entrained by the combustion air, and combustion takes place in the bed. This method of combustion results in lower combustion temperatures that reduce the formation of NO_x, and chemical reagents in the bed are used to remove SO_2 from the exhaust gas stream. At present, there is limited operating experience with fluidized bed combustion units larger than 100 MW.

Photovoltaics and **solar thermal** are two solar technologies being investigated for utility applications. Both of these technologies are currently being used in Maryland by private individuals, usually for residential use.

Photovoltaic cells convert sunlight into electricity by directing light rays onto semiconductor materials, the same kind of metals used to carry electric current in computer chips. Most photovoltaic systems installed in the United States are small, producing less than 10 MW of electricity. A disadvantage of this technology is that large land areas are required to collect sufficient sunlight. Applications of this technology are best suited to remote facilities or sites at which the energy is consumed. The Maryland PSC has recently established a collaborative effort to demonstrate this technology in Maryland. DP&L is currently co-sponsoring a photovoltaic demonstration at the University of Delaware, and is planning another demonstration at one of its offices in 1993.

Solar thermal energy systems use radiant energy from the sun to produce steam, which drives a turbine/generator. This technology offers the benefit of low fuel costs and minimal atmospheric emissions. However, as in the case of photovoltaics, solar thermal facilities also require large land areas to allow the recovery of solar energy.

Nuclear Power Plant Issues

Since the late 1970s, public concerns regarding nuclear power have effectively halted the construction of nuclear power plants in the United States. Although nuclear power plants continue to be built in Europe and Asia, no company in the United States has begun construction on a nuclear facility in more than a decade. Regardless of the status of new plant construction, the nuclear industry and nuclear power regulators continue to address a number of important issues generic to the 113 existing licensed power reactors in this country. Two of the most important issues — plant aging and license renewal, and management and disposal of radioactive waste — are discussed here.

License Renewal Issues

The U.S. Nuclear Regulatory Commission (USNRC) grants 40-year licenses to utilities to construct and operate nuclear power plants. Provisions in the licenses, and federal laws governing nuclear power plant operations, strive to guarantee that nuclear power plants will be operated safely.

The federal government issued a new rule governing **license renewals** for nuclear power plants in December 1991. Under the new program, the utility applying for a renewal of its license to operate a nuclear power plant must define in detail each piece of equipment important to the license renewal, and then

carefully describe age-related degradation and plans for refurbishment for each piece of equipment. The level of detail and the amount of data that the utility must supply in support of a license renewal application is significant. Upon completion of the USNRC evaluation and approval process, a 20-year license may be granted.

Two U.S. plants recently initiated license renewal, a process which requires utilities to supply detailed information on the condition of plant components including the nuclear reactor vessel. The information initially provided to the USNRC was not adequate to support the license renewal requests. The magnitude of the costs that would be required to collect the necessary data resulted in a decision by both applicants to drop or defer license renewal.

In light of aborted industry efforts to take these two plants through license renewal, the USNRC is re-evaluating the renewal process and may possibly revise its rule. A revised rule is expected to include additional guidance and specific age-related condition criteria and standards that must be met by applicants. The nuclear industry is evaluating standards, developing suggested renewal guidance, and pressing the USNRC to clarify and modify the rule.

Independent of nuclear industry groups, BG&E recently met with the USNRC and urged that some specific renewal uncertainties be resolved in 1993. While BG&E has not formally applied for renewal of the operating license for its Calvert Cliffs Nuclear Power Plant, it has been extensively evaluating and upgrading plant conditions and preparing for a potential renewal application. Calvert Cliffs Unit 2, with a current license expiration date of 2016, is a likely and viable candidate for license renewal.

PECO is conducting routine evaluations, required by the USNRC, of the condition of its two boiling water reactors at Peach Bottom Atomic Power Station. That effort, however, is not uniquely directed toward support of a renewal application. PECO has not indicated whether or not it will pursue license renewal.

Calvert Cliffs Independent Spent Fuel Storage Installation

Spent nuclear fuel from Calvert Cliffs is currently covered with water in pools near the reactors. In the mid-1970s when Calvert Cliffs' operating license was issued, it was envisioned that nuclear fuel assemblies used in the generation of electricity would be transported off site for reprocessing or storage. Because spent fuel reprocessing was banned in 1977 and no interim or final spent fuel repositories are expected to be immediately available, BG&E began, in the mid-1980s, exploring options for on-site storage of their spent fuel.

That evaluation culminated in 1989 with an application before the USNRC for a license to construct and operate a spent fuel facility at Calvert Cliffs. PPRP intervened in this licensing proceeding to ensure that there existed "a forum for resolution of issues related to the facility's potential impacts on the State, its environs and the health, safety and welfare of its citizens." PPRP, the USNRC, and BG&E ultimately reached formal agreement whereby PPRP was provided all pertinent information related to the facility and was accorded review and decision-making input privileges. After extensive evaluation by PPRP and the USNRC of BG&E's application, supporting documentation, and subsequent information submittals, the USNRC issued a materials license in December 1992, authorizing BG&E to operate the facility for 20 years.

The $24 million state-of-the-art facility is designed and licensed to hold 2,880 spent fuel assemblies in dry-shielded canisters, housed in 120 concrete modules. Two of the five licensed phases, a total of 48 modules, have been constructed and are ready to receive spent fuel. The facility design and 20-year license will accommodate all of the spent fuel that will be discharged from Calvert Cliffs during its 40-year licensed life.

Radioactive Waste Disposal

The operation of nuclear power facilities generates two types of radioactive waste products: **low-level waste** and **high-level waste**. Low-level waste contains relatively low concentrations of radionuclides, and includes such items as spent decontamination resins, filter sludge, contaminated equipment, and contaminated protective clothing. High-level waste consists of spent nuclear fuel, control rods, and a variety of reactor components.

Regulation and Disposal of Low-level Waste

To address the issue of low-level radioactive wastes, Congress passed the Low-level Radioactive Waste Policy Act. The Act required that each state become responsible for the disposal of all commercially generated waste within its borders. States were allowed to form **compacts** — that is, work with neighboring states as a group — and were given a deadline of December 31, 1992. States or compacts without disposal facilities by the deadline would no longer be permitted to dispose of their waste at the three commercial disposal sites currently available: Richland, Washington; Beatty, Nevada; and Barnwell, South Carolina.

The Richland facility was scheduled to close its site to waste from states outside its compact on December 31, 1992. Beatty will close its site permanently to all waste, even that generated within its compact. The Barnwell site will remain open, although its future status is uncertain. The South Carolina state legislature will ultimately decide if Barnwell will remain open to states other than those in the Southeast Compact. As of August 1992, the state of South Carolina had opted to continue to accept low-level waste from states outside the Southeast Compact until June 30, 1994. The waste would be accepted on the condition that the state from which it came was making adequate progress toward providing waste disposal capacity. The "adequate progress" criterion will be measured by the Southeast Compact Commission.

The Appalachian States Compact, consisting of Maryland, Delaware, Pennsylvania, and West Virginia, continues to make progress towards the siting of a low-level radioactive waste disposal facility in Pennsylvania. Maryland continues in the interim to dispose of its low-level radioactive waste at the Barnwell, South Carolina facility.

High-level Waste/Spent Fuel

Spent fuel, after being removed from the nuclear reactor, is stored under water in a storage pool at the reactor site. These pools are designed to store only a limited amount of fuel; therefore, many of the older reactors are now facing storage capacity problems. As the reactors continue to operate, pool storage space will become depleted, and utilities will have to either ship the spent fuel to another site or expand the on-site storage.

Dry storage is a safe and economical method to expand the on-site storage capacities at the plant until the spent fuel is shipped off site. Dry storage technologies include metal casks, horizontal concrete modules containing sealed canisters, vertical concrete casks, and concrete modular vaults.

Currently, there are no off-site disposal facilities available. The federal government is evaluating potential sites for temporary storage facilities, and one site in Yucca Mountain, Nevada, for a permanent facility.

Department of Energy Repository at Yucca Mountain

In the Nuclear Waste Policy Act, as amended in 1987, Congress directed the Department of Energy (DOE) to determine if the Yucca Mountain, Nevada, site (and only the Yucca Mountain site) would be a suitable site for the nation's first geologic repository for spent nuclear fuel and high-level waste. Site characterization activities are expected to proceed through the year 2001, followed by USNRC licensing review and approval through 2010. Construction and operation would begin after the site is licensed. The objective of the scientific studies is to determine if Yucca Mountain can isolate radioactive materials by using a combination of natural and engineered barriers.

In March 1992, the DOE was granted the last of three major permits required for the Yucca Mountain site characterization work to assess the suitability of the site as a geologic repository. (The other major permits were for air quality granted in June 1991 and for underground injection control granted in July 1991.) In April 1992, the National Academy of Sciences issued a report on the project, unanimously concluding that the Yucca Mountain candidate repository site is not at risk of ground water upwelling or flooding in a layered rock being considered for a potential repository.

In 1993, the DOE will construct a below-ground Exploratory Studies Facility. Research will involve extensive assessments of geologic, hydrologic, and seismic conditions deep within the Yucca Mountain site.

BG&E has received a USNRC license to store spent fuel in a dry storage facility on site for 20 years, sufficient capacity to hold all fuel discharged from Calvert Cliffs beyond its current licensed lifetime. Each of the two spent fuel pools at Peach Bottom currently has about half of its storage capacity still available. Full capacity is expected to be reached about the year 2003 for Unit 2 and a year later for Unit 3. Unlike BG&E, PECO has not actively pursued acquisition of additional on-site spent fuel storage.

Non-utility Generation

Nationwide Trends

One of the most rapidly evolving trends in electric power generation in the United States comes in the form of non-utility generation (NUG). The past decade has seen competition emerging from NUGs in the area of electric power generation, an area long believed to be an electric utility industry function. NUG projects are competing with each other and with utility "self-build" options to serve the growth in power demands. Prior to the 1980s, NUGs were primarily self-generation facilities erected by industrial plants to ensure reliable service and trim power costs — not to compete in the marketplace as a power supplier. In Maryland, the Bethlehem Steel, Amstar, and Westvaco generating units are good examples of traditional industrial self-generation.

The federal **Public Utility Regulatory Policies Act (PURPA)** of 1978 and the **Federal Energy Regulatory Commission (FERC)** rulemaking in 1980 implementing PURPA altered this traditional arrangement. This legislation pulled down the barriers to NUG development, facilitating competition in bulk power supply. NUG facilities meeting certain technical and legal requirements under the FERC rules are granted **qualifying facilities (QF)** status, which entitles them to certain privileges. A QF has a "guaranteed market" for all power it produces and supplies to the local utility, at rates reflecting the purchasing utility's "full avoided cost." This means that the local utility must purchase all power supplied to it by a QF and pay the QF rates reflective of the additional costs the utility would have incurred but for the purchase. This mechanism is designed to 1) eliminate barriers to QF development, 2) protect consumers against unnecessary cost increases, and 3) provide maximum economic encouragement to QFs short of providing financial subsidies.

NUG Categories

Non-utility generators (NUG) fall into three main categories:

Cogenerators produce electricity and usable thermal energy (typically steam) from the source. This normally involves the recovery of waste heat from the power plant boiler or exhaust, which substantially improves overall energy efficiency. Industries with large steam requirements tend to be good candidates as so called "steam hosts" for cogeneration. If the amount of steam produced is large enough, the cogenerator may be considered a **qualifying facility** (QF) under federal rules.

Small power producers are facilities 80 MW or smaller using a renewable resource or waste product as the principal fuel. This includes such sources of energy as municipal solid waste, solar, hydroelectric, wind, or waste coal.

Independent power producers (IPPs) are NUGs lacking federal QF status (unlike cogenerators and small power producers). In theory, IPPs can be utility-owned, but normally do not provide service within the owning utility's franchise service territory. While lacking QF privileges, IPPs tend to have more flexibility in siting and engineering design.

In addition to the Public Utility Regulatory Policies Act (PURPA), legislation currently before Congress is intended to facilitate competitive market entry by IPPs and QFs. The proposed legislation would remove certain legal barriers associated with PURPA and would provide NUGs with more assured access to the transmission grid enabling them to reach more utility buyers.

Most QF capacity in the United States consists of units ranging from roughly 50 to 300 MW, operating with natural gas, coal, or wastes as fuels. The QF usually obtains a long-term (20 to 30 years) power sales contract with the local utility before project development begins. Long-term contracts are an essential precondition because such projects are very expensive and highly capital-intensive; therefore, developers cannot obtain financing without a relatively secure contract identifying pricing terms. As a result, pricing terms tend to be based on long-range forecasts of the utility's capacity needs and other costs, all of which are vulnerable to forecast error. Such contracts are normally subject to PSC review and approval.

At the present time, NUG capacity accounts for only about 3 percent of total installed capacity in the United States, but this capacity source is expected to increase to about 10 to 15 percent over the next 20 years. The U.S. Department of Energy anticipates 25 to 30 percent of new power plant capacity additions over the next 10 years will come from non-utility sources.

NUGs as a Source of Supply for Maryland

NUG development to date in Maryland has been very limited and has been confined to older, industrial self-generation facilities. The only major QF project constructed since 1978 is the 57-MW BRESCO waste-to-energy facility serving BG&E. At the present time, Maryland utilities purchase virtually no power from out-of-state NUGs.

This situation appears to be changing dramatically. Between now and the year 2000, NUG projects serving Maryland utilities will constitute a larger percentage of total planned capacity. Planned or anticipated additions for Maryland utilities are described in Table 3-1.

Table 3-1
Planned NUG Additions

BG&E	Has entered into a long-term contract with AES Northside to purchase the power from a 300-MW coal-fired cogeneration plant that will enter service in the late 1990s. PSC approval of this capacity source is pending. If approved, this would satisfy the majority of BG&E's supply-side capacity requirements during the 1990s.
DP&L	Anticipates several major NUG projects entering service during the 1990s, in all cases obtained through competitive bidding programs. The 48-MW Star peaking unit will enter service in 1992. In 1996, the company anticipates the startup of the Delaware Clean Energy Project (a 165-MW coke gasification project) and the National Energy Resource Corporation facility (33-MW waste-to-energy facility). All three projects are to be located in northern Delaware. The company also anticipates 80 MW of NUG purchases beginning in 1999 to be obtained through a planned competitive solicitation. Thus, the total NUG capacity additions are projected to be 326 MW, representing about half of DP&L's total capacity additions.
PE	At the present time, expects only one major project during the 1990s — the 180-MW AES Warrior Run coal-fired cogeneration plant. That contract has been approved by the PSC and is scheduled for service in late 1995. The AES Warrior Run project accounts for about 28 percent of the planned PE capacity additions during the 1990s.
PEPCO	Currently has three NUGs under contract to come online between 1994 and 1996 — the Dominion Resources cogeneration project in the District of Columbia (about 50 MW), the Montgomery County solid waste facility (about 50 MW), and the Panda Brandywine cogeneration plant (230 MW) located in Prince Georges County. The Dominion and Panda units will be gas-fired. The Montgomery and Panda projects have been approved by the Maryland PSC and the Dominion plant was approved by the District of Columbia Commission. These three projects represent slightly more than 50 percent of PEPCO's total planned capacity additions during the remainder of the 1990s.

In an important decision, the Maryland PSC recently ruled that NUG developers intending to construct power plants in Maryland are generally subject to the same power plant licensing rules as utilities. This means that a NUG facility to be built in Maryland will undergo the same comprehensive environmental review that utility-built power plants undergo during the licensing process.

In addition to the projects outlined in Table 3-1, several other NUG projects have been proposed either by utilities or NUGs themselves but were subsequently rejected by the Maryland PSC. Three recent NUG projects were rejected either because they failed the "avoided cost" test or because it was determined that there was not enough need for the additional capacity.

NUG projects sometimes fail to develop for a variety of other technical or economic reasons. At this time, it is difficult to predict how much of the NUG capacity under contract or planned will actually emerge. It is noteworthy that none of the extensive planned NUG capacity discussed in this section is currently under construction.

Toward a Competitive Market

The burgeoning development of NUG sources is part of the general trend toward a competitive market for bulk power supply. This trend has become apparent in Maryland during the last five years and is expected to accelerate.

The emerging forces encouraging competition include the sanctioning of competitive bidding programs (or competitive procurement methods) for new power supplies, the introduction of "market pricing" in place of traditional regulated pricing, and liberalized transmission access. In competitive procurement or bidding programs, the utility publishes a Request for Proposals (RFP) specifying the amount of capacity it needs, when that capacity is required, and the methods for evaluating bids. Because the majority of the emphasis in project selection is on price, these programs have prompted aggressive price competition among NUGs to supply the capacity. The competitive bids can also serve as a benchmark or standard for evaluating the cost-effectiveness of the utility's own construction plans. In Maryland, DP&L recently concluded a competitive procurement program.

FERC has recently approved applications by two major utilities (Public Service Company of Indiana and Entergy Corporation) to price their "off-system" bulk power sales on the basis of market conditions rather than traditional utility cost of service. By effectively deregulating the wholesale transactions of these companies, FERC encourages their participation in the wholesale power market, thus enhancing competition. In exchange for receiving FERC approval of market pricing, the two companies agreed to make their transmission grids available to other competing utilities. FERC regards "open access" of transmission as an essential precondition to ensure that purchasers of wholesale power have numerous competitive options.

Utility-sponsored Demand-side Management (DSM)

The Role of DSM

Since the mid-1980s, Maryland utilities have been actively engaged in promoting **demand-side management (DSM)** programs as a means of deferring power plant construction and meeting growing customer demands. DSM programs fall into two basic categories: 1) load management and 2) conservation.

The first category, **load management**, refers to utility programs designed to reduce customers' electricity usage at the peak hours of the year or to shift demand from the high-usage peak hours to the low-usage off-peak hours. If successful, load management allows utilities to defer building or buying new generating capacity (which is driven by peak demand growth) and to use existing baseload units more efficiently. While reducing peak hour demand, load management programs have little or no effect on total energy usage.

The second category, **conservation,** refers to utility-sponsored programs that meaningfully reduce customers' total energy demands. Such programs usually, but not always, are intended to achieve peak hour demand savings as well. In general, conservation programs can help the utility defer new power plant construction and also save fuel.

While utilities were heavily emphasizing load management programs during the 1980s, they placed much less reliance on conservation. Utility efforts during this period were largely limited to the provision of energy audits, conservation advertising, low-income weatherization, and providing technical advice to customers. This has changed dramatically within the past three years. Maryland's two largest electric utilities, PEPCO and BG&E, have recently put in place a comprehensive portfolio of conservation programs; DP&L also had several new conservation programs approved by the Maryland PSC in November 1992. The most important uses targeted by these programs include the installation of high-efficiency lighting, air conditioners, and heat pumps; energy-conserving building shell designs; and high-efficiency motors for industrial customers. These newly implemented conservation programs parallel the load management programs by providing strong economic incentives for customer participation. These incentives generally take the form of substantial cash rebates to help defray the cost of the high-efficiency equipment or measures.

It must be emphasized that substantial conservation efforts have in the past and will continue to take place outside of utility-sponsored programs. During the 1980s, manufacturers introduced and consumers and businesses purchased increasingly energy-efficient appliances simply in response to market forces. In the late 1980s, federally mandated appliance efficiency standards were introduced to be phased in over the next several years. Utility-sponsored programs are intended to supplement and accelerate — not replace — the results of these market forces and federal actions.

Load Management

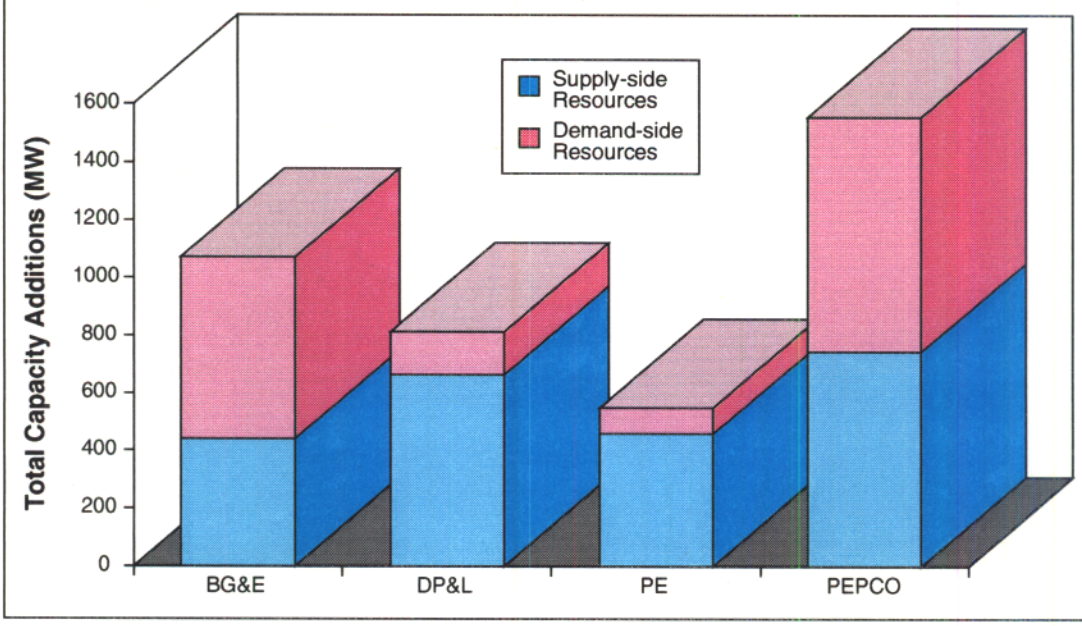
Maryland utilities began to pursue load management aggressively in the mid-1980s when it became apparent that they were facing an imminent and very large need for new capacity. To slow peak demand growth, they introduced or expanded: 1) **time-of-day pricing**, 2) **interruptible service** to commercial and industrial customers, and 3) **direct load control** of air conditioners and electric water heaters. Time-of-day pricing, which is primarily for large business customers, encourages the customer to shift on-peak usage to off-peak hours. Interruptible service and load control are voluntary programs in which service is curtailed for just a few hours per year, usually when demand approaches the annual peak. These programs have proved very successful in reducing capacity additions and have provided substantial cost savings.

DSM Trends in Maryland

All four Maryland utilities have included substantial amounts of DSM in their integrated resource plans. Figure 3-1 illustrates DSM as a portion of total utility capacity additions through the year 2000.

For Maryland's four major utilities, DSM, as a percentage of total peak demand, is expected to increase from 6.3 percent in 1992 to 13.6 percent in the year 2000 (see Figure 3-2). The aggregate figures (including savings in the non-Maryland areas served by these four companies) are 1,043 MW in 1992 increasing to 2,694 MW in the year 2000. By way of comparison, BG&E's Perryman combined cycle generating unit, recently approved by the PSC, will have a rated capacity of 440 MW. Thus, the projected year 2000 savings are equivalent to roughly six utility-size generating units. The projected energy savings from DSM (expressed in kilowatt-hours) are also substantial, but in percentage terms are much smaller than the peak demand savings. Utility-sponsored conservation is presently in a startup mode but by the year 2000 will provide meaningful savings — about five percent of total electrical energy requirements.

Figure 3-1
Demand-side and Supply-side Capacity Additions, 1992-2000

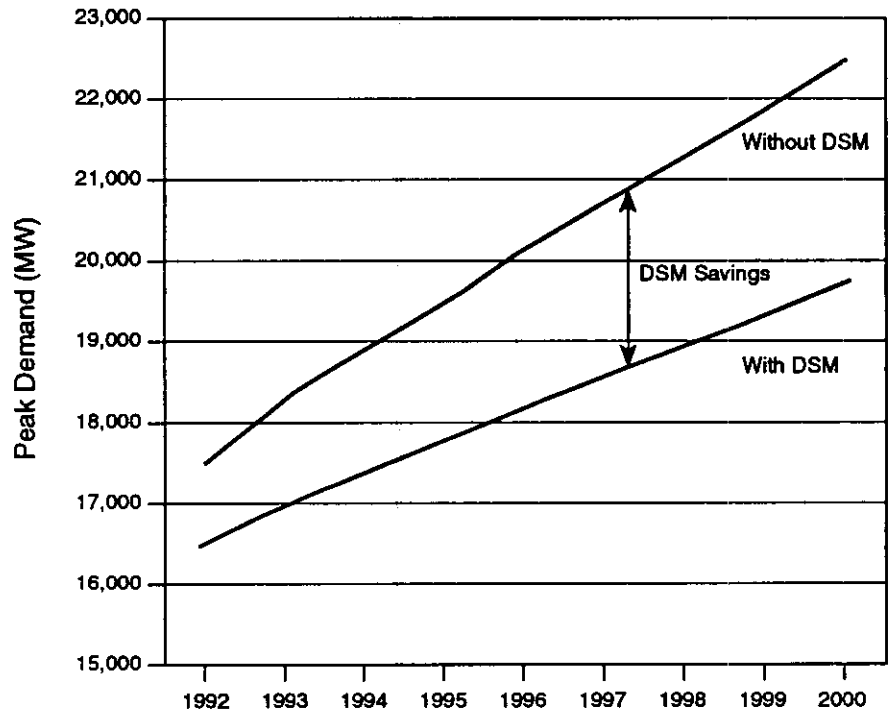


In addition to examining DSM relative to total projected power demands, these load savings should be evaluated relative to the *growth* in demand. Combining the four utilities, DSM is projected to meet nearly 40 percent of required capacity additions during the remainder of this decade (Figure 3-1). While the energy savings predicted from DSM are smaller on a percentage basis, they are nevertheless significant. For the 1992 to 2000 period, energy savings from DSM programs, as a percentage of energy demand growth, range from 2 percent for DP&L to 46 percent for PEPCO. For Maryland's four major utilities combined, DSM is expected to meet 26.5 percent of the overall growth in electricity demand during this period.

The Collaborative Approach

Maryland utilities have recently addressed the design and implementation of conservation programs for their Maryland customers through a collaborative process — a cooperative arrangement among the utility, state agencies, and customer groups to arrive at a mutually acceptable set of programs. This approach to conservation planning incorporates two basic principles. First, the utility agrees to expend the resources required to implement a full range of conservation programs, to the extent that they are cost-effective. Second, the collaborative agrees to a cost recovery plan that fully compensates the utility for incurring the substantial costs associated with deploying the required conservation resources. The implementation and cost recovery of the collaborative conservation programs are subject to PSC approval.

Figure 3-2
Projected Growth in Peak Demand With and Without DSM for Combined PEPCO, BG&E, DP&L, and PE



As a result of collaborative agreements, with PSC approval, PEPCO and BG&E are allowed to implement conservation surcharges on an annual basis. The surcharge mechanism provides the utilities with timely and full recovery of all conservation expenses, as well as an incentive payment. The incentive payment is based on a percentage of the estimated cost savings attributable to conservation and is awarded to the utility provided that certain performance goals are attained. The mechanism not only removes the perceived disincentives associated with standard ratemaking, but it creates a positive financial incentive to pursue conservation and achieve the threshold performance goals.

Emerging Environmental Impact Issues

People around the globe are increasingly concerned with a range of environmental and energy issues. These issues include such topics as global warming, fate and effects of toxics in the environment, and health concerns over electric and magnetic fields (EMF) from transmission lines and even home appliances. We discuss in this section these and other emerging issues that could affect how power is generated in Maryland in the near future.

Greenhouse Warming Issues

The **greenhouse effect** is a naturally occurring phenomenon in which clouds and certain gases found in relatively minute amounts in the atmosphere trap heat emitted by the earth's sun-warmed surface, and warm the atmosphere near the ground. In recent years, there has been a realization that the release of greenhouse gases from human activity, including burning of fossil fuels, could be influencing the greenhouse effect. The potential for dramatic climate change like **global warming** due to emissions of greenhouse gases such as carbon dioxide (CO_2) has spurred intense scientific investigation and prompted response on a world-wide scale.

Reasons for Concern

Based on estimates from complex mathematical computer models, many prominent researchers believe that global warming can be expected as atmospheric concentrations of greenhouse gases rise. There are several important greenhouse gases, including CO_2, chlorofluorocarbons, methane, nitrous oxides, and water vapor. A current estimate suggests that the concentration of all greenhouse gases in the atmosphere will be equivalent to double the preindustrial level of CO_2 by the middle of the next century. This prediction assumes that no policies are in place to limit greenhouse gas emissions. The most up-to-date models suggest that such increases in greenhouse gases could cause an increase in the average global temperature of between 2° and 9°F; however, the timing and magnitude of greenhouse gas accumulation and potential resulting climatic changes are not well defined at this time.

Studies of the global temperature record of the past 100 years indicate an increase of about 1°F. Most experts feel that this warming trend is not conclusive evidence of greenhouse warming because the magnitude of uncertainty concerning this observation masks the true trend. These experts believe that if there is a real warming trend, it will become apparent within the next 10 to 15 years. Some experts, however, believe that we are already in the midst of a global warming trend and point to the record-high global mean temperatures of the 1980s and early 1990s. (The years 1990 and 1991 are now the warmest years on record.) The contradictory cool summer of 1992 has been attributed to sulfur-based

CFCs and Ozone Depletion

Scientists have confirmed in recent years that when chlorofluorocarbons (CFCs) and halons, two types of inert gases, are released to the atmosphere, they eventually reach the stratosphere and destroy the stratospheric ozone layer to varying degrees. The ozone layer helps shield the Earth from the sun's harmful ultraviolet radiation. Worldwide, CFCs have been used primarily for refrigeration, foam production, and aerosol propellants. Their use as an aerosol propellant has been banned in the United States since the 1970s. In the mid-1980s a hole in the ozone layer was first observed over the Antarctic. CFCs have been clearly implicated in the Antarctic hole and in limited ozone losses, but as yet, not in holes appearing over the Arctic, North American, and European continents. As a result, 35 countries, including the United States, signed the 1987 Montreal Protocol, committing to reduce production of CFCs and halon gases drastically. The United States, through the 1990 Clean Air Act Amendments, has gone beyond the requirements of the Montreal Protocol, mandating complete production phase-out of the most potent CFCs, halons, and other related compounds by the year 2000.

In addition to contributing significantly to stratospheric ozone depletion, CFCs can also contribute to the greenhouse effect. Molecule for molecule, CFCs are 20,000 times more potent than CO_2 as a greenhouse gas. Recent studies have shown that the depletion of ozone in the lower stratosphere is believed to have approximately offset the greenhouse effect contribution of CFCs over the last decade or so.

Electric utilities are very minor contributors of atmospheric CFC emissions. However, domestic and commercial use of less effective and less energy-efficient (but environmentally benign) CFC substitutes could increase the demand for electricity. This increased demand could potentially increase the emissions of other greenhouse gases, such as CO_2.

particles due to the eruption of Mount Pinatubo in the Philippines, which have acted to block out an estimated 2 percent of the sunlight.

Several plausible effects may be observed during the next century if there is a true warming trend, including hotter and drier summers, increased likelihood of summer vegetation fires in drier/hotter regions, increased sea levels, and more numerous and intense hurricanes. The potential implications for Maryland may be significant. Unless current trends are reversed, sea-level rise could affect significant portions of Maryland's Chesapeake Bay wetlands in the next century. Hotter summers with accompanying stagnant weather conditions could worsen Maryland's ozone air pollution problem. Hotter summers also could increase electricity demand in Maryland, as well as in the entire northeast region.

Major questions exist regarding the reality, magnitude, and timing of potential greenhouse-induced climatic effects. One major area of uncertainty in predicting human influences on global climate is our ability to estimate greenhouse gas emissions and atmospheric loading. The models used for predicting atmospheric CO2 levels and potential effects are another major source of uncertainty. The current models cannot adequately represent the role of the oceans and the biosphere in the exchange of heat and CO_2, the interactions between changing climate and cloud formation and between changing climate and ice cover, and the effects of global warming on natural sources of greenhouse gases. Adding to the uncertainties in model predictions is a recent finding that the cooling effect of sulfur emissions, not accounted for in recent models, may have offset a significant part of the greenhouse warming in the northern hemisphere during the past several decades.

CO_2 as a Greenhouse Gas

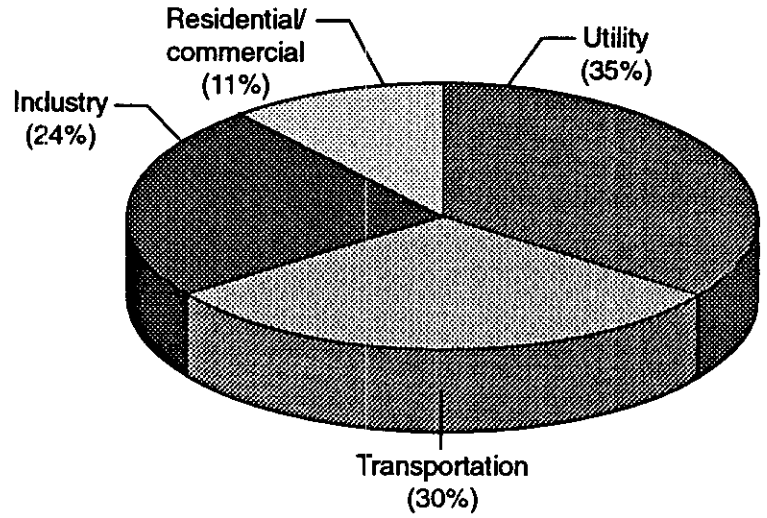
Without CO_2 in the atmosphere, life as we know it would not exist on this planet. The natural atmospheric level of CO_2 is the reason why the Earth's temperature averages about 59°F globally instead of about 0°F.

CO_2 is emitted by natural and human sources. Manmade CO_2 generally is believed to be the prime contributor to CO_2 build-up in the atmosphere. Ice core samples from Antarctica and Greenland and direct atmospheric CO_2 measurements made in Hawaii since 1958 indicate that CO_2 levels have been increasing

since about the time of the Industrial Revolution. These increases have been attributed to emissions from industrial, utility, and transportation-related sources. The oceans and plants act as CO_2 **sinks**, removing approximately half of the manmade CO_2 emissions from the atmosphere.

Additionally, human activities have resulted in increased emissions of other more potent greenhouse gases, such as methane, nitrous oxide, and chlorofluorocarbons. CO_2 is about 100 times more abundant than the other gases combined; however, because of the recent rapid growth in emissions of these more potent greenhouse gases, the relative importance of CO_2 is somewhat reduced. CO_2 levels are thought to be increasing at a rate of about 0.4 percent per year.

Figure 4-1
Relative Contributions of Different Manmade Fossil Fuel CO_2 Sources in the U.S.



The Utility CO_2 Contribution

The primary manmade CO_2 emission sources are fossil fuel combustion, and biomass burning and decay. Combustion of fossil fuels accounts for most of the CO_2 emissions. On a per-energy-unit basis, coal burning generates the most CO_2, and natural gas burning generates the least. In the United States, the utility industry accounts for roughly 35 percent of fossil fuel derived CO_2 emissions (Figure 4-1). The United States contributes approximately 24 percent of worldwide fossil fuel-derived CO_2 emissions, the most of any country; therefore, the utility industry in the United States accounts for about 8 percent of the worldwide fossil fuel-derived CO_2 emissions. Deforestation also increases atmospheric CO_2 by removing natural sinks for CO_2 emissions.

Recent Governmental Responses

The federal government has taken a cautious "wait-and-see" stance on the global warming issue. At a recent environmental conference attended by almost all industrialized nations and many third-world countries, the U.S. government proposed to conduct additional research on the issue and monitor U.S. CO_2 emissions. Further, the 1990 Amendments to the Clean Air Act require sources to measure (or in some cases, calculate) their CO_2 emissions and report this information to the U.S. EPA beginning in 1993. In 1992, two bills, S. 2166 and H.R. 776, which would require greater use of renewable energy and improvements in the energy efficiency of buildings, electricity generation, and appliances were "merged" to create a national energy policy act. These measures will serve to reduce CO_2 emissions indirectly.

Many states have also instituted programs to examine or respond to the global warming issue. Responses mainly focus on reductions in CO_2 emissions through increased efficiency in energy use and greater reliance on renewable energy sources. Missouri and Minnesota have created global warming commissions for directing state policy. Minnesota has also instituted a program to encourage sources that burn carbon-based fuels to plant trees. California, Missouri, and New York are considering aggressive carbon emission reduction plans. In Oregon, the state's Department of Energy is required to develop strategies to reduce greenhouse gas emissions as part of its biennial energy plan. Other states, such as Connecticut, Vermont, and New Jersey, have examined the global warming issue and are focusing their responses on increased energy efficiency and greater reliance on renewable energy sources.

The Maryland PSC has established a least-cost planning group to compare potential investments in energy efficiency and energy production on an equal basis. The Center for Global Change, a nationally recognized research group located at the University of Maryland at College Park, provides up-to-date scientific information about these and other issues to the policy, science, and business communities. PPRP actively collects and reviews new information regarding CO_2 emissions and potential global warming effects, with special attention given to utility emissions.

The 1992 Earth Summit

World leaders from 160 nations met for 12 days in June 1992 in Rio de Janeiro, Brazil, at the United Nations' Conference on the Environment and Development. This Earth Summit was convened to discuss pressing global environmental issues. Discussions focused on two major areas: biodiversity, or the protection of plants, animals, and natural resources; and the control of CO_2 emissions, those emissions primarily responsible for global warming.

Regarding global warming, the Framework Convention on Global Climate Change, more informally referred to as the Global Warming Treaty, was ratified by almost all the countries, including the United States. The treaty states that the ultimate aim of the ratifying nations is to return to their 1990 emission levels of CO_2, but no timetable is mentioned for reaching such levels. The only binding language in the treaty requires each ratifying nation to issue detailed action plans for stabilizing greenhouse gas emissions. Prior to signing, the United States swayed negotiators to loosen the treaty's provisions for imposed reductions in greenhouse gas emissions. The European Community (EC), disappointed by the United States' refusal to adopt binding reduction language, approved its own resolution restating the EC countries' previous commitment to stabilize CO_2 emissions at 1990 levels by the year 2000. President Bush called for a separate meeting of industrialized countries by January 1993 to discuss the implementation of action plans crafted under the treaty.

EMF: Why Is It an Emerging Issue?

More than a century ago, when electricity was first installed in public buildings, hotel owners posted signs assuring guests that electric lights were not harmful. Today, society depends on electricity and takes its benefits for granted; however, we are no longer unequivocally certain of the safety of electricity because of the potential health and environmental effects of **electromagnetic fields (EMF)** associated with generating, transmitting, distributing, and using electric power. Although there is currently no conclusive evidence that the biological effects of power-related EMF are detrimental to human health, the issue is so controversial that some utility companies have been prevented from upgrading transmission lines and substations to meet the growing demand for electricity. Yet, despite intense public concern about the effects of EMF, consumers continue to purchase and use a burgeoning variety of electrical appliances, potentially exposing themselves to stronger and more varied electromagnetic fields than they are exposed to by utility operations.

Increasingly, scientists, regulators, and the public are asking whether exposure to EMF produced during transmission of electric power poses human health risks. Several studies have demonstrated biological effects of EMF on the function

of cells and on hormone production, growth, reproduction, and behavior in animals, but the relationship between these observations and potential human health risks remains unclear. Some studies have suggested a statistical association between human exposure to EMF and increased incidence of some forms of cancer; however, other studies have shown no significant associations. It has not been possible yet to determine if attempting to limit human EMF exposure is justifiable, nor have researchers been able to define a "safe" level of exposure. Although research results to date generally have been inconclusive and frequently contradictory, there is sufficient evidence for potential risk to warrant continued study of the human health effects of EMF.

In Maryland, the potential health effects of EMF first became an issue of public and regulatory concern in 1979 during the licensing process associated with a proposed 500-kilovolt (kV) overhead transmission line from PEPCO's Brighton substation in Montgomery County to BG&E's High Ridge substation in Howard County. As a result of the Brighton-High Ridge hearings, which continued through December 1989, the Maryland PSC concluded that the available scientific evidence for adverse human health effects associated with EMF was insufficient to justify setting standards for field levels or the width of transmission line rights-of-way. The PSC committed to review new research results as they become available and re-evaluate its position on EMF concerns in light of any conclusive information. PPRP reviews all current EMF studies and annually provides a report to the PSC summarizing significant findings.

Definition, Sources, and Characteristics of EMF

Considering power-related EMF in the larger context of all electromagnetic radiation is helpful to understand the controversy surrounding EMF. The electromagnetic fields associated with electric power are just a small portion of the total electromagnetic spectrum, which ranges from direct current to the extremely high-frequency ionizing radiation emitted by radioactive materials. Electromagnetic radiation at some frequencies (measured in cycles per second, or Hertz) is well known to have detrimental biological effects, including the microwaves used in cooking; the portion of the sun's spectrum that causes sunburn; and the ionizing radiation used to treat cancer, which can cause radiation sickness and death. Generally, detrimental biological effects are known to be produced by high-frequency electromagnetic radiation at the upper end of the electromagnetic spectrum. Electric power, however, is transmitted at very low frequencies (60 Hertz in the United States, 50 Hertz in Europe) and produces fields at the lower end of the electromagnetic spectrum. Although biological effects have been

EMF Exposure from Household Appliances

Electric and magnetic fields are produced at frequencies higher than 60 Hz by many household appliances including:

- *stereo headphones (1 kHz)**
- *televisions (20 kHz)*
- *AM (1 MHz) and FM (100 MHz) radio transmitters*
- *microwave ovens (2 GHz)*

Scientists do not know whether fields at these higher frequencies are more or less biologically active than power-frequency fields. However, many of these higher-frequency sources induce more intense currents in the body than are induced by most power-frequency sources.

There have been several epidemiological studies relating appliance use to cancer. Electric blankets have been the subject of most research. However, little or no significant statistical association has been found between electric blanket use and childhood or adult cancer. A recent survey of children's electrical appliance use identified a significant statistical correlation between leukemia and the use of hair dryers and black and white televisions. Remember that this epidemiological study does not imply that using these appliances causes leukemia, only that there is a statistical correlation between using particular appliances and incidence of the disease.

* *1 kHz = 1 thousand Hertz*
1 MHz = 1 million Hertz
1 GHz = 1 billion Hertz