design can be improved by maximizing solar access, by minimizing infiltration but taking full advantage of natural ventilation, by creating non-window spaces as buffers on north walls, and by utilizing natural convection and passive solar designs, for example. High-performance lighting and maximization of natural light by solar access can also improve energy efficiency, reducing energy costs. Institutionally, in the United States, the Energy Policy and Conservation Act (EPC Act) of 1975 and the Energy Policy Act (EP Act) of 1992 have improved the energy efficiency of household and commercial building appliances. Advanced building design techniques and associated technologies and appliances available today can cut in half the energy consumption of buildings. P0155

6. CENTRALIZED VS. DISTRIBUTED ENERGY SUPPLIES S0075

6.1 Implications for Planners S0080

Energy supply, particularly electricity supply, needs to be analyzed in its regional context. It has long P0160 been assumed that increasing returns to scale result from increasing efficiency and technological specialization by means of large-scale supply. Thus, the single-minded pursuit of centralized energy supply led to a North American electric power system that was interconnected on a multistate basis and included gigawatt-scale generating plants. Centralized energy supply also brought with it certain inefficiencies associated with monopoly power, because utilities had few incentives to be operationally efficient and innovative. The recent restructuring efforts have been inspired by expectations of increased dynamic efficiency.

P0165 Another weakness of a centralized energy supply (characterized as "brittle" by Lovins) is the vulnerability of large power plants and transmission lines to disruptions, both natural and man-made, accidental and intentional. From the transmission system-related 1965 Northeast blackout in the United States, to the generation system-related 1986 Chernobyl accident in the former Soviet Union, to the utility distribution system disruptions caused by the 1993 and 2001 World Trade Center attacks in New York, there is accumulating evidence that the redundancies built into the large-scale grid provide
AU:1 inadequate reliability and security.

P0170 The introduction of smaller scale distributed energy (DE) power plants is one potential solution to these problems. Community-based energy supply falls within the planners' geographic sphere of influence. If this paradigm catches hold, energy planning could become a basic task for planners.

S0085 6.2 History of Centralization

P0175 In the United States, the electric power supply grew from the neighborhood scale in the 1880s to the municipal scale by the turn of the century. During the early 1900s, integrated large holding companies emerged, and interconnection of municipal systems proceeded apace, driven by a desire to increase load diversity and reliability of supply. Interstate transmission networks were entering use by the late 1920s. By that time, as mentioned earlier, 16 holding companies supplied most of the U.S. generation. Because of their nontransparent, unstable financial structure, the PUHCA was passed in 1935. This act mandated multistate holding companies to be subject to the state authority, and forbade a parent holding company from taking out loans from an operating utility. The state-based reorganization through PUHCA did not cause any serious problems until the 1960s. Following the 1965 Northeast blackout, the North American Electric Reliability Council (NERC) was formed to coordinate utility responses to regional disruptions and to avoid cascading failures.

Two oil crises in the 1970s and the restructuring of other regulated industries (such as telecommunication) brought about a rethinking of the electricity industry. During this period, technological innovations in gas turbines reduced generation costs and optimal generating-plant sizes, and thus made the large-scale power plants designed to exploit economies of scale no longer necessary. In addition, PUHCA exacerbated problems by placing the siting of transmission lines under state rather than federal authority, thereby constraining power flows from states with power surpluses to other states experiencing shortfalls. As a result, the vertically integrated structure is being unbundled, competition has been introduced in the electricity market, and a greater variety of new power generation techniques and resources are entering use. In particular, the DE technologies are gaining a toehold. P0180

Most DE stations are located close to their ultimate customers. Supply-side distributed energy resources (DERs) include wind turbines, natural gas reciprocating engines, microturbines, photovoltaics, and fuel cells (Fig. 3). Demand-side DERs, for example, include schemes to reduce peak electricity demand and designs for high-efficiency buildings P0185

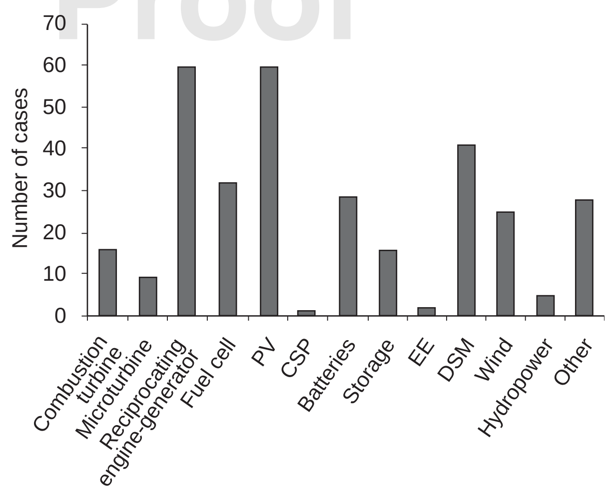


FIGURE 3 In a study of 275 distributed energy resources installations, reciprocating engines, solar electric power (PV, photovoltaic), and demand-side management (DSM) systems are the three most commonly used distributed energy resources technologies. In some cases, more than one technology was used per installation. CSP, Concentrating solar power; EE, energy efficiency. Reprinted from *DER Technologies*, the Office of Energy Efficiency and Renewable Energy, DOE. F0015

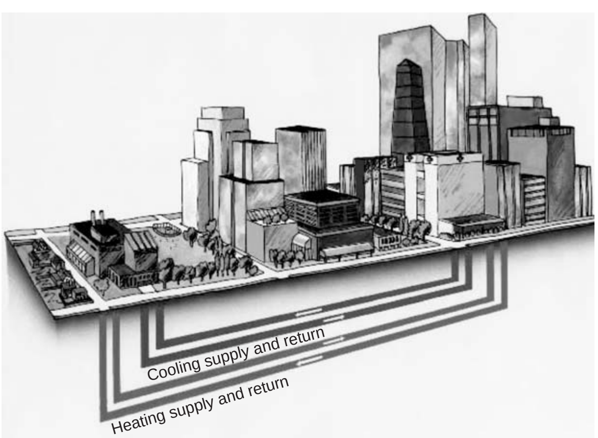
and advanced motors and drives for industrial applications.

S0090 6.3 Special Case of District Energy Systems

P0190 Although centralized energy systems locate generators remote from consumers, some distributed energy systems locate generators on the consumer's premises, occupying valuable floor space and imposing significant installation and maintenance costs. District heating and/or cooling systems lie in-between these extremes. These systems produce steam, hot/chilled water, and electricity at a central location and distribute them to nearby buildings (Fig. 4).

P0195 A district heating or cooling system can reduce capital costs and save valuable building space, and can use not only conventional resources such as coal, oil, and natural gas, but also renewable fuels such as biomass and geothermal, thereby increasing fuel diversity. In particular, central heat and power (CHP; also known as cogeneration), which reuses waste heat after producing electricity, can increase the overall process energy efficiency to more than 70%. Steam or hot water can be transformed to chilled water for refrigeration by means of absorption chiller technology.

P0200 City planning decisions strongly influence the economic feasibility of district heating and cooling systems. Such systems are most viable in compact downtown areas with high load density and a diversity of uses that support 24-hour operations. They are not viable in dispersed suburban settings.



F0020 *FIGURE 4* District energy systems distribute steam, hot/chilled water, and electricity from a central power plant to nearby buildings. With the technology of combined heat and power, they use 40% of input energy for electricity production and 40% for heating and cooling. Reprinted from *What Is District Energy?*, International District Energy Association (2001). AU:5

6.4 Codes and Covenants Affecting Distributed Fossil Energy Systems and Distributed Renewable Energy Systems S0095

The United States Public Utility Regulatory Policies Act of 1978 encouraged cogeneration and renewable (solar photovoltaic, wind) energy production. However, siting the facilities and interconnecting them with the grid involve significant problems, still unsolved today. There is no uniform standard code for interconnection between grids, and utilities have little incentive to modernize technical requirements for grid interconnection. Federal and state regulatory agencies share responsibility for setting the rules governing the development of distributed generation. The California Energy Commission argues that the main issues include paying off the utilities' stranded investments, siting and permitting hurdles, interconnection to the grid, environmental impacts, and transmission system scheduling and balancing. P0205

At the state level, supportive policy-makers could revise the rules on siting facilities, financial incentive programs, interconnection, net-metering programs, and air quality standards to encourage the development of the DE market. At the local level, existing building codes, zoning ordinances, and subdivision covenants often forbid distributed energy system installations. For example, many communities have regulations that restrict homeowners' opportunities to install solar energy systems on their roof. Thus, a partnership among community groups, local governments, and developers is needed to address these restrictions before DERs can move significantly forward. P0210

6.5 Prospects for Local Self-Sufficiency S0100

The United States Department of Energy (DOE)sets forward one long-term vision of DER: "the United States will have the cleanest and most efficient and reliable energy system in the world by maximizing the use of affordable distributed energy resources." In the short term, DOE sets forward the plan to develop the technologies for the next-generation DE systems and to remove regulatory barriers. In the medium term, the goals are concentrated on reducing costs and emissions and on improving energy efficiency. In the long term, the target is to provide clean, efficient, reliable, and affordable energy generation and delivery systems. California is one of the few states to set a target: it has a plan to increase DE generation by 20% of state electricity generation. Yet municipal energy self-sufficiency is P0215 an unlikely prospect anywhere in the world during the next 20 years, if it is even desirable. More likely is an infiltration of DE technologies into a national grid that also contains many large central power plants. DE supply will depend on private investment in the DE industry. To encourage private investment, government will continue to have a role in setting market rules and helping investors overcome barriers associated with siting facilities, grid interconnection standards, and financing.

S0105 7. INTEGRATED VS. SEGMENTED ENERGY PLANNING

S0110 7.1 History of Debate

P0220 In his 2001 book, *Urban Development*, Lewis Hopkins argues that planning, when done well, is very much a big-picture exercise designed to improve coordination among independent, yet interdependent, decision arenas. Good urban plans coordinate various private land use and public infrastructure system decisions, for example. In the energy arena, planning can have a similar integrating function.

S0115 *7.1.1 Economies of Scope*

P0225 A primary driver of integrated energy planning is the potential for economies of scope. This economic argument states that in certain circumstances, the average total cost decreases as the number of different goods produced increases. For instance, a company can produce both refrigerators and air conditioners at a lower average cost than what it would cost two separate firms to produce the same goods, because it can share technologies, facilities, and management skills in production, thereby reducing costs. In the energy industry, for over a century, many firms have realized economies of scope by integrating natural gas and electricity distribution and sales. Governmental energy planners have pursued similar economies since at least the 1970s by planning for the energy sector as a whole rather than keeping electricity, gas, oil, and other sectoral plans apart.

S0120 *7.1.2 Integrated Resource Planning Movement of the 1980s/Early 1990s*

P0230 The energy supply and financing crises of the 1970s inspired some U.S. utility regulators to demand a new kind of planning from regulated utilities. Rather than use only supply-side options and treat demand as exogenous, utility planners were directed to consider both supply- and demand-side options using a methodology known as least-cost planning, and later called integrated resource planning (IRP). In the United States, more than 30 state Public Utility Commissions (PUCs) adopted IRP procedures at the end of 1980s. The EP Act, passed in 1992, encouraged all electric utilities to exploit integrated resource planning.

Under IRP, utilities attempted to shape future P0235
energy supply and demand. In the process of planning, they considered factors such as energy efficiency and load-management programs, environmental and social aspects, costs and benefits, public participation, and uncertainties. In addition, demand-side resources were given the same weight as supply-side resources. Demand-side options included consumer energy efficiency, utility energy conservation, renewables installed on the customer side of the meter, and pricing signals. Supply-side options consisted of conventional power plants, non-utility-owned generation, power purchases from other suppliers, and remote renewables (Table III).

However, many states began to think about P0240
deregulating or restructuring their gas and electric power industries shortly after the EP Act was passed in 1992. This meant that state governments could no longer regulate planning practices and prices so closely, because utility companies were situated under competition in the energy supply market. Under restructuring, IRP became a strategic tool for the utility rather than a public planning process. Additionally, Kevin Kelly, in his 1995 chapter in the book *Regulating Regional Power Systems*, points out that there was a discrepancy between regional least-cost planning at the federal level and state least-cost planning at the state level. The need for public energy planning remained in the United States, but by the mid-1990s it no longer carried the force of regulation.

7.1.3 Sustainable Communities S0125

Since the 1992 Earth Summit in Rio de Janeiro, and P0245
accelerating through the turn of the millennium, the term "sustainable development" has been a visible agenda item in every social sphere. Sustainable development does not simply regard development as growth; as Mark Roseland puts it in his 1998 book, *Toward Sustainable Communities*, it seeks to improve the well being of current and future generations while minimizing the environmental impact. There are different expressions of this idea: sustainable cities, sustainable communities, eco-cities, green communities, ecovillages, green villages,

T0015 *TABLE III*

Demand-Side and Supply-Side Options[a]

Options	Example
Demand Side	
Consumer energy efficiency	Home weatherization, energy-effcient appliances for lighting, heating, air conditioning, water heating, duct repair, motor, refrigeration, energy-efficient construction programs, appliance timers and control, thermal storage, and geothermal heat pumps
Utility energy conservation	Load management, high-efficiency motors, and reduced transmission and distribution losses
Rates	Time-of-use, interruptible, and revenue decoupling
Renewables	Solar heating and cooling, photovoltaics, passive solar design, and daylighting
Supply side	
Conventional power plants	Fossil fuel, nuclear, life extensions of existing plants, hydro/pumped storage, repowering, and utility battery storage
Non-utility-owned generation	Cogeneration, independent power producers, and distributed generation
Purchase	Requirement transactions, coordination transmissions, and competitive bidding
Renewables	Biomass, geothermal, solar thermal, photovoltaics, and wind

[a] *Source*. U.S. Department of Energy (2001).

econeighborhoods, and so on. One of the fundamental concepts is to minimize our consumption of essential natural capital, including energy resources.

In this sense, sustainable communities might perform IRP and could even give more weight to demand-side management than to supply options. However, in doing so, some argue that they push public policies counter to market forces, which currently make supply investments more profitable. Yet IRP could be performed from the consuming community's point of view, as a guide to aggregate expenditures on energy services. Some municipal electric utilities (in Sacramento, California, for example) have adopted this approach and they have maintained stable energy bills while shifting toward renewable energy supplies and more efficient energy usage. P0250

Restructuring of energy industries is replacing regulated, firm-level IRP processes. Energy supply service is becoming more diversified under deregulation. Now communities are well placed to take on the challenge of integrative planning, and a very few are already becoming broad community businesses, extending the concept of the community energy utility to include recycling and reusing waste products within the community (Table IV). P0255

7.2 Industrial Complexes and Ecoindustrial Parks S0130

Integrated planning can clearly extend beyond energy into other realms. The Kalundborg industrial complex in Denmark is frequently cited as an P0260

T0020 *TABLE IV*

Comparison of Conventional and Community Energy Utilities[a]

Parameter	Conventional energy utility	Community energy utility
Generating plant	Large scale and remote from customers	Small scale and locally based near customers
Customer base	Very large, with tens of thousands of customers	Relatively small, usually a few thousand customers and could be much smaller
Legal structure	Public limited company, subsidiary to multinational parent company	Variety of legal structures, including joint venture companies, cooperatives, and charities
Control	Main control lies with the multinational parent, but shareholders also influence decisions through their desire to maximize dividends	Day-to-day control could be in the hands of a commercial management; energy end users have a substantial stake in the utility; local authority may also be a stakeholder as an agent for the community
Technology	Conventional steam electricity, nuclear power, conventional hydroelectricity, etc.	Combustion turbine, microturbine, reciprocating engine-generator, fuel cell, photovoltaic, wind, etc.

[a] Adapted from Houghton (2000).

exemplar of industrial symbiosis that uses energy cascades and closed-loop materials cycling among several firms to yield economic benefits with less pollution, more efficient use of resources, and less need for environmental regulatory supervision, compared to traditional arrangements.

P0265 Firms in such ecoindustrial parks can share their environmental management infrastructure and increase ecoefficiency by rationalizing and optimizing aggregate materials and energy flows. Power plants, especially CHP systems, make natural anchor tenants. City planners specializing in industrial parks are just beginning to focus on such possibilities, although the examples and ideas have been around for decades.

S0135 7.3 Optimizing across Multiple Energy Sources

P0270 Energy planning must consider several factors: energy resources are unevenly distributed across Earth, technological innovations can disrupt existing equilibria, political and economic boundaries and regulations affect the use of energy resources, culturally and socioeconomically mediated human behavior can influence energy consumption patterns, and different places have different climates. Optimizing the use of energy resources will require different strategies in different places to reflect specific local conditions. For instance, a higher population density will make CHP more practical, but it may militate against other devices, such as passive solar design, due to the increased overshadowing.

S0140 7.4 What the Future Holds

P0275 Integrated energy planning remains an attractive proposition for firms and for governments, although deregulation of electricity and gas markets has disrupted previous regulatory drivers of this practice. Its scope may intersect in a significant way with that of city planning if current interest in distributed generation, industrial ecology, and sustainable communities persists.

S0145 *8. ENERGY FOR THE WORLD'S BURGEONING MEGACITIES*

S0150 8.1 Challenges of Scale and City–Hinterland Linkages

P0280 One of the trends at the beginning of the 21st century is the emergence of big cities. Currently, there are 30–35 cities in the world whose population size is more than 5 million. With the growing concern for the environmental impact of cities, people are beginning to pay attention to city systems from the perspective of sustainability. In his 2000 book, *Green Urbanism*, Timothy Beatley considers the ecological footprints of cities, which consume energy, materials, water, land, and food to support them, and then emit wastes. Urban growth and development have triggered the expansion of urban infrastructures, increasing energy consumption. For instance, in their 1997 *Nature* article, "The Value of the World's Ecosystem Service and Natural Capital," Robert Costanza and colleagues estimate that the energy consumed in urban areas is produced in coastal areas, forests, grasslands, and wetlands, and its total value is at least $721 billion per year. There is no primary energy production in urban areas. Rather, urban systems consume energy produced from the environment. The United Kingdom's International Institution of Environment and Development estimates that the entire productive land of the UK is necessary to maintain the population of London, whose population size is 7 million. The goal of managing urban areas is shifting from ensuring the unconstrained consumption of energy resources to encouraging their efficient use.

8.2 Cities as Systems S0155

Cities are extremely complex combinations of P0285
physical subsystems, including those of urban infrastructure, various housing and other structures, transportation, communication, water transport, geology, ecosystem, solid waste, food and water distribution, economic zones, and demographics. In addition, social, political, economic, and cultural networks are interconnected, and create these built environments. To maintain and manage complex city systems, many agencies are involved. In the United States, these include the Department of Energy, Department of Defense, Department of Transportation, Environmental Protection Agency, Department of Housing and Urban Development, Federal Emergency Management Agency, United Nations, state and local planning agencies, and others. Yet none of these government agencies controls or plans cities to any significant extent: cities are self-organizing systems. Their top-down steering capacity is minimal. With continued urbanization worldwide, and with the development of high technology and the growing concerns for the limit of natural resources, there are severe challenges for cities. Adequate

energy supplies rank high among these challenges. In the developing world, financial and environmental constraints will dictate more diversity in energy supplies, and more common use of demand management tools, than has been the case in the industrialized world to date.

S0160 8.3 Spaces of Flows

P0290 Cities are connected to one another in global transportation and communication networks that allow rapid flows of information, capital, people, and goods from one place to another. Under global capitalism, a hierarchy of cities exists in which a few cities (e.g., New York, London, and Tokyo) serve as corporate command centers while others specialize in manufacturing, back-office operations, market niches, and tourism, or serve primarily local needs. Cities likewise withdraw resources from and deliver products and residues to their hinterlands. In his 2001 book, *The Rise of the Network Society*, Manuel Castells refers to a shift from spaces of places to spaces of flows, arguing that cities are nodes through which flows occur. This conception implies that cities are influenced by a larger systemic logic, and that the nature of the flows and transformations the city imposes on those flows is relevant to city planners. The flows slow to a trickle in the absence of adequate energy supplies, and environmentally insensitive transformations of energy flows in urban areas are choking places such as Bangkok and Mexico City. Efforts by planners and local officials worldwide to ensure reliable, secure urban energy infrastructures have increased since the terrorist acts of September 11, 2001.

S0165 9. CONCLUSION

P0295 City planning evolved as a reaction to the ugliness and unhealthfulness of urban areas following the industrialization and urbanization in the late 19th century. In the 20th century, city planning broadened its scope and developed its tools, including land use planning, zoning, transportation planning, and growth management. Energy planning has not been the major agenda in city planning.

P0300 Since the oil crises in the 1970s and with increasing public awareness of the environmental impacts of fossil fuel consumption, there has been a fundamental change in energy policy. The security of the energy supply, the price of energy, and its environmental impacts have formed a volatile tripartite political agenda, and technically innovative, alternative energy resources have begun emerging.

Policy levers exist at several levels. For instance, although transit-oriented development is located in macro-level (or metropolitan) planning, walkable street development belongs to meso-level (or community) planning, and parking requirements play out at the micro (site) level of planning. At the meso (community) level are the placement of technological innovations such as distributed energy resources. At the micro (site) level, design decisions can alter the energy efficiency of building layouts and materials, lighting, and appliances. However, some innovations are restricted by current regulations and energy policies at each government level. There are especially severe energy-related challenges for city planning in the world's growing megacities. P0305

Planning spans the gap between innovative technologies of energy production and their implementation. Hopkins argues that planning is a complicated and integrated process interconnecting regulation, collective choice, organizational design, market correction, citizen participation, and public section action. Planners struggle with the vagueness of what their goals are, how their processes perform, and who can be involved in the planning process. P0310

In sum, energy planning could be one of the major agendas in city planning, and it could conceivably be incorporated into city planning, although it has not been to date. Energy planning and city planning intersect at both the community and metropolitan levels, and thus planners will be involved in all attempts to provide more reliable, affordable, and environmentally sound energy for the world's cities. P0315

SEE ALSO THE FOLLOWING ARTICLES

Ecological Footprints and Energy (00120) • Economic Growth and Energy (00147) • Heat Islands and Energy (00394) • Land Requirements of Energy Systems (00404) • Population Growth and Energy (00018) • Suburbanization and Energy (00020) • Urbanization and Energy (00019)

Further Reading

Andrews, C. J. (2002). Industrial ecology and spatial planning. *In* "A Handbook of Industrial Ecology" (R. U. Ayres and L. W. Ayres, Eds.). Edward Elgor, Cheltenham, UK. AU:2

Barton, H. (ed.). (2000). "Sustainable Communities the Potential for Eco-neighbourhoods." Earthscan Publ. Ltd., London.

Beatley, T. (2000). "Green Urbanism: Learning From European Cities." Island Press, Washington, D.C.
Calthorpe, P., and Fulton, W. (2001). "The Regional City." Island Press, Washington, D.C.
Campbell, S., and Fainstein, S. (eds.). (2000). "Readings in Planning Theory." Blackwell Publ., Cambridge, Massachusetts.
Castells, M. (2001). "The Rise of the Network Society." Blackwell Publ., Cambridge, Massachusetts.
Hopkins, L. D. (2001). "Urban Development: the logic of making plans." Island Press, Washington, D.C.
Newman, P., and Kenworthy, J. (1999). "Sustainability and Cities." Island Press, Washington, D.C.

Author's Contact Information

Clinton J. Andrews
Bloustein School of Urban Planning and Public Policy
Rutgers University
33 Livingston Avenue, Rm 302
New Brunswick
NJ 08901-1987
USA
Tel: 732-932-3822 x721
Fax: 732-932-2253
e-mail: cja1@rci.rutgers.edu

Author Query Form

Title: Encyclopedia of Energy (NRGY)
Article/ID Number: City Planning and Energy Use/00498

Dear Author,

During the preparation of your manuscript for typesetting some questions have arisen. These are listed below. Please check your typeset proof carefully and mark any corrections in the margin of the proof or compile them as a separate list. Your responses should then be returned with your marked proof/list of corrections to Joanna Dinsmore at Elsevier.

Queries and/or remarks

AU:6	Ok
AU:7	GRP-? Please change if necessary
AU:3	Permissions for all four figures required? If so, please provide.
AU:4	VP as spelled out OK? Spelled out "g/pass.-km" OK?
AU:1	Update with comment about the 2003 blackout?
AU:5	Permission asked/granted?
AU:2	Please provide page number

ORDER YOUR REPRINTS NOW!

Take advantage of the opportunity to order chapter reprints at the best prices.

Why Order?

Make the most of your hard work!

- Lectures/appearances
- Commercial solicitation
- Pharmaceutical interest
- Promotional material
- Course adoptions
- Corporate sales
- Generate further interest in your book

Do not delay in ordering your reprints! Timing is crucial! To take advantage of the prices given below, please send in your orders **within one week**.

IMPORTANT

Minimum order: 50 copies (not including gratis copies).

Order form enclosed. Prices quoted do not apply to orders received after the book has been printed.

Please **use our order form** and **fill it out completely**.
Return our order form even if no reprints are desired.

Please fax and mail order form to: ATTN: Lisa Pawlak
Book Chapter Reprints, Academic Press, 525 B St., Suite 1900, San Diego, CA 92101-4495
Fax: (619) 699-6305

Academic Press Book Chapter Reprint Price List

COPIES: / *PAGES*	*50*	*100*	*200*	*300*	*400*	*500*	*600*	*700*	*800*	*900*	*1000*
1-2	$ 90	$ 155	$ 280	$ 395	$ 500	$ 600	$ 685	$ 760	$ 825	$ 880	$ 925
3-4	105	190	345	490	620	735	835	925	1,000	1,060	1,105
5-6	125	220	410	575	730	865	980	1,080	1,165	1,230	1,280
7-8	140	255	470	665	840	1,000	1,130	1,245	1,335	1,405	1,455
9-10	160	285	535	760	955	1,130	1,280	1,405	1,505	1,580	1,635
11-12	175	320	600	850	1,070	1,265	1,430	1,570	1,680	1,760	1,810
13-14	195	355	665	940	1,185	1,400	1,580	1,730	1,850	1,935	1,990
15-16	210	390	730	1,030	1,300	1,530	1,730	1,890	2,015	2,110	2,165
17-18	230	425	790	1,120	1,410	1,665	1,875	2,050	2,185	2,285	2,345
19-20	250	455	855	1,210	1,525	1,795	2,025	2,210	2,355	2,460	2,520
21-22	260	465	880	1,250	1,575	1,855	2,095	2,290	2,440	2,545	2,605
23-24	265	475	905	1,290	1,625	1,920	2,165	2,365	2,520	2,630	2,690
25-26	275	485	930	1,325	1,675	1,980	2,235	2,440	2,600	2,715	2,780
27-28	285	490	955	1,365	1,730	2,040	2,305	2,520	2,685	2,800	2,865
29-30	295	500	980	1,405	1,780	2,100	2,375	2,595	2,765	2,880	2,950
31-32	305	510	1,005	1,445	1,830	2,165	2,445	2,670	2,845	2,965	3,035
add'l 1-2	$ 10	15	30	45	55	65	75	80	85	90	90

PRICES INCLUDE SHIPPING AND HANDLING

IF COLOR ILLUSTRATIONS ARE REPRODUCED IN YOUR CHAPTER, ADD $50.OO PER 100 PURCHASED REPRINTS ($25.00 FOR FIRST 50 COPIES).

ACADEMIC PRESS

525 B STREET, SUITE 1900, SAN DIEGO, CALIFORNIA 92101-4495
TELEPHONE (619) 699-6473 FAX (619) 699-6305

ORDERING INSTRUCTIONS: please fax completed order form *and* mail original (with purchase order, if necessary)

Order for Book Chapter Reprints

TITLE OF BOOK: Encyclopedia of Energy	
EDITOR(S): Cutler Cleveland	
AUTHOR(S):	
TITLE OF CHAPTER:	No. of pages in Chapter:

25 COPIES GRATIS

- **PRICES INCLUDE POSTAGE**
- **TAX EXTRA**

NUMBER OF REPRINTS TO BE PURCHASED:

_______ **Copies** **$** _______________

Cost for Color **$** _______________

Total Due **$** _______________

THE ABOVE ORDERED REPRINTS ARE TO BE **INVOICED** TO:

NAME ____________________

DEPARTMENT ____________________

DIVISION ____________________

INSTITUTION ____________________

STREET ____________________

CITY __________ STATE ______ ZONE __________

COUNTRY ____________________

INSTITUTIONAL PURCHASE ORDER
No. ____________________

☐ **is attached** ☐ **not necessary**

☐ **will be transmitted separately**

CREDIT CARD PURCHASE

☐ MC ☐ VISA ☐ AMEX

No. ____________________

EXP. DATE ____________________

SIGNED ____________________

E-MAIL ____________________ TEL. NO. ____________________ FAX NO. ____________________

Purchase orders for payment of reprints by an institution must be indicated on this order form.

SHIPPING LABEL **(Please TYPE or PRINT clearly)**

Name		
Dept.		Rm. No.
Division		
Institution		
Street PO BOX NOT ACCEPTABLE		
City	State	Zone
Country		

Include any *special instructions* here: