Nuclear Regulatory Commission
Exhibit # - APL000048-00-BD01
Docket # - 05200016
Identified: 01/26/2012

Admitted: 01/26/2012 Withdrawn:
Rejected: Stricken:

APL000048
10/21/2011

9.1 NO ACTION ALTERNATIVE

The "No-Action" alternative refers to a scenario where a new nuclear power plant, as described in Chapter 2, is not constructed and no other generating station, either nuclear or non-nuclear, is constructed and operated.

The most significant effect of the No-Action alternative would be loss of the potential 1,600 MWe additional generating capacity that CCNPP Unit 3 would provide, which could lead to a reduced ability of existing power suppliers to maintain reserve margins and supply lower cost power to customers. Chapter 8 describes a 1.5% annual increase in electricity demand in Maryland over the next 10 years. Under the No-Action alternative, this increased need for power would need to be met by means that involve no new generating capacity.

As discussed in Chapter 8, this area of the country where CCNPP Unit 3 would be sited currently imports a large portion of its electricity, so the ability to import additional resources is limited. Demand-side management is one alternative; however, even using optimistic projections, demand-side management will not meet future demands.

Implementation of the No-Action alternative could result in the future need for other generating sources, including continued reliance on carbon-intensive fuels, such as coal and natural gas. Therefore, the predicted impacts, as well as other unidentified impacts, could occur in other areas.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

9.2 ENERGY ALTERNATIVES

This section discusses the potential environmental impacts associated with electricity generating sources other than a new nuclear unit at the CCNPP site. These alternatives include: purchasing electric power from other sources to replace power that would have been generated by a new unit at the CCNPP site, a combination of new generating capacity and conservation measures, and other generation alternatives that were deemed not to be viable replacements for a new unit at the CCNPP site.

Alternatives that do not require new generating capacity were considered, including energy conservation and Demand-Side Management (DSM). Alternatives that would require the construction of new generating capacity, such as wind, geothermal, oil, natural gas, hydropower, municipal solid wastes (MSW), coal, photovoltaic (PV) cells, solar power, wood waste/biomass, and energy crops, as well as any reasonable combination of these alternatives, were also analyzed.

The proposal to develop a nuclear power plant on land adjacent to the existing nuclear plant was primarily based on market factors such as the proximity to an already-licensed station, property ownership, transmission corridor access, and other location features conducive to the plant's intended merchant generating objective.

Alternatives that do not require new generating capacity are discussed in Section 9.2.1, while alternatives that do require new generating capacity are discussed in Section 9.2.2. Some of the alternatives discussed in Section 9.2.2 were eliminated from further consideration based on their availability in the region, overall feasibility, and environmental consequences. Section 9.2.3, describes the remaining alternatives in further detail relative to specific criteria such as environmental impacts, reliability, and economic costs.

9.2.1 Alternatives Not Requiring New Generating Capacity

The Federal Energy Regulatory Commission (Commission) issued a Final Rule, in 1996, requiring all public utilities that own, control or operate facilities used for transmitting electric energy in interstate commerce to have on file open access non-discriminatory transmission tariffs that contain minimum terms and conditions of nondiscriminatory service. The Final Rule also permitted public utilities and transmitting utilities to seek recovery of legitimate, prudent and verifiable stranded costs associated with providing open access and Federal Power Act section 211 transmission services. The Commission's goal was to remove impediments to competition in the wholesale bulk power marketplace and to bring more efficient, lower cost power to the Nation's electricity consumers (FERC, 1996).

This section describes the assessment of the economic and technical feasibility of supplying the demand for energy without constructing new generating capacity. Specific alternatives include:

- Initiating conservation measures (including implementing DSM actions)
- Reactivating or extending the service life of existing plants within the power system
- Purchasing power from other utilities or power generators
- A combination of these elements that would be equivalent to the output of the project and therefore eliminate its need.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

9.2.1.1 Initiating Conservation Measures

Under the Energy Policy Act of 2005 (PL, 2005) a rebate program was established for homeowners and small business owners who install energy-efficient systems in their buildings. The rebate was set at $3,000, or 25% of the expenses, whichever was less. The Act authorized $150 million in rebates for 2006 and up to $250 million in 2010. This new legislation was enacted in the hope that homeowners and small business owners would become more aware of energy-efficient technologies, lessening energy usage in the future.

Historically, state regulatory bodies have required regulated utilities to institute programs designed to reduce demand for electricity. DSM has shown great potential in reducing peak-load consumption (maximum power requirement of a system at a given time). In 2005, peak-load consumption was reduced by approximately 25,710 MWe, an increase of 9.3% from the previous year (EIA, 2006a). However, DSM costs increased by 23.4% (EIA, 2006b).

The following DSM programs can be used to directly reduce summer or winter peak loads when needed:

- Large load curtailment - This program provides a source of load that may be curtailed at the Company’s request in order to meet system load requirements. Customers who participate in this program receive a credit on their bill.

- Voltage control - This procedure involves reducing distribution voltage by up to 5% during periods of capacity constraints. This level of reduction does not adversely affect customer equipment or operations.

9.2.1.1.1 Conservation Programs

In 1991, the Maryland General Assembly enacted an energy conservation measure that is codified as Section 7-211 of the Public Utility Companies (PUC) Article (MGA, 1991). This provision requires each gas and electric company to develop and implement programs to encourage energy conservation. In response to this mandate and continuing with preexisting initiatives under its existing authority, the Maryland Public Service Commission (PSC) directed each affected utility to develop a comprehensive conservation plan. The PSC further directed each utility to engage in a collaborative effort with staff, the Office of People's Counsel (OPC), and other interested parties to develop its conservation plan. The result of these actions was that each utility implemented conservation and energy efficiency programs. (MDPSC, 2007a)

The PSC requires Maryland electric utilities to implement DSM as a means to conserve energy and to take DSM energy savings into account in long-range planning. Baltimore Gas and Electric Company, the regulated electric distribution affiliate of Constellation Generation Group, has an extensive program of residential, commercial, and industrial programs designed to reduce both peak demands and daily energy consumption (i.e., DSM). Program components include the following:

- Peak clipping programs - Include energy saver switches for air conditioners, heat pumps, and water heaters, allowing interruption of electrical service to reduce load during periods of peak demand; dispersed generation, giving dispatch control over customer backup generation resources; and curtailable service, allowing customers’ load to be reduced during periods of peak demand.

- Load shifting programs - Use time-of-use rates and cool storage rebate programs to encourage shifting loads from peak to off-peak periods.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

- Conservation programs - Promoting use of high-efficiency heating, ventilating, and air conditioning; encouraging construction of energy-efficient homes and commercial buildings; improving energy efficiency in existing homes; providing incentives for use of energy-efficient lighting, motors, and compressors.

It is estimated that the Baltimore Gas and Electric DSM program results in an annual peak demand generation reduction of about 700 MWe, and believed that generation savings can continue to be increased from DSM practices. The load growth projection anticipates a DSM savings of about 1,000 MWe in 2016. These DSM savings are an important part of the plan for meeting projected regional demand growth in the near-tem (BGE, 1998).

However, since the most viable and cost-effective DSM options are pursued first, it is not likely that demand reductions of similar size will be available or practical in the future. Consequently, DSM is not seen as a viable "offset" for the additional baseload generation capacity that will be provided by CCNPP Unit 3, and UniStar Nuclear Operating Services does not foresee the availability of another 1,600 MWe (equivalent to the CCNPP Unit 3 capacity) of viable and cost-effective DSM to meet projected load demand and baseload power needs. Therefore, it is concluded that DSM is not a feasible alternative for the CCNPP Unit 3 facility.

9.2.1.2 Reactivating or Extending Service Life of Existing Plants

Maryland's dependence on out-of-state electricity supplies will likely increase over the next several years. On the supply side, few new in-state electric generating facilities are scheduled to be built during the next 5 years. Additionally, some fossil-fired generating capacity may be de-rated or retired in order to comply with both federal and state air emission requirements, including the sulfur dioxide and mercury provisions of Maryland's Healthy Air Act (HAA). On the demand side, Maryland's electric utilities and PJM Interconnection, LLC (PJM), the regional electricity grid operator, forecast that electricity demand will continue to rise, albeit at a modest pace of between 1% and 2% per year, further increasing Maryland's need for additional electricity supplies (MDPSC, 2007a).

There has been very little change to the amount and the mix of electrical power generation in Maryland this decade. No significant generation has been added in the past 3 years, and no units have been retired since the Gould Street plant (101 MWe) ceased operations in November 2003 (MDPSC, 2007a).

It is possible that some older units that cannot meet stricter environmental standards at the federal or state level may eventually be retired. Certificate of Public Convenience and Necessity (CPCN) filings have been made to the State of Maryland by six Maryland coal-fired facilities for various environmental upgrades for compliance with the HAA. However, some of these units and other older Maryland coal units may have to be retired if the emissions restrictions (including those for carbon dioxide that may be mandated by the Regional Greenhouse Gas Initiative) make these plants uneconomic to operate in the future (MDPSC, 2007a).

Scheduled retirement of older generating units will also occur elsewhere in PJM. In New Jersey, four older facilities are scheduled to retire in the next 2 years: 285 MWe at Martins Creek (September 2007), 447 MWe at B.L. England (December 2007), 453 MWe at Sewaren (September 2008), and 383 MWe at Hudson (September 2008) (MDPSC, 2007a).

Retired fossil fuel plants and fossil fuel plants slated for retirement tend to be those old enough to have difficulty economically meeting today's restrictions on air contaminant

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

emissions. In the face of increasingly stringent environmental restrictions, delaying retirement or reactivating plants in order to forestall closure of a large baseload generation facility would require extensive construction to upgrade or replace plant components. Upgrading existing plants would be costly and at the same time would neither increase the amount of available generation capacity, nor alleviate the growing regional need for additional baseload generation capacity. A new baseload facility would allow for the generation of needed power and would meet future power needs within the region of interest (ROI), which is Maryland. This ROI is further evaluated in Section 9.3. Therefore, extending the service life of existing plants or reactivating old plants may not be feasible.

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

The uncertainty of Maryland's supply adequacy begins with Maryland's status as one of the largest electric energy importing states in the country. Maryland currently imports more than 25% of its electric energy needs. On an absolute basis, Maryland is the fifth-largest electric energy importer in the U.S. Neighboring states Virginia and New Jersey are in a comparable situation, being respectively the third and fourth largest energy importers in the country, and Delaware and the District of Columbia are also large electricity importers.

Consequently, not only is Maryland a large importer of electricity, but so are states to the south, east and north of it. This makes much of the mid-Atlantic region deficient in generating capacity, or what is referred to in the industry as a "load sink." Of the states in the surrounding area, Maryland can only import electricity in appreciable amounts from West Virginia and Pennsylvania, and is competing with Delaware, Virginia, New Jersey, and the District of Columbia for the available exports from those states (MDPSC, 2007a).

Maryland has been relying on the bulk electric transmission grid to make up the difference between economically dispatched in-state supply and demand. However, Maryland's ability to import additional electricity over that grid, particularly during times of peak demand, is limited at best. The current transmission facilities that allow the importation of electricity into the State already operate at peak capacity during peak load periods. In other words, even though generators in Pennsylvania, West Virginia, and states farther west may have excess power to sell to Maryland, the transmission network is unable to deliver that power during times of peak demand (MDPSC, 2007a).

Imported power from Canada or Mexico is also unlikely to be available to supply the equivalent capacity of the proposed facility. In Canada, 62% of the country's electricity capacity is derived from renewable sources, principally hydropower. Canada has plans to continue developing hydroelectric power, but the plans generally do not include large-scale projects. Canada's nuclear power generation is projected to decrease by 1.7% by 2020, and its share of power generation in Canada is projected to decrease from 14% currently to 13% by 2020 (EIA, 2001b).

The Department of Energy projects that total gross U.S. imports of electricity from Canada and Mexico will gradually increase from 47.4 billion kWh in 2000 up until year 2005, and then gradually decrease to 47.4 billion kWh in 2020 (EIA, 2001b). Therefore, imported power from Canada or Mexico is not a viable option to alleviate the growing regional need for power, or the need for additional baseload generation capacity to meet projected power demands.

In conclusion, because there is not enough electricity to import from nearby states or Canada and Mexico, purchasing power from other utilities or power generators is not considered feasible.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

9.2.2 Alternatives That Require New Generating Capacity

Although many methods are available for generating electricity and many combinations or mixes can be assimilated to meet system needs, such expansive consideration would be too unwieldy to reasonably examine in depth, given the purposes of this alternatives analysis. The alternative energy sources considered are listed below.

- Wind
- Geothermal
- Hydropower
- Solar Power
  - Concentrating Solar Power Systems
  - Photovoltaic (PV) Cells
- Wood Waste
- Municipal Solid Waste
- Energy Crops
- Petroleum liquids (Oil)
- Fuel Cells
- Coal
- Natural Gas
- Integrated Gasification Combined Cycle (IGCC)

Based on the installed capacity of 1,600 MWe that CCNPP Unit 3 will produce, not all of the above-listed alternative sources are competitive or viable. Each of the alternatives is discussed in more detail in later sections, with an emphasis on coal, solar, natural gas, and wind energy. As a renewable resource, solar and wind energies, alone or in combination with one another, have gained increasing popularity over the years, in part due to concern over greenhouse gas emissions. Air emissions from solar and wind facilities are much smaller than fossil fuel air emissions. Although the use of coal and natural gas has undergone a slight decrease in popularity, it is still one of the most widely used fuels for producing electricity.

The current mix of power generation options in Maryland is one indicator of the feasible choices for electric generation technology within the state. Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services evaluated Maryland's electric power generating capacity and utilization characteristics. "Capacity" is the categorization of the various installed technology choices in terms of their potential output. "Utilization" is the degree to which each choice is actually used.

Combined heat and power systems that are geographically dispersed and located near customers were identified as a potential option for producing heat and electrical power.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

However, distributed energy generation was not seen as a competitive or viable alternative and was not given detailed consideration.

In 2005, electricity imports amounted to 27.5% of all the electricity consumed in Maryland, about 10% more than the imported 17.7% of the electricity consumed in 1999. Consumption increased 15.7% from 1999 to 2005, while generation only increased by 1.9% during the same period. In effect, nearly all the electricity load growth in Maryland between 1999 and 2005 was met by importing electricity from other states within the region. This growing dependence on imported power means that Maryland has an enormous stake in the reliability of the regional transmission grid and the existence of a robust wholesale power market. (MDPSC, 2007a)

As required by Section 7-505(e) of the PUC Article, the Electric Supply Adequacy Report of 2007 included an assessment of the regional need for power. This review of the need for power in this region takes into account conservation, load management, and other demand-side options along with new utility-owned generating plants, non-utility generation, and other supply-side options in order to identify the resource plan that will be most cost-effective for the ratepayers consistent with the provision of adequate, reliable service (MDPSC, 2007a).

- The need for power assessment contains the following information:
- A description of the power system in Maryland
- An assessment of power demand and predictions
- An evaluation of present and planned capacity (including other utility company providers
- A concluding assessment of the need for power

In 2006, the Department of Energy released a transmission congestion study that shows that the region from New York City to northern Virginia (which includes Maryland) is one of the two areas of the country most in need of new bulk power transmission lines (MDPSC, 2007a).

This section includes descriptions of power generating alternatives that Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services have concluded are not reasonable and the basis for this conclusion. This COL application is premised on the installation of a facility that would primarily serve as a large base-load generator and that any feasible alternative would also need to be able to generate baseload power. In performing this evaluation, Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services have relied heavily upon the NRC Generic Environmental Impact Statement (GEIS) (NRC, 1996).

The GEIS is useful for the analysis of alternative sources because NRC has determined that the technologies of these alternatives will enable the agency to consider the relative environmental consequences of an action given the environmental consequences of other activities that also meet the purpose of the proposed action. To generate the set of reasonable alternatives that are considered in the GEIS, common generation technologies were included and various state energy plans were consulted to identify the alternative generation sources typically being considered by state authorities across the country.

From this review, a reasonable set of alternatives to be examined was identified. These alternatives included wind energy, PV cells, solar thermal energy, hydroelectricity, geothermal energy, incineration of wood waste and municipal solid waste, energy crops, coal, natural gas,

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

oil, and delayed retirement of existing non-nuclear plants. These alternatives were considered pursuant to the statutory responsibilities imposed under the National Environmental Policy Act of 1969 (NEPA) (NEPA, 1982).

Although the GEIS is provided for license renewal, the alternatives analysis in the GEIS can be compared to the proposed action to determine if the alternative represents a reasonable alternative to the proposed action.

Each of the alternatives is discussed in the subsequent sections relative to the following criteria:

- ♦ The alternative energy conversion technology is developed, proven, and available in the relevant region within the life of the COL.
- ♦ The alternative energy source provides baseload generating capacity equivalent to the capacity needed and to the same level as the proposed nuclear plant.
- ♦ The alternative energy source does not create more environmental impacts than a nuclear plant would, and the costs of an alternative energy source do not make it economically impractical.

Each of the potential alternative technologies considered in this analysis are consistent with national policy goals for energy use and are not prohibited by federal, state, or local regulations. Based on one or more of these criteria described above, several of the alternative energy sources were considered technically or economically infeasible after a preliminary review and were not considered further. Alternatives considered to be technically and economically feasible are described in greater detail in Section 9.2.3.

9.2.2.1 Wind

In general, areas identified by the National Renewable Energy Laboratory (NREL) as wind resource Class 4 and above are regarded as potentially economical for wind energy production with current technology. Class 4 wind resources are defined as having mean wind speeds between 15.7 and 16.8 mph (25.3 to 27.0 kph) at 50 m elevation.

As a result of advances in technology and the current level of financial incentive support, a number of additional areas with a slightly lower wind resource (Class 3+) may also be suitable for wind development. These would, however, operate at a lower annual capacity factor and output than used by National Renewable Energy Laboratory (NREL) for Class 4 sites. Class 3 wind resources are defined as having mean wind speeds between 14.3 and 15.7 mph (23.0 to 25.3 kph) at 50 m (164 ft) elevation, with Class 3+ wind resources occupying the high end of this range.

Wind Powering America indicates that Maryland has wind resources consistent with utility-scale production. Several areas are estimated to have good-to-excellent wind resources. These are the barrier islands along the Atlantic coast, the southeastern shore of Chesapeake Bay, and ridge crests in the western part of the state, west of Cumberland. In addition, small wind turbines may have applications in some areas (EERE, 2006a).

Wind resource maps show that much of Maryland has a Class 1 or 2 wind resource, with mean wind speeds of 0.0 to 14.3 mph (0.0 to 23.0 kph) at 50 m (164 ft) elevation. The reason for the moderate wind speeds overall, despite strong winds aloft much of the year, is the high surface roughness of the forested land. The wind resource in central Maryland is moderate, but it

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

improves near the coast because of the influence of the Atlantic Ocean and Chesapeake Bay. Offshore, especially on the Atlantic side, the wind resource is predicted to reach 16.8 to 19.7 mph (27.0 to 31.7 kph) at 50 m (164 ft), or NREL Class 4-5 (EERE, 2003).

For any wind facility, the amount of land needed for operation could be significant. Wind turbines must be sufficiently spaced to maximize capture of the available wind energy. If the turbines are too close together, they can lose efficiency. A 2 MWe turbine requires approximately 10,890 ft^2 (1000 m^2) of dedicated land for the actual placement of the wind turbine, allowing landowners to use the remaining acreage for some other purpose that does not affect the turbine, such as agricultural use.

For illustrative purposes, if all of the resources in Class 3+ and 4 sites were developed using 2 MWe turbines, with each turbine occupying 10,890 ft^2 (1,000 m^2) (i.e., 100 ft (30.5 m) spacing between turbines), 9,000 MWe of installed capacity would utilize 1.8 mi^2 (4.6 km^2) just for the placement of the wind turbines alone. Based upon the NERC capacity factor, it would create an average output of 1,530 MWe requiring approximately 31,800 ft^2 (2,954 m^2) per MWe. This is a conservative assumption because Class 3+ sites will have a lower percentage of average annual output.

If a Cla ss 3+ site were available and developed using 2 MWe turbines within the ROI, 9,400 MWe of installed capacity would be needed to produce the equivalent 1,600 MWe of baseload output. This would encompass a footprint area of approximately 1.9 mi^2 (4.9 km^2), which is more than half the size of the entire CCNPP site (Units 1 and 2 and proposed Unit 3). The CCNPP site is a Class 1 site; therefore, it would not be feasible to construct a wind power facility at the CCNPP site (EERE, 2003).

Technological improvements in wind turbines have helped reduce capital and operating costs. In 2000, wind power was produced in a range of $0.03 to $0.06 per kWh (depending on wind speeds), but by 2020 wind power generating costs are projected to fall to $0.03 to $0.04 per kWh.

The installed capital cost of a wind farm includes planning, equipment purchase, and construction of the facilities. This cost, typically measured in $/kWe at peak capacity, has decreased from more than $2,500 per kWe in the early 1980s to less than $1,000 per kWe for wind farms in the U.S, but "economies of scale" may not be available in the ROI, given the availability of the resource.

The EIA's "Annual Energy Outlook 2004" provides some unique insights into the viability of the wind resource (EIA, 2004a):

- In addition to the construction, operating, and maintenance costs for wind farms, there are costs for connection to the transmission grid. Any wind project would have to be located where the project would produce economical generation, but that location may be far removed from the nearest connection to the transmission system. A location far removed from the power transmission grid might not be economical, because new transmission lines would be required to connect the wind farm to the distribution system.

  Existing transmission infrastructure may need to be upgraded to handle the additional supply. Soil conditions and the terrain must be suitable for the construction of the towers' foundations. Finally, the choice of a location may be limited by land use regulations and the ability to obtain the required permits from local, regional, and

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

national authorities. The farther a wind energy development project is from transmission lines, the higher the cost of connection to the transmission and distribution system.

- ♦ The distance from transmission lines at which a wind developer can profitably build depends on the cost of the specific project. For example, the cost of construction and interconnection for a 115 kV transmission line that would connect a 50 MWe wind farm with an existing transmission and distribution network. The EIA estimated, in 1995, the cost of building a 115 kV line to be $130,000 per mile, excluding right-of-way costs (EIA, 2003b).

  This amount includes the cost of the transmission line itself and the supporting towers. It also assumes relatively ideal terrain conditions, including fairly level and flat land with no major obstacles or mountains (more difficult terrain would raise the cost of erecting the transmission line). In 1993, the cost of constructing a new substation for a 115 kV transmission line was estimated at $1.08 million, and the cost of connection for a 115 kV transmission line with a substation was estimated to be $360,000 (EIA, 1995).

- ♦ In 1999, the DOE analyzed the total cost of installing a wind facility in various North American Electric Reliability Corporation (NERC) regions. The agency first looked at the distribution of wind resources and excluded land from development based on the classification of land. For example, land that was considered wetlands and urban were totally excluded, whereas land that was forested had 50% of its land excluded. Next, resources that were sufficiently close to existing 115 kV to 230 kV transmission lines were classified into three distinct zones and an associated standard transmission fee for connecting the new plant with the existing network was applied. DOE then used additional cost factors to account for the greater distances between wind sites and the existing transmission networks. Capital costs were added based on whether the wind resource was technically accessible at the time and whether it could be economically accessible by 2020 (EIA, 1999).

- ♦ Another consideration on the integration of the wind capacity into the electric utility system is the variability of wind energy generation. Wind-driven electricity generating facilities must be located at sites with specific characteristics to maximize the amount of wind energy captured and electricity generated. In addition, for transmission purposes, wind generation is not considered ″dispatchable,″ meaning that the generator can control output to match load and economic requirements. Since the resource is intermittent, wind, by itself, is not considered a firm source of baseload capacity. The inability of wind alone to be a dispatchable, baseload producer of electricity is inconsistent with the objectives for the CCNPP site.

Finally, wind facilities pose environmental impacts, in addition to the land requirements posed by large facilities, as follows:

- ♦ Large-scale commercial wind farms can be an aesthetic problem, obstructing viewsheds and initiating conflict with local residents.

- ♦ High-speed wind turbine blades can be noisy, although technological advancements continue to lessen this problem.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

- Wind facilities sited in areas of high bird use can expect to have avian fatality rates higher than those expected if the wind facility were not there.

Recently, the Center for Biological Diversity (CBD) has voiced mixed reviews regarding wind farms along migratory bird routes. The CBD supports wind energy as an alternative energy source and as a way to reduce environmental degradation. However, wind power facilities, such as the Altamont Pass Wind Resource Area (APWRA) in California, are causing mortality rates in raptor populations to increase as a result of turbine collisions and electrocution on power lines. The APWRA kills an estimated 881 to 1,300 birds of prey each year. Birds that have been affected to the greatest extent include golden eagles, red-tailed hawks, burrowing owls, great horned owls, American kestrels, ferruginous hawks, and barn owls (CBD, 2007).

Maryland's Renewable Energy Portfolio Standard, enacted in May 2004, and revised in 2007, requires electricity suppliers (all utilities and competitive retail suppliers) to use renewable energy sources to generate a minimum portion of their retail sales. Beginning in 2006, electricity suppliers are required to provide 1% of retail electricity sales in the State from Tier 1 renewable resources, such as wind. The requirement to produce electricity from Tier 1 renewable resources increases to 9.5% by 2022. (MDPSC, 2007b)

Wind energy will not always be dependable due to variable wind conditions, and there is no proven storage method for wind-generated electricity. Consequently, in order to use wind energy as a source of baseload generation it would be necessary to also have an idle backup generation source to ensure a steady, available power supply. With the inability of wind power to generate baseload power due to low capacity factors and limited dispatchability, the projected land use impacts of development of Class 3+ and Class 4 sites, the cost factors in construction and operation, along with the impacts associated with development, and cost of additional transmission facilities to connect turbines to the transmission system, a wind power generating facility by itself is not a feasible alternative to the new plant. Off-shore wind farms are not competitive or viable with a new nuclear reactor at the CCNPP site, and were therefore not considered in more detail.

Many renewable resources, such as wind, are intermittent (i.e., they are not available all of the time). The ability to store energy from renewable energy sources would allow supply to more closely match demand. For example, a storage system attached to a wind turbine could store captured energy around the clock, whenever the wind is blowing, and then dispatch that energy into higher demand times of the day (NREL, 2006). However, these technologies are not competitive or viable at this time.

9.2.2.2 Geothermal

As illustrated by Figure 8.4 in the GEIS (NRC, 1996), geothermal plants might be located in the western continental U.S., Alaska, and Hawaii, where hydrothermal reservoirs are prevalent.

Maryland is not a candidate for large scale geothermal energy and could not produce the proposed 1,600 MWe of baseload power. Therefore, geothermal energy is non competitive with a new nuclear unit at the CCNPP site.

9.2.2.3 Hydropower

The GEIS (NRC, 1996) estimates land use of 1,600 mi^2 (4,144 km^2) per 1,000 MWe generated by hydropower. Based on this estimate, hydropower would require flooding more than 2,600 mi^2 (6,734 km^2) to produce a baseload capacity of 1,600 MWe, resulting in a large impact on land use.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

According to a study performed by the Idaho National Engineering and Environmental Laboratory (INEEL), Maryland has 36 possible hydropower sites: 1 developed and with a power-generating capacity of 20 MWe, 32 developed and without power and a possible generating capacity of 10 MWe, and 3 undeveloped sites with a possible 0.10 MWe of generating capacity. Only one site had the potential generating capacity of 20 MWe or more (INEEL, 1998). Therefore, hydropower is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.4 Solar Power

Solar energy depends on the availability and strength of sunlight (strength is measured as kWh/m^2), and solar power is considered an intermittent source of energy. Solar facilities would have equivalent or greater environmental impacts than a new nuclear facility at the CCNPP site. Such facilities would also have higher costs than a new nuclear facility.

The construction of solar power-generating facilities has substantial impacts on natural resources (such as wildlife habitat, land use, and aesthetics). In order to look at the availability of solar resources in Maryland, two collector types must be considered: concentrating collectors and flat-plate collectors. Concentrating collectors are mounted to a tracker, which allows them to face the sun at all times of the day. In Maryland, approximately 3,500 to 4,000 $W\text{-}hr/m^2/day$ can be collected using concentrating collectors. Flat-plate collectors are usually fixed in a tilted position to best capture direct rays from the sun and also to collect reflected light from clouds or the ground. In Maryland, approximately 4,500 to 5,000 $W\text{-}hr/m^2/day$ can be collected using flat-plate collectors. (EERE, 2006a). The footprint needed to produce a 1,600 MWe baseload capacity is much too large to construct at the proposed plant site.

9.2.2.4.1 Concentrating Solar Power Systems

Concentrating solar plants produce electric power by converting solar energy into high temperature heat using various mirror configurations. The heat is then channeled through a conventional generator, via an intermediate medium (i.e., water or salt). Concentrating solar plants consist of two parts: one that collects the solar energy and converts it to heat, and another that converts heat energy to electricity.

Concentrating solar power systems can be sized for ″village″ power (10 kWe) or grid-connected applications (up to 100 MWe). Some systems use thermal energy storage (TES), setting aside heat transfer fluid in its hot phase during cloudy periods or at night. These attributes, along with solar-to-electric conversion efficiencies, make concentrating solar power an attractive renewable energy option in the southwest part of the U.S. and other Sunbelt regions worldwide (EERE, 2006b). Others can be combined with natural gas. This type of combination is discussed in Section 9.2.3.3.

There are three kinds of concentrating solar power systems—troughs, dish/engines, and power towers – classified by how they collect solar energy (EERE, 2006b).

Concentrating solar power technologies utilize many of the same technologies and equipment used by conventional power plants, simply substituting the concentrated power of the sun for the combustion of fossil fuels to provide the energy for conversion into electricity. This ″evolutionary″ aspect – as distinguished from ″revolutionary″ or ″disruptive″ – allows for easy integration into the transmission grid. It also makes concentrating solar power technologies the most cost-effective solar option for the production of large-scale electricity generation (10 MWe and above).

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

While concentrating solar power technologies currently offer the lowest-cost solar electricity for large-scale electricity generation, these technologies are still in the demonstration phase of development and cannot be considered competitive with fossil or nuclear-based technologies (CEC, 2003). Current concentrating solar collection technologies cost $0.09 to $0.12 per kWh. In contrast, nuclear plants are anticipated to produce power in the range of $0.031 to $0.046 per kWh (DOE, 2002). In addition, concentrating solar power plants only perform efficiently in high-intensity sunlight locations, specifically the arid and semi-arid regions of the world (NREL, 1999). This does not include Maryland.

9.2.2.4.2 "Flat Plate" Photovoltaic Cells

The second common method for capturing the sun's energy is through the use of PV cells. A typical PV or solar cell might be a square that measures about 10 cm (4 in) on a side. A cell can produce about 1 watt of power—more than enough to power a watch, but not enough to run a radio.

When more power is needed, some 40 PV cells can be connected to form a "module." A typical module is powerful enough to light a small light bulb. For larger power needs, about 10 such modules are mounted in PV arrays, which can measure up to several meters on a side. The amount of electricity generated by an array increases as more modules are added.

"Flat-plate" PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture more sunlight over the course of a day. Ten to 20 PV arrays can provide enough power for a household; for large electric utility or industrial applications, hundreds of arrays can be interconnected to form a single, large PV system (NREL, 2007). The land requirement for this technology is approximately 14 hectares (35 acres) per MWe (NRC, 1996). In order to produce the 1,600 MWe baseload capacity as CCNPP Unit 3, 22,660 hectares (55,993 acres) would be required for construction of the photovoltaic modules.

Some PV cells are designed to operate with concentrated sunlight, and a lens is used to focus the sunlight onto the cells. This approach has both advantages and disadvantages compared with flat-plate PV arrays. Economics of this design turn on the use of as little of the expensive semi-conducting PV material as possible, while collecting as much sunlight as possible. The lenses cannot use diffuse sunlight, but must be pointed directly at the sun and moved to provide optimum efficiency. Therefore, the use of concentrating collectors is limited to the west and southwest areas of the U.S.

Available PV cell conversion efficiencies are in the range of approximately 15% (SS, 2004). In Maryland, solar energy can produce an annual average of 4.5 to 5.0 kWh/m^2/day and even slightly higher in the summer. This value is highly dependent on the time of year, weather conditions, and obstacles that may block the sun (NREL, 2004).

Currently, PV solar power is not competitive with other methods of producing electricity for the open wholesale electricity market. When calculating the cost of solar systems, the totality of the system must be examined. There is the price per watt of the solar cell, price per watt of the module (whole panel), and the price per watt of the entire system. It is important to remember that all systems are unique in their quality and size, making it difficult to make broad generalizations about price. The average price for modules (dollars per peak watt) increased 9%, from $3.42 in 2001 to $3.74 in 2002. For cells, the average price decreased 14%, from $2.46 in 2001 to $2.12 in 2002. (EIA, 2003a) The module price, however, does not include the design costs, land, support structure, batteries, an inverter, wiring, and lights/appliances.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

With all of these included, a full system can cost anywhere from $7 to $20 per watt. (Fitzgerald, 2007) Costs of PV cells in the future may be expected to decrease with improvements in technology and increased production. Optimistic estimates are that costs of grid-connected PV systems could drop to $2,275 per kWe and to $0.15 to $0.20 per kWh by 2020 (ELPC, 2001). These costs would still be substantially in excess of the costs of power from a new nuclear plant. Therefore, PV cells are non-competitive with a new nuclear plant at the CCNPP site.

Environmental impacts of solar power systems can vary based on the technology used and the site specific conditions.

- Land use and aesthetics are the primary environmental impacts of solar power.
- Land requirements for each of the individual solar energy technologies are large, compared to the land used by a new nuclear plant. The land required for the solar power generating technologies ranges from 56,660 to 141,640 ft^2 (60,000 to 140,000 m^2) per MWe compared to 10,000 ft^2 (1,000 m^2) per MWe for nuclear technology.
- Depending on the solar technology used, there may be thermal discharge impacts. These impacts are anticipated to be small. During operation, PV and solar thermal technologies produce no air pollution, little or no noise, and require no transportable fuels.
- PV technology creates environmental impacts related to manufacture and disposal. The process to manufacture PV cells is similar to the production of a semiconductor chip. Chemicals used in the manufacture of PV cells include cadmium and lead. Potential human health risks also arise from the manufacture and deployment of PV systems because there is a risk of exposure to heavy metals such as selenium and cadmium during use and disposal (CEC, 2004). There is some concern that landfills could leach cadmium, mercury, and lead into the environment in the long term.

  Generally, PV cells are sealed and the risk of release is considered slight; however, the long-term impact of these chemicals in the environment is unknown. Another environmental consideration with solar technologies is the lead-acid batteries that are used with some systems. The impact of these lead batteries is lessening; however, as batteries become more recyclable, batteries of improved quality are produced and better quality solar systems that enhance battery lifetimes are created (REW, 2001).

Concentrating solar power systems could provide a viable energy source for small power generating facilities, with costs as low as $0.09 to $0.12 per kWh. However, concentrating solar power systems are still in the demonstration phase of development and are not cost competitive with nuclear-based technologies. PV cell technologies are increasing in popularity as costs slowly decrease. However, the cost per kWh is substantially in excess of the cost of power from a new nuclear plant. Additionally, for all of the solar power options, because the output of solar-based generation is dependent on the availability of light, it would require a supplemental energy source to meet the CCNPP Unit 3 baseload capacity. The large estimate of land required for a solar facility is another limitiation.

Therefore, based on the lack of information and experience regarding large scale systems able to produce the 1,600 MWe baseload capacity, concentrating solar power systems are non-competitive with a new nuclear plant at the CCNPP site.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

9.2.2.5 Wood Waste and Other Biomass

The use of wood waste and other biomass to generate electricity is largely limited to states with significant wood resources, such as California, Maine, Georgia, Minnesota, Oregon, Washington, and Michigan. Electric power is generated in these states by the pulp, paper, and paperboard industries, which consume wood and wood waste for energy, benefiting from the use of waste materials that could otherwise represent a disposal problem. However, the largest wood waste power plants are 40 to 50 MWe in size. This would not meet the proposed 1,600 MWe baseload capacity.

Nearly all of the wood-energy-using electricity generation facilities in the U.S. use steam turbine conversion technology. The technology is relatively simple to operate and it can accept a wide variety of biomass fuels. However, at the scale appropriate for biomass, the technology is expensive and inefficient. Therefore, the technology is relegated to applications where there is a readily available supply of low, zero, or negative cost delivered feedstock.

Construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, wood-waste plants require large areas for fuel storage, processing, and waste (i.e., ash) disposal. Additionally, the operation of wood-fired plants creates environmental impacts, including impacts on the aquatic environment and air (NRC, 1996).

According to a technical report (NREL, 2005), the availability of biomass resources in Maryland are as follows in thousand metric tons/year (thousand tons/year): Crop Residues 530 (584), switchgrass on CRP lands 246 (271), forest residues 239 (263), methane from landfills 185 (204), methane from manure management 5.4 (6), primary mill 125 (138), secondary mill 30 (33), urban wood 566 (624), and methane from domestic wastewater 8.2 (9). This totals approximately 1,933 thousand metric tons/year (2,131 thousand tons/year)) total biomass availability in the State of Maryland (NREL, 2005).

Biomass fuel can be used to co-fire with a coal-fueled power plant, decreasing cost from $0.023/ to $0.021 per kWh. This is only cost effective if biomass fuels are obtained at prices equal to or less than coal prices. In today's direct-fired biomass power plants, generation costs are about $0.09 per kWh (EERE, 2007), which is significantly higher than the costs associated with a nuclear power plant ($0.031 to $0.046 per kWh) (DOE, 2002). Because of the environmental impacts and costs of a biomass-fired plant, biomass is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.6 Municipal Solid Waste

The initial capital costs for municipal solid waste (MSW) plants are greater than for comparable steam turbine technology at wood-waste facilities (NRC, 1996). This is because of the need for specialized waste separation and handling equipment.

The decision to burn MSW to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of the numerous obstacles and factors that may limit the growth in MSW power generation. Chief among them are environmental regulations and public opposition to siting MSW facilities.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

Estimates suggest that the overall level of construction impacts from a waste-fired plant should be approximately the same as those for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal) (NRC, 1996). Some of these impacts would be moderate, but still larger than the proposed action.

In 2003, 12,337,018 metric tons (13,599,235 tons) of solid waste was managed or disposed of in Maryland, with 1,310,270 metric tons (1,444,325 tons) of that amount being incinerated (MDE, 2004). As an MSW reduction method, incineration can be implemented, generating energy and reducing the amount of waste by up to 90% in volume and 75% in weight (USEPA, 2006b).

The U.S. has about 89 operational MSW-fired power generation plants, generating approximately 2,500 MWe, or about 0.3% of total national power generation. However, economic factors have limited new construction. This comes to approximately 28 MWe per MSW-fired power generation plant, and would not meet the proposed 1,600 MWe baseload capacity. Burning MSW produces nitrogen oxides and sulfur dioxide as well as trace amounts of toxic pollutants, such as mercury compounds and dioxins. MSW power plants, much like fossil fuel power plants, require land for equipment and fuel storage. The non-hazardous ash residue from the burning of MSW is typically deposited in landfills (USEPA, 2006a).

The cost of power for MSW-fired power generation plants would be partially offset by savings in waste disposal fees. However, MSW-fired power generation remains significantly more costly than nuclear power, even when disposal fee savings are included into the cost of power. A study performed for a proposed MSW-fired power facility in 2002 found that cost of power varied from $0.096 to $0.119¢ per kWh in the case with low MSW disposal fees, and from $0.037 to $0.055 per KWh in the case with high MSW disposal fees (APT, 2004). These costs, accounting for the disposal fees, are significantly higher than the costs associated with a nuclear power plant ($0.031 to $0.046 per kWh) (DOE, 2002). Therefore, MSW is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.7 Energy Crops

In addition to wood and MSW fuels, there are several other concepts for fueling electric generators, including burning energy crops, converting crops to a liquid fuel such as ethanol (ethanol is primarily used as a gasoline additive), and gasifying energy crops (including wood waste). None of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant capacity of 1,600 MWe.

Estimates suggest that the overall level of construction impacts from a crop-fired plant should be approximately the same as those for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air) (NRC, 1996). In addition, these systems have large impacts on land use because of the acreage needed to grow the energy crops.

Ethanol is perhaps the best known energy crop. It is estimated that 3.0 mi^2 (7.69 km^2) of corn are needed to produce 1 million gallons of ethanol, and in 2005 Maryland produced approximately 727 mi^2 (1,882 km^2) of corn. Currently in Maryland, more corn is used for grain products than any other purpose. If ethanol were to be proposed as an energy crop, Maryland would have to supplement its corn production from nearby states. (USDA, 2006) Surrounding states also use corn for grain products and do not have the resources to supplement ethanol-based fuel facilities.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

The energy cost per KWh for energy crops is estimated to be similar to, or higher than, other biomass energy sources (EIA, 2004b). A DOE forecast concluded that the use of biomass for power generation is not projected to increase substantially in the next ten years because of the cost of biomass relative to the costs of other fuels and the higher capital costs relative to those for coal- or natural-gas-fired capacity (EIA, 2002). Therefore, energy crops are non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.8 Petroleum Liquids (Oil)

From 2002 to 2005, petroleum costs almost doubled, increasing by 92.8%, and the period from 2004 to 2005 alone produced an average petroleum increase of 50.1% (EIA, 2006c). As a result, from 2005 to 2006, net generation of electricity from petroleum liquids dropped by about 84% in Maryland (EIA, 2007b). In the GEIS for License Renewal, the staff estimated that construction of a 1,000 MWe oil-fired plant would require about 0.19 mi^2 (0.49 km^2) (NRC, 1996).

Operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant. Oil-fired plants also have one of the largest carbon footprints of all the electricity generation systems analyzed. Conventional oil-fired plants result in emissions of greater than 650 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 130 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Future developments such as carbon capture and storage and co-firing with biomass have the potential to reduce the carbon footprint of oil-fired electricity generation (POST, 2006).

Apart from fuel price, the economics of oil-fired power generation are similar to those for natural gas-fired power generation. Distillate oil can be used to run gas turbines in a combined-cycle system; however, the cost of distillate oil usually makes this type of combined-cycle system a less competitive alternative when natural gas is available. Oil-fired power generation experienced a significant decline in the early 1970s. Increases in world oil prices have forced utilities to use less expensive fuels; however, oil-fired generation is still an important source of power in certain regions of the U.S. (NRC, 1996).

On these bases, an oil-fired generation plant is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.9 Fuel Cells

Phosphoric acid fuel cells are the most mature fuel cell technology, but they are only in the initial stages of commercialization. During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. Today, the most widely marketed fuel cells cost about $4,500 per kWh of installed capacity.

By contrast, a diesel generator costs $800 to $1,500 per kWh of installed capacity, and a natural gas turbine can cost even less. DOE has launched an initiative – the Solid State Energy Conversion Alliance – to bring about dramatic reductions in fuel cell cost. The DOE goal is to cut costs to as low as $400 per kWh of installed capacity by the end of this decade, which would make fuel cells competitive for virtually every type of power application. (DOE, 2006)

As market acceptance and manufacturing capacity increase, natural-gas-fueled fuel-cell plants in the 50 to 100 MWe range are projected to become available. This will not meet the proposed 1,600 MW(e) baseload capacity. At the present time, fuel cells are not economically

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

or technologically competitive with other alternatives for baseload electricity generation and that the fuel cell alternative non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.10 Coal

Coal-fired steam electric plants provide the majority of electric generating capacity in the U.S., accounting for about 52% of the electric utility industry's total generation, including co-generation, in 2000 (EIA, 2001a). Conventional coal-fired plants generally include two or more generating units and have total capacities ranging from 100 MWe to more than 2,000 MWe. Coal is likely to continue to be a reliable energy source well into the future, assuming environmental constraints do not cause the gradual substitution of other fuels (EIA, 1993).

The U.S. has abundant low-cost coal reserves, and the price of coal for electric generation is likely to increase at a relatively slow rate. Even with recent environmental legislation, new coal capacity is expected to be an affordable technology for reliable, near-term development and for potential use as a replacement technology for nuclear power plants (NRC, 1996).

The environmental impacts of constructing a typical coal-fired steam plant are well known because coal is the most prevalent type of central generating technology in the U.S. The impacts of constructing a 1,000 MWe coal plant at a greenfield site can be substantial, particularly if it is sited in a rural area with considerable natural habitat. An estimated 2.66 mi^2 (6.88 km^2) would be needed, resulting in the loss of the same amount of natural habitat and/ or agricultural land for the plant site alone, excluding land required for mining and other fuel cycle impacts (NRC, 1996).

Currently, the state of Maryland produces 60% of its electricity through coal-fired power plants. These plants produce more than 80% of the carbon dioxide released via electricity production. Data collected by the EIA shows that electricity generation is the single biggest source of carbon dioxide emissions in Maryland.

An existing coal-fueled power plant usually averages about $0.023/kWh. However, co-firing with inexpensive biomass fuel can decrease the cost to $0.021/kWh. This is only cost effective if biomass fuels are obtained at prices equal to or less than coal prices (EERE, 2007).

The operating impacts of new coal plants would be substantial for several resources. Concerns over adverse human health effects from coal combustion have led to important federal legislation in recent years, such as the Clean Air Act and Amendments (CAAA). Although new technology has improved emissions quality from coal-fired facilities, health concerns remain. Air quality would be degraded by the release of additional carbon dioxide, regulated pollutants, and radionuclides.

Carbon dioxide has been identified as a leading cause of global warming. Sulfur dioxide and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management. Losses to aquatic biota would occur through impingement and entrainment and discharge of cooling water to natural water bodies. However, the positive socioeconomic benefits can be considerable for surrounding communities in the form of several hundred new jobs, substantial tax revenues, and plant spending.

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a coal gas-fired power

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.11 Natural Gas

Currently, there are 15 natural gas-fired plants or plants with natural gas-fired components in Maryland. Together, they are able to generate more than 6,700 MWe of energy (PPRP, 2006).

Most of the environmental impacts of constructing natural gas-fired plants are similar to those of other large central generating stations. Land-use requirements for gas-fired plants are small, at 0.17 mi^2 (0.45 km^2) for a 1,000 MWe plant, so land-dependent ecological, aesthetic, erosion, and cultural impacts should be small. Siting at a greenfield location would require new transmission lines and increased land-related impacts, whereas co-locating the gas-fired plant with an existing nuclear plant would help reduce land-related impacts. Also, gas-fired plants, particularly combined cycle and gas turbine facilities, take much less time to construct than other plants (NRC, 1996).

According to the EIA, net generation from natural gas in the state of Maryland decreased by almost 16% between 2005 and 2006 (EIA, 2007a).

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a natural gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.12 Integrated Gasification Combined Cycle (IGCC)

Integrated Gasification Combined Cycle (IGCC) is an emerging, advanced technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is substantially cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream prior to combustion.

The IGCC alternative generates substantially less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a black, glassy, sand-like material that is potentially a marketable byproduct. Slag production is a function of ash content. The other large-volume byproduct produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes.

At present, IGCC technology still has insufficient operating experience for widespread expansion into commercial-scale, utility applications. Each major component of IGCC has been broadly utilized in industrial and power generation applications. But the integration of coal gasification with a combined cycle power block to produce commercial electricity as a primary output is relatively new and has been demonstrated at only a handful of facilities around the world, including five in the U.S. Experience has been gained with the chemical processes of gasification, coal properties and their impact on IGCC design, efficiency, economics, etc.

However, system reliability is still relatively lower than conventional pulverized coal-fired power plants. There are problems with the integration between gasification and power production as well. For example, if there is a problem with gas cleaning, uncleaned gas can cause various damages to the gas turbine. (PU, 2005)

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

Overall, IGCC plants are estimated to be about 15% to 20% more expensive than comparably sized pulverized coal plants, due in part to the coal gassifier and other specialized equipment. Recent estimates indicate that overnight capital costs for coal-fired IGCC power plants range from $1,400 to $1,800 per kilowatt (EIA, 2005). The production cost of electricity from a coal-based IGCC power plant is estimated to be about $0.033 to $0.045 per kilowatt-hour. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 cents per kWh.

To advance the development of IGCC technology, a $557 million advanced IGCC facility will be constructed in Central Florida as part of the U.S. Department of Energy's (DOE) Clean Coal Power Initiative. The 285 MW plant will gasify coal using state-of-the-art emissions controls. The DOE will contribute $235 million and commercial entities will contribute $322 million. (OUC, 2004).

Because IGCC technology currently requires further research to achieve an acceptable level of reliability, an IGCC facility is not a competitive alternative to CCNPP Unit 3.

9.2.3 Assessment of Reasonable Alternative Energy Sources and Systems

For the viable alterative energy source options identified in Section 9.2.2, the issues associated with these options were characterized based on the significance of impacts, with the impacts characterized as being either SMALL, MODERATE, or LARGE. This characterization is consistent with the criteria that NRC established in 10 CFR 51, Appendix B, Table B-1, Footnote 3, as follows:

- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.
- MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.
- LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource (NRC, 1996).

Table 9.2-1provides a comparison of the alternatives regarding environmental categories.

9.2.3.1 Coal-Fire Generation

The environmental impacts from coal-fired generation alternatives were evaluated in the GEIS (NRC, 1996). It was concluded that construction impacts for coal-fired generation could be substantial, in part because of the large land area required (for the plant site alone; 2.65 mi^2 (6.88 km^2) for a 1,000 MWe plant), which would be in addition to the land resourced required for mining and other fuel cycle impacts. These construction impacts would be decreased to some degree by siting a new coal-fired plant where an existing nuclear plant is located.

9.2.3.1.1 Air Quality

The air quality impacts of coal-fired generation are considerably different from those of nuclear power. A coal-fired plant would emit sulfur dioxide (SO_2, as SO_x surrogate), oxides of nitrogen (NO_x), particulate matter (PM), and carbon monoxide (CO), all of which are regulated pollutants. Air quality impacts from fugitive dust, water quality impacts from acidic runoff, and

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

aesthetic and cultural resources impacts are all potential adverse consequences of coal mining.

Air emissions were estimated for a coal-fired generation facility based on the emission factors contained in NETL document DOE/NETL-2007/1281 (NETL, 2007). The emissions from this facility are based on a power generation capacity of 1,600 MWe. The coal-fired generation facility assumes the use of bituminous coal fired in a supercritical pulverized coal (PC) wall-fired unit. Emissions control was assumed to include the use of a flue gas desulfurization system to control acid gas emissions, selective catalytic reduction to minimize NO_x emissions and a baghouse to control PM. Table 9.2-2summarizes the air emissions produced by a 1,600 MWe coal-fired facility.

Operating impacts of a new coal plant include concerns over adverse human health effects, such as increased cancer and emphysema. Air quality would be impacted by the release of CO_2, regulated pollutants, and radionuclides. CO_2 has been identified as a leading cause of global warming, and SO_2 and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would be also be produced and would require constant management. Losses of aquatic biota due to cooling water withdrawals and discharges would also occur.

The Maryland Healthy Air Act proposes to limit future emissions of nitrous oxides (NO_x), sulfur dioxide (SO_2), and mercury from coal-fired power plants (MDE, 2006). Maryland is also planning to participate in the Regional Greenhouse Gas Initiative (RGGI), which would cap carbon dioxide (CO_2) emissions from power plants unless the plants obtain emission offsets from qualified CO_2 emission offset projects.

Coal burning power systems have the largest carbon footprint of all the electricity generation systems analyzed. Conventional coal systems result in emissions of greater than 1,000 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 200 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Lower emissions can be achieved using new gasification plants (less than 800 gCO_2eq/kWh), but this is still an emerging technology so and not as widespread as proven combustion technologies. Future developments such as carbon capture and storage (CCS) and co-firing with biomass have the potential to reduce the carbon footprint of coal-fired electricity generation. (POST, 2006)

Based on the emissions generated by a coal-fired facility, air impacts would be MODERATE to LARGE.

9.2.3.1.2 Waste Management

Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management (NRC, 1996).

With proper placement of the facility, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources. There would also need to be an estimated 34.4 mi^2 (89 km^2) for mining the coal and disposing of the waste could be committed to supporting a coal plant during its operational life (NRC, 1996).

As a result of the above mentioned factors, waste management impacts would be MODERATE.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

9.2.3.1.3 Economic Comparison

DOE has estimated the cost of generating electricity from a coal facility to be approximately $0.049 per kWh. The projected cost associated with operating a new nuclear facility similar to the CCNPP Unit 3 facility is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004).

9.2.3.1.4 Other Impacts

Construction of the power block and coal storage area would disturb approximately 0.47 mi^2 (1.21 km^2) of land and associated terrestrial habitat and 0.94 mi^2 (2.42 km^2) of land would be needed for waste disposal (MDPSC, 2007a). As a result, land use impacts would be MODERATE.

Impacts to aquatic resources and water quality would be minimized but could be construed as MODERATE to LARGE as a result of the plant using a new cooling water system design. Losses to aquatic biota would occur through impingement and entrainment and discharge of cooling water to natural water bodies. Physical impacts are discussed in Section 4.2.

As noted in Section 2.5.2.10.4, there is no direct rail access in Calvert or St. Mary's counties within an 8-mile vicinity of the CCNPP site. The nearest railhead, owned by CSX Transportation (CSXT), is located at the Benedict/Chalk Point node in adjacent Prince George's County (ORNL, 2003). Coal would need to be transported overland to the CCNPP site by heavy haul trucks or by barge on the Chesapeake Bay. As a result, the potential impacts from heavy haul traffic or from construction of a coal off-loading facility would be MODERATE to LARGE.

Three new, 200 ft (61 m) power plant structures and 600 ft (183 m) stacks potentially visible for 40 mi (64 km) in a relatively non-industrialized area would need to be constructed along with a possible 520 ft (159 m) cooling tower and associated plumes (MDPSC, 2007a). As a result, aesthetic impacts would be LARGE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed CCNPP site.

Socioeconomic impacts would result from the additional staff needed to operate the coal-fired facility, and several hundred mining jobs and additional tax revenues would be associated with the coal mining. As a result, socioeconomic impacts would be MODERATE.

As a result of increased safety technologies, accident impacts would be SMALL.

As a result of increased air emissions and public health risks such as cancer and emphysema associated with those emissions, human health impacts would be MODERATE.

9.2.3.1.5 Summary

In order for a coal-fired plant constructed on the CCNPP site to be competitive with a nuclear plant on the same site, the coal-fired plant would need to generate power in excess of 1,600 MWe. The nuclear plant requires a much smaller construction footprint, whereas the coal-fired plant would require more than 2.66 mi^2 (688 km^2), and greenhouse gas emissions would be significantly greater (NRC, 1996). Therefore, a 1,600 MWe coal-fired generation plant would not be viable with the land area currently available.

9.2.3.2 Natural Gas Generation

Most environmental impacts related to constructing natural gas-fired plants should be approximately the same for steam, gas-turbine, and combined-cycle plants. These impacts, in turn, generally will be similar to those of other large central generating stations. The

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

environmental impacts of operating gas-fired plants are generally less than those of other fossil fuel technologies of equal capacity.

9.2.3.2.1 Air Quality

Natural gas is a relatively clean-burning fossil fuel. Also, because the heat recovery steam generator does not receive supplemental fuel, the combined-cycle operation is highly efficient (56% vs. 33% for the coal-fired alternative). Therefore, the gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative. Control technology for gas-fired turbines focuses on the reduction of NO_x emissions.

Human health effects are SMALL based on decreased air quality impacts. Natural gas technologies produce fewer pollutants than other fossil technologies, and SO_2, a contributor to acid rain, is not emitted in significant quantities (NRC, 1996). Air emissions were estimated for a natural gas-fired generation facility based on the emission factors contained in the NETL document DOE/NETL-2007/1281 (NETL, 2007). Emissions from the facility were based on a power generation capacity of 1,600 MWe.

Current gas powered electricity generation has a carbon footprint around half that of coal (approximately 500 gCO_2eq/kWh), because gas has a lower carbon content than coal. This is approximately 100 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Like coal-fired plants, gas plants could co-fire biomass to reduce carbon emissions in the future (POST, 2006).

The natural gas-fired generation facility assumes the use of a combined cycle gas turbine generator (GTG) with no duct firing. Selective catalytic reduction is used to control nitrogen oxides emissions. Table 9.2-2summarizes the air emissions produced by a 1,600 MWe natural gas-fired facility. Based on the emissions generated from a natural gas-fired facility, air impacts would be MODERATE.

9.2.3.2.2 Waste Management

Gas-fired generation would result in almost no waste generation, producing minor (if any) impacts. As a result, waste management impacts would be SMALL.

9.2.3.2.3 Economic Comparison

DOE has estimated the cost of generating electricity from a gas-fired facility to be $0.047 per kWh. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004).

9.2.3.2.4 Other Impacts

Construction of the power block and would disturb approximately 0.1 mi^2 (0.24 km^2) of land and associated terrestrial habitat, and 435,600 ft^2 (40,000 m^2) of land would be needed for pipeline construction (MDPSC, 2007a). As a result, land use impacts would be SMALL.

Consumptive water use is about the same for steam cycle plants as for other technologies, although water consumption is likely to be less for gas turbine plants. There are potential impacts to aquatic biota through impingement and entrainment and increased water temperatures in receiving water bodies (NRC, 1996). Water quality impacts would be SMALL. Physical impacts are discussed in Section 4.2.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

A new 100 ft (30 m) turbine building and 230 ft (70 m) exhaust stacks would need to be constructed. A closed-cycle cooling alternative could also introduce plumes (MDPSC, 2007a). As a result, aesthetic impacts would be MODERATE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed CCNPP site.

Socioeconomic impacts would result from the approximately 150 people needed to operate the gas-fired facility, as estimated in the GEIS (NRC, 1996). As a result, socioeconomic impacts would be SMALL.

Due to increased safety technologies, accidents and human health impacts would be SMALL.

A proposed gas-fired unit would connect to an existing gas line adjacent to the site. The Dominion Cove Point Liquid Natural Gas (DCPLNG) pipeline passes within approximately 1.54 mi (2.48 km) of CCNPP Unit 3. As a result, construction impacts related to connecting to an existing gas line would be SMALL.

9.2.3.2.5 Summary

The gas-fired alternative discussed in Section 9.2.2.11 would be located at the CCNPP site. The natural gas generation alternative at the CCNPP site would require less land area than the coal-fired plant but more land area than the nuclear plant. The plant site alone would require 0.17 mi^2 (0.45 km^2) for a 1,000 MWe generating capacity. An additional 5.6 mi^2 (14.6 km^2) of land would be required for wells, collection stations, and pipelines to bring natural gas to the generating facility. (NRC, 1996) This is significantly greater than the 0.35 mi^2 (0.92 km^2) required for construction of a new nuclear unit. Therefore, constructing a natural gas generation plant would not be viable on the CCNPP site.

9.2.3.3 Combination of Alternatives

CCNPP Unit 3 will have a baseload capacity of approximately 1,600 MWe. Any alternative or combination of alternatives would be required to generate the same baseload capacity.

Because of the intermittent nature of the resources and the lack of cost-effective technologies, wind and solar energies are not sufficient on their own to generate the equivalent baseload capacity or output of CCNPP Unit 3, as discussed in Section 9.2.2.1 and Section 9.2.2.4. As noted in Section 9.2.3.1 and Section 9.2.3.2, fossil fuel fired technology generates baseload capacity, but the associated environmental impacts are greater than for a nuclear facility.

A combination of alternatives may be possible, but should be sufficiently complete, competitive, and viable to provide NRC with appropriate comparisons to the proposed nuclear plant.

9.2.3.3.1 Determination of Alternatives

A number of combinations of alternative power generation sources could be used satisfy the baseload capacity requirements of the CCNPP facility. Some of these combinations include renewable sources, such as wind and solar. Wind and solar do not, by themselves, provide a reasonable alternative energy source to the baseload power to be produced by the CCNPP facility. However, when combined with fossil fuel-fired plant(s), wind and solar may be a reasonable alternative to nuclear energy produced by the CCNPP facility.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

CCNPP Unit 3 will operate as a baseload, merchant independent power producer. The power produced will be sold on the wholesale market without specific consideration to supplying a traditional service area or satisfying a reserve margin objective. The ability to generate baseload power in a consistent, predictable manner meets the business objective of CCNPP Unit 3. Therefore, when examining combinations of alternatives to CCNPP Unit 3, the ability to consistently generate baseload power must be the determining feature when analyzing the reasonableness of the combination. This section reviews the ability of the combination alternative to have the capacity to generate baseload power equivalent to CCNPP Unit 3.

When examining a combination of alternatives that would meet business objectives similar to that of CCNPP Unit 3, any combination that includes a renewable power source (either all or part of the capacity of CCNPP Unit 3) must be combined with a fossil-fueled facility equivalent to the generating capacity of CCNPP Unit 3. This combination would allow the fossil-fueled portion of the combination alternative to produce the needed power if the renewable resource is unavailable and to be displaced when the renewable resource is available.

For example, if the renewable portion is provided by some amount of wind generation and that resource became available, then the output of the fossil fueled generation portion of the combination alternative could be lowered to offset the increased generation from the renewable portion. This facility, or facilities, would satisfy business objectives similar to those of the CCNPP facility in that it would be capable of supporting fossil-fueled baseload power.

Greenhouse gas emissions are another factor that must be considered when evaluating alternative power generation combinations. CCNPP Unit 3 will not rely on carbon-based fuels for power generation, and will produce only a small amount of carbon dioxide (CO_2) emissions. Carbon dioxide is the principal greenhouse gas from power generating facilities that combust solid or liquid fuels. If the source of the carbon is biomass or derived from biomass (ethanol), then the impact is carbon neutral. If the source of the carbon is fossil fuel, then there is a net increase in atmospheric CO_2 concentrations and global climate change unless the carbon emissions are offset or sequestered.

Coal-fired and gas-fired generation have been examined as having environmental impacts that are equivalent to or greater than the impacts of CCNPP Unit 3. Based on the comparative impacts of these two technologies, as shown in Table 9.2-1, it can be concluded that a gas-fired facility would have less of an environmental impact than a comparably sized coal-fired facility. In addition, the operating characteristics of gas-fired generation are more amenable to the kind of load changes that may result from inclusion of renewable generation such that the baseload generation output of 1,600 MWe is maintained.

"Clean Coal" power plant technology could decrease the air pollution impacts associated with burning coal for power. Demonstration projects show that clean coal programs reduce NOx, SOx, and particulate emissions. However, the environmental impacts from burning coal using these technologies, if proven, will still be greater than the impacts from natural gas (NETL, 2001). Therefore, for the purpose of examining the impacts from a combination of alternatives to CCNPP Unit 3, a facility equivalent to that will be used in the environmental analysis of combination alternatives.

The analysis accounts for the reduction in environmental impacts from a gas-fired facility when generation from the facility is displaced by the renewable resource. The impact associated with the combined-cycle natural gas-fired unit is based on the gas-fired generation impact assumptions discussed in Section 9.2.3.2. Additionally, the renewable portion of the

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

combination alternative would be any combination of renewable technologies that could produce power equal to or less than CCNPP Unit 3 at a point when the resource was available.

This combination of renewable energy and natural gas fired generation represents a viable mix of non-nuclear alternative energy sources. Many types of alternatives can be used to supplement wind energy, notably solar power. PV cells are another source of solar power that would complement wind power by using the sun during the day to produce energy while wind turbines use windy and stormy conditions to generate power. Wind and solar facilities in combination with fossil fuel facilities (coal, petroleum) could also be used to generate baseload power.

However, wind and solar facilities in combination with fossil fuel facilities would have equivalent or greater environmental impacts relative to a new nuclear facility at the CCNPP site. Similarly, wind and solar facilities in combination with fossil fuel facilities would have costs higher than a new nuclear facility at the CCNPP site. Therefore, wind and solar facilities in combination with fossil fuel facilities are non-competitive with a new nuclear unit at the CCNPP site.

9.2.3.3.2 Environmental Impacts

The environmental impacts associated with a gas-fired power generation facility sized to produce power equivalent to CCNPP Unit 3 have already been analyzed. Depending on the level of potential renewable output included in the combination alternative, the level of impact of the gas-fired portion will be comparably lower. If the renewable portion of the combination alternative were not enough to displace the power produced by the fossil fueled facility, then there would be some level of impact associated with the fossil fueled facility.

Consequently, if the renewable portion of the combination alternative were enough to fully displace the output of the gas-fired facility, then, when the renewable resource is available, the output of fossil fueled facility could be eliminated, thereby eliminating its operational impacts. Determination of the types of environmental impacts of these types of 'hybrid' plants or combination of facilities can be surmised from analysis of past projects.

For instance, in 1984, Luz International, Ltd. built the Solar Electric Generating System (SEGS) plant in the California Mojave Desert. The SEGS technology consists of modular parabolic-trough solar collector systems, which use oil as a heat transfer medium. One unique aspect of the Luz technology is the use of a natural-gas-fired boiler as an oil heater to supplement the thermal energy from the solar field or to operate the plant independently during evening hours. SEGS I was installed at a total cost of $62 million (approximately $4,500/kW) and generates power at $0.24 per kWh (in 1988 real levelized dollars).

The improvements incorporated into the SEGS III-VI plants (approximately $3,400/kW) reduced generation costs to about $0.12 per kWh, and the third-generation technology, embodied in the 80 MW design at an installed cost of $2,875/kW, reduced power costs still further, to $0.08 to $0.10 per kWh. Because solar energy is not a concentrated source, the dedicated land requirement for the Luz plants is large compared to conventional plants--on the order of 5 acres/MWe (2 hectares/MWe) (NREL, 1993), compared to 0.23 acres/MWe (0.093 hectares/MWe) for a nuclear plant.

Parabolic trough plants require a significant amount of land; typically the use is preemptive because parabolic troughs require the land to be graded level. A report, developed by the

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

California Energy Commission (CEC), notes that 5 to 10 acres (2 to 4 hectares) per MWe is necessary for concentrating solar power technologies such as trough systems (CEC, 2003).

The environmental impacts associated with a solar or wind facility equivalent to CCNPP Unit 3 have already been analyzed. It is reasonable to expect that the impacts associated with an individual unit of a smaller size would be similarly scaled. If the renewable portion of the combination alternative is unable to generate an equivalent amount of power as CCNPP Unit 3, then the combination alternative would have to rely on the gas-fired portion to meet the equivalent capacity of CCNPP Unit 3.

Consequently, if the renewable portion of the combination alternative has a potential output that is equal to that of CCNPP Unit 3, then the impacts associated with the gas-fired portion of the combination alternative would be lower but the impacts associated with the renewable portion would be greater. The greater the potential output of the renewable portion of the combination alternative, the closer the impacts would approach the level of impacts. The gas-fired facility alone has impacts that are larger than CCNPP Unit 3; some environmental impacts of renewables are also greater than or equal to CCNPP Unit 3. The combination of a gas-fired plant and wind or solar facilities would have environmental impacts that are equal to or greater than those of a nuclear facility.

- All of the environmental impacts of a new nuclear plant at the CCNPP site and all of the impacts from a gas-fired plant are small, except for air quality impacts from a gasfired facility (which are moderate). Use of wind and/or solar facilities in combination with a gas-fire facility would be small, and therefore would be equivalent to the air quality impacts from a nuclear facility.

- All of the environmental impacts of a new nuclear plant at the CCNPP site and all of the impacts from wind and solar facilities are small, except for land use and aesthetic impacts from wind and solar facilities (which range from moderate to large). Use of a gas-fired facility in combination with wind and solar facilities would reduce the land usage and aesthetic impacts from the wind and solar facilities. However, at best, those impacts would be small, and therefore would be equivalent to the land use and aesthetic impacts from a nuclear facility.

Therefore the combination of wind and solar facilities and gas-fired facilities is not environmentally preferable to CCNPP Unit 3.

9.2.3.3.3 Economic Comparison

As noted earlier, the combination alternative must generate power equivalent to the capacity of CCNPP Unit 3. DOE has estimated the cost of generating electricity from a gas-fired facility ($0.047 per kWh), a biomass facility ($0.09 per KWh), a coal facility ($0.049 per kWh), a wind facility ($0.057 per kWh), and a solar facility ($0.04 to $0.05 per kWh). The cost for a gas-fired facility in combination with a renewable facility would increase, because the facility would not be operating at full availability when it is displaced by the renewable resource.

As a result, the capital costs and fixed operating costs of the gas facility would be spread across fewer kWh from the gas facility, thereby increasing its cost per kWh. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004). The projected costs associated with forms of generation other than from a nuclear unit would be higher. Therefore, the cost associated

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

with the operation of the combination alternative would be non-competitive with CCNPP Unit 3.

9.2.3.3.4 Summary

As noted earlier, the combination alternative must generate power equivalent to the capacity of CCNPP Unit 3. DOE has estimated the cost of generating electricity from a gas-fired facility ($0.047 per kWh), a biomass facility ($0.09 per KWh), a coal facility ($0.049 per kWh), a wind facility ($0.057 per kWh), and a solar facility ($0.04 to $0.05 per kWh). The cost for a gas-fired facility in combination with a renewable facility would increase, because the facility would not be operating at full availability when it is displaced by the renewable resource.

As a result, the capital costs and fixed operating costs of the gas facility would be spread across fewer kWh from the gas facility, thereby increasing its cost per kWh. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004). The projected costs associated with forms of generation other than from a nuclear unit would be higher. Therefore, the cost associated with the operation of the combination alternative would be non-competitive with CCNPP Unit 3.

9.2.4 Conclusion

Based on environmental impacts, it has been concluded that neither a coal-fired, gas-fired,or a combination of alternatives, including wind-powered and solar-powered facilities would appreciably reduce overall environmental impacts when compared to a nuclear plant. Furthermore, each of these types of alternatives, with the possible exception of the combination alternative, would entail a significantly greater environmental impact on air quality than a nuclear plant would.

To achieve the small reduction in air quality impact in the combination alternative; however, a moderate to large impact on land use would be incurred. It is therefore concluded that neither a coal-fired, gas-fired, nor a combination of alternatives would be environmentally preferable to a nuclear plant. Furthermore, these alternatives would have higher economic costs and therefore are not economically preferable to a nuclear plant.

9.2.5 References

APT, 2004. Investigation into Municipal Solid Waste Gasification for Power Generation, Alameda Power and Telecom, May 2004, Website: http://www.alamedapt.com/newsroom/reports/gasification.pdf, Date accessed: June 12, 2007.

BGE, 1998. Calvert Cliffs Nuclear Power Plant, Units 1 and 2, Docket Numbers 50-317 and 50-318, Application for License Renewal, Baltimore Gas and Electric Company, April 8, 1998.

CBD, 2007. Altamont Pass Wind Resource Area, The Center for Biological Diversity, Website: http://www.biologicaldiversity.org/swcbd/Programs/bdes/altamont/altamont.html, Date accessed: May 18, 2007.

CEC, 2003. Renewable Resources Development Report, Report 500-03-080F, November 2003, California Energy Commission (CEC), Website: http://www.energy.ca.gov/reports/2003-11-24_500-03-080.PDF, Date accessed: June 6, 2008.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

CEC, 2004. Potential Health and Environmental Impacts Associated with the Manufacture and Use of Photovoltaic Cells, Report P500-04-003, California Energy Commission, August 2004, Website: http://www.energy.ca.gov/reports/500-04-053.PDF, Date accessed: May 17, 2007.

DOE, 2002. Business Case for New Nuclear Power Plants, U.S. Department of Energy, Office of Nuclear Energy, Science and Technology, July 2002, Website: http://www.ne.doe.gov/home/bc/businesscase.html, Date accessed: May 19, 2007.

DOE, 2004. The Economic Future of Nuclear Power, U.S. Department of Energy, Office of Nuclear Energy, August 2004, Website: http://nuclear.energy.gov/np2010/reports/NuclIndustryStudy-Summary.pdf, Date accessed: May 19, 2007.

DOE, 2006. Future Fuel Cells R&D, U.S. Department of Energy, Office of Science and Technology, Website: http://www.fossil.energy.gov/programs/powersystems/fuelcells/, Date accessed: May 18, 2007.

EERE, 2003. Wind Resource Maps of Maryland, U.S. Department of Energy, Energy Efficiency and Renewable Energy, January 2003, Website: http://www.eere.energy.gov/windandhydro/windpoweringamerica/maps_template.asp?stateab=md, Date accessed: May 19, 2007.

EERE, 2006a. State Energy Alternatives: Alternative Energy Resources in Maryland, U.S. Department of Energy, Energy Efficiency and Renewable Energy, Website: http://www.eere.energy.gov/states/alternatives/resources_md.cfm, Date accessed: May 19, 2007.

EERE, 2006b. Concentrating Solar Power, U.S. Department of Energy, Energy Efficiency and Renewable Energy, 2006, Website: http://www1.eere.energy.gov/solar/csp.html, Date accessed: May 31, 2007.

EERE, 2007. State Energy Alternatives, U.S. Department of Energy, Energy Efficiency and Renewable Energy, Website: http://www.eere.energy.gov/states/alternatives/biomass.cfm, Date accessed: May 18, 2007.

EIA, 1993. Renewable Resources in the U.S. Electricity Supply, USDOE/EIA-0561(92), U.S. Department of Energy, Energy Information Administration, February 1993, Website: ftp://ftp.eia.doe.gov/pub/electricity/renewmas.pdf, Date accessed: May 18, 2007.

EIA, 1995. Renewable Energy Annual 1995, DOE/EIA-0603(95), U.S. Department of Energy, Energy Information Administration, December 1995, Website: http://tonto.eia.doe.gov/FTPROOT/renewables/060395.pdf, Date accessed: May 18, 2007.

EIA, 1999. Issues in Midterm Analysis and Forecasting 1999, EIA/DOE-0607(99), U.S. Department of Energy, Energy Information Administration, 1999.

EIA, 2001a. Annual Energy Outlook, 2002: With Projections to 2020, USDOE/EIA-0383(2002), U.S. Department of Energy, Energy Information Administration, December 2001, Website: http://tonto.eia.doe.gov/FTPROOT/forecasting/0383(2002).pdf, Date accessed: May 17, 2007.

EIA, 2001b. International Energy Outlook 2001, DOE/EIA-0484(2001), U.S. Department of Energy, Energy Information Administration, March 2001, Website: http://tonto.eia.doe.gov/FTPROOT/forecasting/04842001.pdf, Date accessed: May 17, 2007.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

EIA, 2002. Biomass for Electricity Generation, U.S. Department of Energy, Energy Information Administration, Website: http://www.eia.doe.gov/oiaf/analysispaper/biomass/index.html, Date accessed: June 12, 2007.

EIA, 2003a. Renewable Energy Annual 2002, DOE/EIA-0603(2002), U.S. Department of Energy, Energy Information Administration, November 2003, Website: http://tonto.eia.doe.gov/FTPROOT/renewables/060304.pdf, Date accessed: May 17, 2007.

EIA, 2003b. Table FE2 - Typical Costs and Capacity of New Transmission Lines, U.S. Department of Energy, Energy Information Administration, Website: http://www.eia.doe.gov/cneaf/pubs_html/feat_trans_capacity/table2.html, Date accessed: May 19, 2007.

EIA, 2004a. Annual Energy Outlook, 2004: With Projections to 2025, USDOE/EIA-0383(2004), U.S. Department of Energy, Energy Information Administration, January 2004, Website: http://www.econstats.com/EIA/AEO2004.pdf, Date accessed: May 19, 2007.

EIA, 2004b. Biomass for Electricity Generation, U.S. Department of Energy, Energy Information Administration, April 2004, Website: http://www.epa.gov/cleanrgy/pdf/haq_apr20.pdf, Date accessed: on June 12, 2007.

EIA, 2005. Annual Energy Outlook, 2005: With Projections to 2025, USDOE/EIA-0383(2005), U.S. Department of Energy, Energy Information Administration, February 2005, Website: http://www.econstats.com/EIA/AEO2004.pdf, Date accessed: June 3, 2007.

EIA, 2006a. Demand-Side Management Actual Peak Load Reductions by Program Category, U.S. Department of Energy, Energy Information Administration, October 2006, Website: http://www.eia.doe.gov/cneaf/electricity/epa/epat9p1.html, Date accessed: May 18, 2007.

EIA, 2006b. Demand-Side Management Program Direct and Indirect Costs, U.S. Department of Energy, Energy Information Administration, October 2006, Website: http://www.eia.doe.gov/cneaf/electricity/epa/epat9p7.html, Date accessed: February 12, 2007.

EIA, 2006c. Electric Power Annual 2005, DOE/EIA-0348(2005), U.S. Department of Energy, Energy Information Administration, November 2006, Website: http://www.eia.doe.gov/cneaf/electricity/epa/epa.pdf, Date accessed: May 19, 2007.

EIA, 2006d. Impact of Energy Policy Act of 2005 Section 206 Rebates on Customers and Renewable Energy Consumption, with Projections to 2010, U.S. Department of Energy, Energy Information Administration, Website: http://www.eia.doe.gov/cneaf/solar.renewables/page/epact/background.html, Date accessed: May 18, 2007.

EIA, 2007a. Net Generation from Natural Gas by State by Sector, Year-to-Date through December 2006 and 2005, U.S. Department of Energy, Energy Information Administration, Website: http://www.eia.doe.gov/cneaf/electricity/epm/table1_10_b.html, Date accessed: May 19, 2007.

EIA, 2007b. "Net Generation from Petroleum Liquids by State by Sector, Year-to-Date through December 2006 and 2005," U.S. Department of Energy, Energy Information Administration, Washington, D.C., available online at: http://www.eia.doe.gov/cneaf/electricity/epm/table1_8_b.html, accessed May 19, 2007.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

Fitzgerald, 2007. Solar Electric Frequently Asked Questions, M. Fitzgerald, Website: http://www.solareco.com/articles/article.cfm?id=121, Date accessed: February 8, 2007.

INEEL, 1998. U.S. Hydropower Resource Assessment Final Report, Report DOE/ID-10430.2, Idaho National Engineering and Environmental Laboratory, December 1998.

MDE, 2004. Solid Waste Managed in Maryland Calendar Year 2003, Maryland Department of the Environment, September 2004, Website: http://www.mde.state.md.us/assets/document/SW_Managed_in_MD_Report_CY_2003.pdf, Date accessed: May 19, 2007.

MDE, 2006. Title 26, Subtitle 11, Section 27, Emission Limitations for Power Plants, Maryland Department of the Environment, 2006, Website: http://www.mde.state.md.us/assets/document/Emergency_Action_published_in_MDReg_2207.pdf, Date accessed: June 19, 2007.

MPPRP, 2006. Generation from Power Plants in Maryland, Maryland Department of Natural Resources, Maryland Power Plant Research Program, September 2006, Website: http://esm.versar.com/pprp/factbook/generation.htm, Date accessed: May 19, 2007.

MDPSC, 2007a. Electric Supply Adequacy Report of 2007, Maryland Public Service Commission, January 2007.

MDPSC, 2007b. Annotated Code of Maryland, Public Utilities Companies Article, Title 7, Subtitle 7, Section 7-701, Renewable Energy Portfolio Standards, Website: http://mlis.state.md.us/cgi-win/web_statutes.exe?gpu&7-701, Date accessed: June 19, 2007.

MGA, 1991. Section 7-211 of the Public Utility Companies Articles, Maryland General Assembly, Annapolis, Maryland.

NEPA, 1982. The National Environmental Policy Act of 1969, as amended, Publication L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Publication L. 94-52, July 3, 1975, Publication L. 94-83, August 9, 1975, and Publication L. 97-258, Section 4(b), September 13, 1982.

NETL, 2001. Environmental Benefits of Clean Coal Technologies, Topical Report 18, U.S. Department of Energy, National Energy Technology Laboratory, April 2001, Website: http://www.netl.doe.gov/technologies/coalpower/cctc/topicalreports/pdfs/topical18.pdf, Date accessed: June 19, 2007.

NETL, 2007. National Energy Technology Laboratory (NETL), 2007. Cost and Performance Baseline for Fossil Energy Plants Volume 1: Bituminous Coal and Natural Gas to Electricity, U.S. Department of Energy, National Energy Technology Laboratory report, DOE/NETL-2007/1281 Rev. 1, August 2007; Available online at: http://www.netl.doe.gov/energy-analyses/pubs/BituminousBaseline_Final Report.pdf

NRC, 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Nuclear Regulatory Commission, May 1996.

NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

NREL, 2004. PV Solar Radiation: Annual (Flat Plate, Facing South, Latitude Tilt), U.S. Department of Energy, National Renewable Energy Laboratory, Website: http://www.nrel.gov/gis/images/us_pv_annual_may2004.jpg, Date accessed: May 19, 2007.

NREL, 2005. A Geographic Perspective on the Current Biomass Resource Availability in the United States, Technical Report NREL/TP-560-39181, U.S. Department of Energy, National Renewable Energy Laboratory, December 2005, Website: http://www.nrel.gov/docs/fy06osti/39181.pdf, Date accessed: May 19, 2007.

NREL, 2006. Energy Storage Basics, U.S. Department of Energy, National Renewable Energy Laboratory, December 2005, Website: http://www.nrel.gov/learning/eds_energy_storage.html, Date accessed: June 19, 2007.

NREL, 2007. Photovoltaics, U.S. Department of Energy, National Renewable Energy Laboratory, Website: http://www.nrel.gov/learning/re_photovoltaics.html, Date accessed: April 3, 2007.

ORNL, 2003. Transportation Routing Analysis Geographic Information System (TRAGIS) User's Manual, Rev. 0, National Transporation Research Center (NTRC), managed by UT-Battelle for DOE, ORNL/NTRC-006, Oak Ridge National Laboratory, June 2003.

OUC, 2004. Department of Energy Selects OUC - Southern Company to Build Clean Coal Technology Plant, Orlando Utilities Commission, October 2004, Website: http://www.ouc.com/news/arch/20041021-cleancoal_proj.htm, Date accessed: June 3, 2007.

PL, 2005. Energy Policy Act of 2005, Public Law 109-58, August 2005.

POST, 2006. Carbon Footprint of Electricity Generation, October 2006, Parliamentary Office of Science and Technology, Website: http://www.parliament.uk/documents/upload/postpn268.pdf, Date accessed: June 19, 2007.

PU, 2005. Factors that Affect the Design and Implementation of Clean Coal Technologies in Indiana, Purdue Energy Research Modeling Groups, Purdue University, R. Rardin, Y. Zuwei, F. Holland, A. Black, J. Oberbeck, June 2005, Website: http://www.purdue.edu/dp/energy/pdf/Purdue-InterimReport-Jun10-2005.pdf, Date accessed: June 3, 2007.

REW, 2001. Minimizing the Environmental Impact of Large-Scale Rural PV, Renewable Energy World, Volume 4, Number 1, M. Real, H. Bader, and R. Scheidegger, January-February 2001.

SS, 2004. Facts about Solar Energy, Siemens Solar, Website: http://www.siemenssolar.com/facts.html, Date accessed: May 18, 2004.

USDA, 2006. Maryland State Agricultural Overview – 2005, U.S. Department of Agriculture, National Agricultural Statistics Service, Website: http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_MD.pdf, Date accessed: May 19, 2007.

USEPA, 1995. AP-42, Fifth Edition, Volume I, as posted in the Technology Transfer Network, Clearinghouse for Inventories and Emission Factors, U.S. Environmental Protection Agency, Website: http://www.epa.gov/ttn/chief/ap42/, Date accessed: May 19, 2007.

USEPA, 2006a. Electricity from Municipal Solid Waste, U.S. Environmental Protection Agency, Website: http://www.epa.gov/cleanenergy/muni.htm, Date accessed: May 19, 2007.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

USEPA, 2006b. Municipal Solid Waste: Basic Facts, U.S. Environmental Protection Agency, Website: http://www.epa.gov/msw/facts.htm, Date accessed: May 19, 2007.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED

Table 9.2-1— Impacts Comparison Table

Impact Category	CCNPP Unit 3	Coal-Fired Generation	Gas-Fired Generation	Combinations
Air Quality MT (tons)/yr	Small	Large SO_2 = 4,700 (5,177) NO_2 = 3,884 (4,278)	Moderate SO_2 = 83 (92) NO_2 = 385 (424)	Small to Large
Waste Management MT (tons)/yr	Small	Moderate Substantial amount scrubber sludge and fly ash produced	Small	Small to Moderate
Land Use mi^2 (km^2)	Small	Moderate Waste disposal -- 0.94 (2.43) Coal storage and power block area 0.47 (1.21)	Small	Small to Large
Water Quality	Small	Moderate to Large Cooling water system losses to biota through impingement/ entrainment, discharge of cooling water to natural water bodies	Moderate to Large Cooling water system losses to biota through impingement/ entrainment, discharge of cooling water to natural water bodies	Small to Large
Aesthetics m (ft)	Small to Moderate Plant structures	Large Plant structures 61(200) high Stacks 183 (600) high	Moderate Turbine building 30 (100) high Stacks 70 (230) high	Small to Large
Cultural Resources	Small	Small	Small	Small
Ecological Resources	Small	Small	Small	Small
Threatened & Endangered Resources	Small	Small	Small	Small
Socioeconomics	Small	Moderate Staff needed to operate facility, several hundred mining jobs and additional tax revenues	Small	Small to Moderate
Accidents	Small	Small	Small	Small
Human Health	Small	Moderate (see air quality)	Small	Small to Moderate

Notes:
SMALL – Environmental effects are not noticeable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MEDIUM – Environmental effects are sufficient to alter noticeably, nut not destabilize, any important attribute of the resource.
LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

© 2007-2010 UniStar Nuclear Services, LLC. All rights reserved.
COPYRIGHT PROTECTED