FENOC

FirstEnergy Nuclear Operating Company

Davis-Besse Nuclear Power Station
5501 N. State Route 2
Oak Harbor, Ohio 43449

September 19, 2011
L-11-289

10 CFR 54

ATTN: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT:
Davis-Besse Nuclear Power Station, Unit No. 1
Docket No. 50-346, License Number NPF-3
License Renewal Application Amendment No. 16, Supplemental Information for the Review of the Davis-Besse Nuclear Power Station, Unit No. 1, License Renewal Application Environmental Report (TAC No. ME4613)

By letter dated August 27, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102450565), FirstEnergy Nuclear Operating Company (FENOC) submitted an application pursuant to Title 10 of the *Code of Federal Regulations*, Part 54 for renewal of Operating License NPF-3 for the Davis-Besse Nuclear Power Station, Unit No. 1 (DBNPS).

Amendment 16 to the DBNPS License Renewal Application, which provides updated information for the Davis-Besse Nuclear Power Station, Unit No. 1, License Renewal Application, Appendix E, "Applicant's Environmental Report, Operating License Renewal Stage," Chapters 7 and 8, is provided as Enclosure A. Enclosure B provides a copy of the Amendment that shows the changes in redline (or tracked-changes) format to facilitate NRC review.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Clifford I. Custer, Fleet License Renewal Project Manager, at 724-682-7139.

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I declare under penalty of perjury that the foregoing is true and correct. Executed on September 19, 2011.

Sincerely,

KWByrd

Kendall W. Byrd
Director, Site Performance Improvement

Enclosure-:
A. Amendment No. 16 to the DBNPS License Renewal Application
B. FENOC Annotation of Amendment No. 16 to the DBNPS License Renewal Application to Facilitate NRC Review

cc: NRC DLR Project Manager
NRC DLR Environmental Project Manager
NRC Region III Administrator

cc: w/o Enclosure
NRC DLR Director
NRR DORL Project Manager
NRC Resident Inspector
Utility Radiological Safety Board

Enclosure A

Davis-Besse Nuclear Power Station, Unit No. 1 (DBNPS)

Letter L-11-289

Amendment No. 16 to the
DBNPS License Renewal Application

86 Pages
(not including this cover page)

License Renewal Application
Sections Affected

Appendix E, Chapter 7

Appendix E, Chapter 8

This Enclosure provides updated information for the Davis-Besse Nuclear Power Station, Unit No. 1, License Renewal Application, Appendix E, "Applicant's Environmental Report, Operating License Renewal Stage," Chapters 7 and 8, that are to be replaced, in their entirety, with the attached.

7.0 ALTERNATIVES TO THE PROPOSED ACTION

Regulatory Requirement: 10 CFR 51.45(b)(3)

The environmental report shall discuss "Alternatives to the proposed action." [adopted by reference at 10 CFR 51.53(c)(2)].

7.0.1 OVERVIEW

This chapter assesses alternatives to the proposed renewal of the Davis-Besse operating license. It includes discussions of the no-action alternative and alternatives that meet system generating needs. Descriptions are provided in sufficient detail to facilitate comparison of the impacts of the alternatives to those of the proposed action. In considering the level of detail and analysis that it should provide for each category, FENOC relied on the NRC decision-making standard for license renewal:

> *...the NRC staff, adjudicatory officers, and Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. [10 CFR 51.95(c)(4)]*

As noted in 10 CFR 51.53(c)(2), a discussion is not required of need for power or economic costs and benefits of the proposed action or of alternatives to the proposed action except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation.

Section 7.1 addresses the "no-action" alternative in terms of the potential environmental impacts of not renewing the Davis-Besse operating license, independent of any actions taken to replace or compensate for the loss of generating capacity. Section 7.2 describes feasible alternative actions that could be taken, which FENOC also considers to be elements of the no-action alternative, and presents other alternatives that FENOC does not consider to be reasonable. Section 7.3 presents the environmental impacts for the reasonable alternatives.

The environmental impact evaluations of alternatives presented are intended to provide enough information to support NRC decision-making by demonstrating whether an alternative would have a smaller, comparable, or greater environmental impact than the proposed action. Additional detail or analysis was not considered useful or necessary if it would identify only additional adverse impacts of license renewal alternatives; i.e., information beyond that necessary for a decision. This approach is consistent with the CEQ regulations, which provide that the consideration of alternatives (including the proposed action) be adequately addressed so reviewers may evaluate their comparative merits (40 CFR 1502.14(b)).

The characterization of environmental impacts in this chapter applies the same definitions of "SMALL," "MODERATE," and "LARGE" used in Chapter 4 of this ER and by the NRC in the GEIS (**NRC 1996**). Chapter 8 presents a summary comparison of environmental impacts of the proposed action and alternatives.

7.0.2 REGION OF INTEREST

NRC environmental guidance for siting new reactors defines the "Region of interest" (ROI) as "the geographic area considered in searching for candidate sites." NUREG-1555, at 9.3-1 (1999). That definition is not directly applicable to this license renewal action because Davis-Besse is already sited as an operating reactor in Ohio. The application here is for license renewal, and not for initial plant siting, construction, or operation. However, that same environmental guidance explains that "the basis for an ROI is the State in which the proposed site is located or the relevant service area for the proposed plant." NUREG-1555, at 9.3-2. This explanation, or basis for selecting the ROI for siting new reactors, is applicable for defining the ROI for purposes of license renewal. Accordingly, FENOC is adopting an ROI for this Environmental Report as the State in which Davis-Besse is located: Ohio. The second portion of the explanation in NUREG-1555—"the relevant service area for the proposed plant"—is not applicable to Davis-Besse, because the electricity that Davis-Besse generates is sold on the wholesale power market. Accordingly, there is no "relevant service area" for the plant.

7.1 NO-ACTION ALTERNATIVE

FENOC considers the no-action alternative is not to renew the Davis-Besse operating license. With this alternative, FENOC expects Davis-Besse would continue to operate until the expiration of the existing operating license in 2017, at which time plant operations would cease, decommissioning would begin, and FirstEnergy or others would take the appropriate actions to meet system-generating needs created by discontinued operation of the plant.

Section 7.1.1 addresses the impacts of terminating operations and decommissioning, whereas Section 7.1.2 discusses the actions to replace power from Davis-Besse.

7.1.1 TERMINATING OPERATIONS AND DECOMMISSIONING

In the event the NRC does not renew the Davis-Besse operating license, FENOC assumes for this ER that it would operate the plant until the current license expires, then terminate operations and initiate decommissioning activities in accordance with NRC requirements. For purposes of this discussion, terminating operations includes those actions directly associated with permanent cessation of operations, which may result in more or less immediate environmental impacts (e.g., socioeconomic impacts from reduction in employment and tax revenues).

Decommissioning, as defined in the GEIS, is the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license (**NRC 1996**, Section 7.1). The two decommissioning options typically selected for United States reactors are rapid decontamination and dismantlement (DECON), and safe storage of the stabilized and de-fueled facility (SAFSTOR), followed by final decontamination and dismantlement (**NRC 1996**, Section 7.2.2). Under the DECON option, radioactively contaminated portions of the facility and site are decontaminated or removed promptly after cessation of operations to a level that permits termination of the license; these activities require several years for large light-water reactors like Davis-Besse (**NRC 1996**, Table 7.8). The SAFSTOR option involves safe storage of the stabilized and defueled facility for a period of time followed by decontamination to levels that permit license termination. Regardless of the option selected, decommissioning typically must be completed within 60 years after operations cease in accordance with NRC requirements at 10 CFR 50.82 (**NRC 1996**, Section 7.2.2).

FENOC has not selected a decommissioning method for Davis-Besse. The decommissioning method for Davis-Besse would be described in post-shutdown decommissioning plans for the plant, which must be submitted to NRC within two years following cessation of operations. For purposes of the present analysis, FENOC assumes that the DECON option would be employed upon license termination.

The NRC presents in Chapter 7 and Section 8.4 of the GEIS a summary of generic environmental impacts of the decommissioning process and an evaluation of potential changes in impact that could result from deferring the decommissioning process for up to 20 years (**NRC 1996**). For a pressurized water reactor decommissioning, NRC used a 1,175 MWe reference reactor. Although larger than Davis-Besse (910 MWe), FENOC considers the reference reactor to be representative of Davis-Besse. As a result, FENOC believes the decommissioning activities described in the GEIS to be representative of activities FENOC would perform for decommissioning at Davis-Besse.

The NRC concluded from its evaluation that decommissioning impacts would not be significantly greater as a result of the proposed action, assumed to result in 20 additional years of operation (**NRC 1996**, Sections 7.3 and 8.4). The NRC conclusions also indicate that the impacts of the decommissioning process itself, addressed in this ER as part of the no-action alternative, would have SMALL impacts with respect to radiation dose, waste management, air quality, water quality, and ecological resources (see 10 CFR Part 51, Subpart A, Appendix B, Table B-1). FENOC considers this generic evaluation and associated conclusions applicable to Davis-Besse as well.

The NRC has provided additional analysis of the environmental impacts associated with decommissioning in the Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (**NRC 2002**). Except for issues that require site-specific evaluation, environmental impacts, including radiological releases and doses from decommissioning activities, were assessed to be SMALL (**NRC 2002**, Sections 4.3 and 6.1).

Regardless of the NRC decision on license renewal, FENOC will have to decommission Davis-Besse; license renewal would only postpone decommissioning for an additional 20 years. In the GEIS, the NRC concludes that there should be little difference between the environmental impacts from decommissioning at the end of 40 years of operation versus those associated with decommissioning after an additional 20 years of operation under a renewed license (**NRC 1996**, Section 7.4).

By reference, FENOC adopts the NRC findings regarding environmental impacts of decommissioning in the license renewal GEIS (**NRC 1996**) and in the decommissioning GEIS (**NRC 2002**), and concludes that environmental impacts under the no-action alternative would be similar to those that occur following license renewal. Further, FENOC believes that decommissioning activities would not involve significant land-use disturbance offsite or significant activities beyond current operational areas that would offer potential for impacts on land use, ecological resources, or cultural resources. Decommissioning impacts would be temporary and occur at the same time as those associated with the operation of replacement generating sources.

7.1.2 Replacement Capacity

Davis-Besse is a base-load generator of electric power, with a net generating capability of 908 MWe (Section 3.1.2). In 2008, Davis-Besse generated approximately 8.3% of FirstEnergy's total base-load electricity generation (**FirstEnergy 2008a**, Page 7; **USDOE 2010**). The power produced by Davis-Besse, which represents a significant portion of the electricity FirstEnergy supplies to 2.1 million customers in its service territories located in Ohio (**FirstEnergy 2009a**, Page 81), would be unavailable in the event the Davis-Besse operating license is not renewed.

As provided in 10 CFR 51.53(c)(2), FENOC does not consider the need for power from Davis-Besse in this analysis, but does consider the potential impact of alternatives for replacing this power. Replacement options considered include building new base-load generating capacity, purchasing power, delaying retirement of non-nuclear assets, and reducing power requirements through demand reduction, as discussed in Section 7.2.

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7.2 ALTERNATIVES THAT MEET SYSTEM GENERATING NEEDS

If the Davis-Besse operating license is not renewed, then the State of Ohio, FirstEnergy Corp. and its subsidiary companies, and other participants in the wholesale power market would lose approximately 910 MWe* of base-load capacity. Renewal would preserve the option of relying on Davis-Besse to meet future electric power needs through the period of extended operation.

While many methods are available to generate electricity, the GEIS indicates that a "reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially viable" (**NRC 1996**, Section 8.1). Considering that Davis-Besse serves as a large base-load generator, FENOC considers reasonable alternatives to be those that would also be able to generate base-load power. FENOC believes that any alternative would be unreasonable if it did not consider replacement of the energy resource.

7.2.1 ALTERNATIVES CONSIDERED AS REASONABLE

Fossil-Fuel Alternatives Summary

FENOC believes that coal-fired and gas-fired generation capacity are feasible alternatives to nuclear power generating capacity, based on current (and expected) technological and cost factors, as compared to the other alternatives listed in the GEIS (**NRC 1996**, Section 8.1). FENOC considers the coal-fired and gas-fired technologies reasonable alternatives for purposes of this analysis to replace Davis-Besse generating capacity in the event its operating license is not renewed. The GEIS further notes that natural gas combined-cycle plants are particularly efficient and are used as base-load facilities (**NRC 1996**, Section 8.3.10). The specific coal-generating technologies that would represent viable alternatives are less certain, particularly in view of potentially higher air emissions compared to natural gas firing. For example, large-capacity integrated gasification combined-cycle (IGCC) and fluidized-bed-combustion (FBC) technologies (atmospheric and pressurized) are at or near commercial viability and could prove to be appropriate replacements. However, modern pulverized coal plants with advanced, clean-coal technology air emission controls represent currently proven technology and are economically competitive and commercially available in large-capacity unit sizes that could effectively replace Davis-Besse. Therefore, FENOC uses a representative plant of this type for purposes of impact evaluation, noting that air emission impacts of IGCC and FBC options may be lower than modern pulverized coal, but would be higher than the gas-fired combined-cycle alternative (**USDOE 1999**, Pages 5-7).

*910 MWe is used for calculation convenience instead of 908 Mwe, as noted in Section 3.1.2.

Renewable Energy Alternatives Summary

On April 26, 2011, an NRC Atomic Safety and Licensing Board (Board) presiding over the license renewal proceeding for Davis-Besse issued a Memorandum and Order (LBP-11-13) admitting a contention alleging that the FENOC analysis of renewable energy alternatives in the Environmental Report was not adequate. As admitted by the Board, the contention states:

> [FENOC's ER] fails to adequately evaluate the full potential for renewable energy sources, specifically wind power in the form of interconnected wind farms and/or solar photovoltaic power, in combination with compressed air energy storage, to offset the loss of energy production from Davis-Besse, and to make the requested license renewal action unnecessary. The FENOC Environmental Report (Section 7.2) treats all of the alternatives to license renewal except for natural gas and coal plants as unreasonable and does not provide a substantial analysis of the potential for significant alternatives in the Region of Interest.

The Board's phrasing of the contention, as admitted, arguably includes the following renewable energy alternatives: 1) wind power in the form of interconnected wind farms; 2) wind power in the form of interconnected wind farms with compressed air energy storage (CAES); 3) solar (photovoltaic) power combined with CAES; or 4) a combination of interconnected wind farms and solar (photovoltaic) power with CAES.

FENOC does not believe that any of these are "reasonable" alternatives under NEPA. However, in order to resolve the issues raised in the admitted contention, FENOC has revised this ER to evaluate the renewable energy alternatives listed above as an alternative to replace the rated electrical output of Davis-Besse by 2017.

FENOC considers the other technologies listed in the GEIS as not reasonable alternatives for the reasons discussed in Section 7.2.2.

<u>Disclaimer</u>

Throughout Chapters 7 & 8, FENOC presents information about renewable energy resources compiled by others. FENOC has not independently confirmed the accuracy of these statements, nor does FENOC agree with them.

Additionally, FENOC does not agree that the renewable energy alternatives listed above can provide base-load generation or that the existing and any interstate transmission system available by 2017 could accommodate such renewable energy.

Finally, even if such a group of renewable resources were built, there is no way to assure that the power generated by those resources would be available to the CAES facility to create the alternative that Joint Petitioners envision. There are a number of considerations for the development of a solar or wind resource including the availability of sufficient sun or wind, the availability of land, grid access, cost of interconnection (which may be economically prohibitive in some cases), and sufficient transmission resources to assure the CAES's ability to interact with the resource.

The NRC has noted that, while there are many methods available for generating electricity and many combinations of alternative power generation sources that could provide base-load capacity, such an expansive consideration of alternatives would be too unwieldy (**NRC 1996**, Section 8.1).

7.2.1.1 Coal-Fired Generation

For purposes of this analysis, FENOC assumed development of a modern pulverized coal-fired power plant with state-of-the-art emission controls similar to that described in its license renewal application, Appendix E (Environmental Report), for the Beaver Valley Power Station (**FENOC 2007**, Section 7.2.2.2). In defining the Davis-Besse coal-fired alternative, FENOC has used site-specific input as appropriate.

The representative plant would consist of commercially available standard-sized units, with a nominal net output of approximately 910 MWe, and would be designed to meet applicable standards with respect to control of air and wastewater emissions. As a minimum, FENOC assumed that the plant would feature low nitrogen oxide burners with overfire air to minimize formation of nitrogen oxides, and selective catalytic reduction for post-combustion nitrogen oxide control. Emissions of particulate matter and mercury would be limited by use of a fabric filter (baghouse), and sulfur oxide emissions would be controlled using a wet scrubber using limestone as the reagent.

Table 7.2-1 lists the basic specifications for the representative plant.

The Davis-Besse site would not be a viable location for the representative plant as a result of space limitations (see Section 7.3.1, Land Use). Land area requirements for a coal-fired plant of similar capacity to Davis-Besse would be approximately 1.7 acres per MWe (**NRC 1996**, Section 8.3.9), or 1,547 acres for a 910 MWe plant. The needed land area, therefore, far exceeds the 954-acre Davis-Besse site, most of which is occupied by marshland that is leased to the U.S. Government as a national wildlife refuge (Section 2.1).

Therefore, FENOC assumed for the analysis that the representative coal-fired plant would be located elsewhere at a greenfield or (preferably) brownfield site close to a commercially, navigable waterway or existing railway. A navigable waterway location would be highly desirable from a technical and economic perspective, considering the relative abundance of cooling water and low fuel cost afforded by barge transportation of coal and limestone. FENOC further assumed for the analysis that the representative coal-fired plant would use closed-cycle cooling with a natural draft cooling tower.

Lastly, FENOC assumed for the analysis that the environmental impacts associated with siting, design, and operation of the plant would be subject to comprehensive review under Ohio Power Siting Board (OPSB) rules or a comparable process.

7.2.1.2 Gas-Fired Generation

For purposes of this analysis, FENOC assumed development of a modern natural gas-fired combined-cycle plant based on a commercially available design similar to that described in its license renewal application, Appendix E (Environmental Report), for the Beaver Valley Power Station (**FENOC 2007**, Section 7.2.2.1). In defining the Davis-Besse gas-fired alternative, FENOC has used site-specific input as appropriate.

The representative plant would consist of commercially available standard-sized units, with a nominal net output of approximately 910 MWe, and would be designed to meet applicable standards with respect to control of air and wastewater emissions. As a minimum, FENOC assumed that the plant would use natural gas as its only fuel and feature dry low-NO_X burners to minimize formation of nitrogen oxides during combustion and selective catalytic reduction for post-combustion nitrogen oxide control. Emissions of particulate matter and carbon monoxide would be limited through proper combustion controls.

Table 7.2-2 lists the basic specifications for the representative plant.

The Davis-Besse site is uncertain as a viable location for the representative plant due to space limitations. Land area requirements for a gas-fired plant of similar capacity to Davis-Besse, for example, would be approximately 0.11 acres per MWe (**NRC 1996**, Table 8.1), or 100 for a 910 MWe plant. Of the 954 acres of land occupied by the Davis-Besse site, 733 acres is occupied by marshland that is leased to the U.S. Government as a national wildlife refuge (Section 2.1). The remaining 221 acres is mostly occupied by Davis-Besse structures. Therefore, FENOC assumed for the analysis that the representative gas-fired plant would be located elsewhere at a greenfield or (preferably) brownfield site, but has not identified a specific site. However, primary considerations for a cost-competitive site include close proximity to adequate natural gas supply, transmission infrastructure, cooling water, and sufficient land suitable for development. For this analysis, FENOC assumed, based on FirstEnergy experience in gas-fired plant siting, that northwestern Ohio would be a realistic general area to locate the new plant (**FENOC 2007**, Section 7.2.2.1). FENOC further assumed for the analysis that the representative gas-fired plant would use closed-cycle cooling with mechanical draft cooling towers.

Lastly, FENOC assumed for the analysis that the environmental impacts associated with siting, design, and operation of the plant would be subject to comprehensive review under Ohio Power Siting Board (OPSB) rules or a comparable process.

7.2.1.3 Renewable Energy Generation

As explained above in Section 7.2.1, and subject to the disclaimers in that Section, FENOC is evaluating for the sole purpose of this NEPA analysis certain renewable energy alternatives. These alternatives are discussed in more detail below. Other renewable energy alternatives were rejected for the reasons explained below in Section 7.2.2.

Interconnected Wind Farms

Wind energy facilities use wind turbines to harness the kinetic energy of wind and transform it into electrical power. Output depends on a turbine's size and the wind's speed through the rotor as well as the availability of wind itself. Wind turbines manufactured today range from 250 watts (**AWEA 2002**) to 10 megawatts (MW) (**SWAY 2010**), and wind farms can range in capacity from a few megawatts to the 781+ megawatt Roscoe Wind Complex in Texas. (**CBS 2010**) Wind availability, speed and turbine height are critical factors for wind farm generating capacity. The stronger and more consistent the wind, and the taller the turbines, the higher potential capacity exists. Multiple land uses are often possible on wind farms. For example, a wind farm may generate electricity while cattle graze or corn grows on the land surrounding the turbines. (**AWEA 2002**)

Neither a single wind turbine nor interconnected wind farms currently provide baseload power anywhere in the United States. However, the theory that multiple wind farms located throughout a region and interconnected via the grid could provide for more consistent power generation due to the reduced likelihood that all sites would experience the same wind patterns at any given time, has been studied.

In one study, the benefits of interconnecting wind farms were evaluated for 19 sites located in the midwestern United States with annual average wind speeds greater than 6.9 meters per second (m/s) (class 3 or greater) at 80 m above ground, the hub height of modern wind turbines. The study reported that, on average, only 33% and a maximum of 47% of yearly-averaged wind power from interconnected wind farms could theoretically be relied upon to produce electricity. And there were days when no electricity was produced from these wind farms. (**JACM 2007**)

Additionally, delays in the implementation of interconnected wind technology can be due to transmission line construction difficulties, as the North American Electric Reliability Corporation (NERC) explains in its 2009 Long-Term Reliability Assessment. The NERC points out that siting of new bulk power transmission lines brings with it unique challenges due to the high visibility, their span through multiple states/provinces and, potentially, the amount of coordination/cooperation required among multiple regulating agencies and authorities. Lack of consistent and agreed-upon cost allocation approaches, coupled with public opposition due to land-use and property valuation concerns, have, at times, resulted in long delays in transmission line construction. New transmission, including transmission in the DOE's designated "National Interest Electric Transmission Corridors" can be delayed or halted by individual states, increasing the difficulty to site bulk transmission, including those projects focused on unlocking location-constrained renewable generation. These siting issues create a potential congestion issue and challenge the economic viability of new generation projects. (**NERC 2009**)

In the specific case of wind power, a wind project must be located where it would produce economical generation, and that location may be far removed from the nearest possible connection to the transmission system. A location far removed from the power transmission grid might not be economical, as new transmission lines would be required to connect the wind farm to the distribution system, and the question of who pays for the transmission upgrade would be at issue. 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 national authorities.

Jacobs and Archer completed a study of interconnected wind farms with consisting of up to 19 wind farm sites, and concluded that maximum capacity factors of approximately 45% could theoretically be obtained (**JACM 2007**). Davis-Besse's recent capacity factor has been in excess of 90%, which would generate approximately 7,158,672 MWh over a full year. To achieve a similar annual average at a 45% capacity factor, interconnected wind farms with a minimum of 1210 GE 1.5 MW turbines would be required, and would not be guaranteed due to the uncontrollability of the wind availability. It must be noted, however, that the studies by Jacobs and Archer were based on areas with higher annual average wind speeds (over 8 m/s). Thus, in Ohio, it would be expected that the GE 1.5-MW turbines might not operate as efficiently and thus the number of turbines required for replacement power generation would be higher. And there would still be times when reserve capacity from traditional generation or energy storage would be required. Using larger turbines could be used if wind speeds supported their economical use, especially in offshore locations (discussed below), which would reduce land use.

Since 1998-99, average turbine nameplate capacity has increased by 151%, but growth in this metric has slowed in recent years due to the dominance of GE's 1.5 MW turbine and as a result of the logistical challenges associated with transporting larger turbines to project sites. (**USDOE 2011**) There are several land based wind farms under construction or planned in Ohio. These wind farms will utilize wind turbines ranging from 1.8 MW (Timber Ridge Wind Farm) to 2.0 MW (Blue Creek Wind Farm). (**WAG 2011** and **TBM 2011**)

FENOC reviewed several recent documents describing studies conducted by the National Renewable Energy Laboratory (NREL) related to wind integration and transmission studies for both land-based and offshore wind generating facilities (**NREL 2011, NREL 2010, NREL 2010a**). Based on the findings in these documents, a land-based interconnected transmission system in the central and eastern United States is likely to be completed by 2024. For the sole purpose of this NEPA analysis, however, FENOC evaluates renewable energy alternatives as if an interconnected grid system would be available by 2017.

FENOC also evaluated the potential for offshore wind generation and integrating that power into the transmission system. Although both Lake Erie and Lake Michigan have significant wind resources, no offshore wind turbines have been sited in freshwater, particularly a potable water source such as the Great Lakes. (**USDOE 2011**)

Offshore wind power project and policy developments continued in 2010; however, to date no offshore projects have been installed in the United States and the emergence of an offshore wind power market still faces many challenges. Nonetheless, interest exists in developing offshore wind energy in several parts of the country, with nine projects totaling 2322 MW of unstated capacity factors primarily located in the Northeast and Mid-Atlantic, though proposed projects also exist in the Great Lakes and Gulf of Mexico. (**USDOE 2011**) Many of these projects have advanced significantly in the permitting and development process, including three that have signed power purchase agreements with terms and details that have been made public. Notably, the Cape Wind project was granted approval by the Department of Interior in 2010; several significant strides relating to offshore wind energy have been made recently in the federal arena; and a variety of other recent project and state policy announcements demonstrate continued activity in the offshore wind energy sector. (**USDOE 2011**)

In August 2009, Lake Erie Energy Development Corporation (LEEDCo) was created by the Great Lakes Energy Development Task Force (GLEDTF), then developed and launched by NorTech Energy Enterprise, the Cleveland Foundation, City of Cleveland, Cuyahoga and Lorain Counties (Ohio). It was founded as a private, non-profit regional corporation to initially build wind turbines in Lake Erie, and eventually help stimulate an entire offshore freshwater wind industry. Initially LEEDCo plans to build and install a 20-30 megawatt (MW) wind energy pilot project seven miles offshore of downtown Cleveland which would be the first offshore freshwater wind energy project in North America. LEEDco then plans to use the initial project as a road map to develop the permitting process and catalyze future offshore wind projects by commissioning the first 20-to-30 MW, five-to-seven turbines by 2013, with a long-term vision of generating 1000 MW of wind energy by 2020. (**LEEDCo 2011**)

Despite the unlikely development of sufficient offshore wind generation as outlined above, FENOC evaluates—for the sole purpose of this NEPA analysis—wind energy from interconnected wind farms as if such energy was available by 2017. Therefore, FENOC evaluated the potential environmental impacts for offshore wind generation and integrating that power into the transmission system as a replacement for Davis-Besse's rated electrical output.

Solar Farms

Electric power generation from photovoltaic (PV) cells has been commercially demonstrated. However, because the sun only shines during the day, solar PV arrays cannot by themselves consistently produce electricity. There is currently only one operational solar energy facility in Ohio greater than 10 MW—the 12-MWe Wyandot Solar Farm in Upper Sandusky, OH (**PSEG 2010**). The 49.9 MWe Turning Point Solar project near Cumberland, OH, is projected to be completed in 2015 (**AEP 2011**). FENOC is not aware of other planned solar energy facilities greater than 10 MW in Ohio that would be operational by 2017, and whose output is not already dedicated to an existing commercial or industrial facility.

A solar project would have to be located where the project would produce economical generation, and that location may be far removed from the nearest possible connection to the transmission system. A location far removed from the power transmission grid might require construction of new transmission lines to connect the solar farm to the distribution system, and the question of who pays for the transmission upgrade would be at issue. 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 solar farms. 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 national authorities.

Although solar resources are limited in Ohio, FENOC evaluates—for the sole purpose of this NEPA analysis—solar energy combined with CAES, and combined with interconnected wind farms and CAES, as alternatives to replace the rated electrical output of Davis-Besse by 2017.

Compressed Air Energy Storage

FENOC is presenting the following information about CAES technology as background for the discussion that follows about CAES combined with interconnected wind farms or solar energy facilities.

CAES can be linked with renewable energy by offering one way to supplement and back-up the electricity produced by intermittent resources such as wind and solar. This energy storage method enhances the ability of these resources to provide the electricity that customer's need, when they need it.

However, CAES facilities are generally operated as peaking plants with energy placed into storage during the less expensive, non-peak demand hours and generated from the storage units during the higher-priced, peak demand hours. CAES involves using compressors powered by the generation source to pump air into a storage facility, such as an underground cavern. During peak demand hours, the compressed air is used in combination with a heat source, such as natural gas, to drive turbines and generate electricity. To generate electricity from CAES, natural gas usage is between one-third and one-half that needed to generate the same amount of electricity at a natural gas generating plant (**USDOE 2009**). Due to the cost differential between peak and non-peak hours and the reduction in the volume of natural gas used to generate a specific amount of power, a CAES facility can be an economically and environmentally attractive method of producing peaking power (**RES 2005**; **PEI 2008**).

These economic benefits evaporate if the energy source used to pump air into the storage facility is solar power, or wind power available during the day. Since solar is a resource mostly available during the onpeak daytime hours, storage offers little economic benefit when evaluating solar (or daytime wind power) with CAES. FENOC is not aware of any existing CAES facilities that are combined solely with wind or solar power.

The Iowa Stored Energy Park (ISEP) was proposed to be a 270 MW CAES facility integrated with a wind farm in Iowa. However, testing and analysis of the site geology concluded that the ability to store the air underground at the ISEP site near Dallas Center, Iowa was unfeasible. (**ISEP 2011**)

Two CAES facilities combined with natural gas power plants, a 110-MW facility in Alabama and a 290-MW plant in Germany, have been built and are in operation (**PEI 2008**). A CAES facility powered with energy from generation facilities already on the power grid is proposed for Norton, Ohio. This facility, which is still in the project development stage, is planned to eventually—i.e., after 2017—provide 2700 MW of peaking power generation (**PEI 2008**). The Norton CAES project is somewhat different from the other CAES projects in that a pre-existing mine on a brownfield site would be utilized. The size and the mining engineered construction of the pre-existing mine allows a much greater planned capacity for the Norton facility as compared to other existing or proposed CAES projects.

Norton Energy Storage

In 2009, FirstEnergy Generation Corp., a subsidiary of FirstEnergy Corp., purchased the rights to develop the Norton Energy Storage (NES) facility. The facility is located on a 92-acre site in Norton, Ohio. The compressed air would be stored in a 600-acre underground cavern, formerly operated as a limestone mine, which is ideal for energy storage technology. The facility would generate electricity during on-peak and intermediate periods, which would enable the more efficient operation of large, base-load power plants. FirstEnergy is currently developing the NES facility and it would be constructed in phases. The initial phase is designed to produce 268 MW of generation, 220 MW of compression, and 373 hours of storage using two 134 MW generators. FirstEnergy estimates that up to four units or 536 MW of generation could be online by 2017. The existing air permit for the NES facility authorizes FirstEnergy Generation Corp to expand the facility to a capacity of 804 MW (see Table 7.2-3). (**NES 2010**) This project has two major components: the above-ground equipment and the subsurface abandoned limestone mine used to store compressed air. The size of the cavern could eventually allow the project to provide up to 2700 MW of generation if the current air permit could be modified.

The NES facility would include two power generation units designed specifically for the CAES application. Each unit would consist of an air compressor, a motor, an expander, an associated combustor and a generator. The facility would be designed to operate on natural gas only; no fuel oil would be combusted in the turbines or in-line burners. The major ancillary support equipment would consist of an emergency generator, a backup diesel fire pump, and wet cooling towers to cool compressor air to be injected into storage and provide other equipment cooling. Other support equipment would include cooling water treatment systems, acid/caustic or neutralization tanks, instrument air compressors, electric driven fuel compressors, sumps, and oil/water separators.

<u>Available Alternatives for Renewable Energy Generation in Combination with Energy Storage</u>

The potential for using renewable power sources as an alternative to license renewal can be enhanced if the generation source is combined with an energy storage technology, thus increasing the availability, reliability, and predictability of the delivery of power. The two renewable power generation sources evaluated in this ER are interconnected wind farms and photovoltaic solar facilities.

The theory behind the combination of renewable power generation with energy storage is that when the generation capacity is available, the amount of power produced could, at times, exceed the demand for power at that time. Excess energy could be stored and returned later to the electrical grid when the renewable power generation resource is either not available or is available at a diminished level that is insufficient to satisfy the demand for power.

Therefore, in order for this combination of technologies to function, the renewable energy source would have to be sized larger than the base-load power level in this case for Davis-Besse, 910 MW. The need to have generation capacity greater than base-load requirements in order to place energy into storage would cause greater environmental impacts than a generation source rated at the base-load value alone. For example, a solar or wind generation source assumed to be available for 12 hours every day, and a CAES facility assumed to be available to generate electricity the remaining 12 hours in the day, would require that generation source to be rated at, and consistently produce 1820 MW in order to provide 24-hours of continuous electricity (i.e., 12 hours to provide 910 MW of generation onto the grid, and the same 12 hours to provide 910 MW to recharge the CAES facility, so that the CAES facility could feed the grid the remainder of the day).

As explained in Section 7.2.1, FENOC evaluates—for the sole purpose of this NEPA analysis—renewable energy sources combined with energy storage as an alternative to replace the rated electrical output of Davis-Besse.

Wind Energy Generation Combined with CAES

As of 2011, there is currently 11 MWe of wind generation in Ohio with another 406 MWe under construction. (**AWEA 2011**) However, Ohio has a potential wind generation capacity of nearly 55,000 MW according to the NREL (**AWEA 2011 and NREL 2011a**), which at a 30% capacity factor would be more than sufficient to provide power to operate a CAES facility. The 30% capacity factor is derived from PJM Interconnection (a regional transmission organization) and the U.S. Department of Energy (USDOE) (**PJM 2011** and **USDOE 2011**. The environmental impacts of developing this type of generation alternative are evaluated in Section 7.3.3.

For this combination, FENOC evaluated wind energy generating electricity for both 910 MW to replace Davis-Besse's rated output and 910 MW of storage capacity, for a total of 1820 MWe. Sufficient energy must be put into storage when the wind resources are available to account for the lack of power generation capabilities for the periods of time when adequate wind resources are unavailable. Under this alternative, natural gas would be needed to recover the energy captured in the CAES process, but would not be used as a source of supplemental power generation if wind generation or generation from the storage facility is not available for extended periods of time.

Photovoltaic Power Combined with CAES

As stated previously, there is currently only one operational solar energy facility in Ohio greater than 10 MW: the 12-MWe Wyandot Solar Farm in Upper Sandusky, OH. (**PSEG 2010**) The 49.9-MWe Turning Point Solar project near Cumberland, OH, is projected to be completed in 2015. (**AEP 2011**) FENOC is not aware of other planned solar energy facilities greater than 10 MW in Ohio that would be operational by 2017, and whose output is not already dedicated to an existing commercial or industrial facility. As with wind, FENOC evaluated solar farms as if they were interconnected with CAES to provide electricity to the grid.

Combinations of Wind and Solar with CAES

As referenced above, approximately 1820 MWe of base-load power would be required from renewable energy generation plus storage to account for the lack of power generation capabilities for the periods of time when adequate wind and solar resources are unavailable.

FENOC evaluates—for the sole purpose of this NEPA analysis—the following a combined alternative to replace the rated electrical output of Davis-Besse by 2017: sufficient interconnected wind farms and solar (PV) facilities available with high reliability, and connected to an operating CAES facility; an operating CAES facility expanded to a capacity similar to Davis-Besse; and an interconnected grid system. The potential environmental impacts related to this scenario are presented in Section 7.3.3.3.

7.2.2 Alternatives Considered as Not Reasonable

The following alternatives were considered as not reasonable replacement base-load power generation for one or more reasons as listed in Section 7.2.2.1 and Section 7.2.2.2. Although several of the alternatives could be considered in combination for replacement power generation at multiple sites, they do not generally provide base-load generation, and would entail greater environmental impacts.

7.2.2.1 Alternatives Not Requiring New Generating Capacity

This section discusses the economic and technical feasibility of supplying replacement energy without constructing new base-load generating capacity. Specific alternatives include:

- Conservation measures (including implementing demand side management (DSM) actions);
- Delayed retirement of existing non-nuclear plants; and
- Purchased power from other utilities equivalent to the output of Davis-Besse (i.e., eliminating the need for license renewal).

<u>Conservation Programs</u>

There is a variety of conservation technologies (e.g., DSM) that could be considered as potential alternatives to generating electricity at Davis-Besse. Examples include:

- Conservation Programs—homeowner agreements to limit energy consumption; educational programs that encourage the wise use of electricity.

- Energy Efficiency Programs– discounted residential rates for homes that meet specific energy efficiency standards; programs providing residential energy audits and encouraging efficiency upgrades; incentive programs used to encourage customers to replace older inefficient appliances or equipment with newer versions that are more efficient.
- Load Management Programs – programs that encourage customers to switch load to customer-owned standby generators during periods of peak demand; programs that encourage customers to allow a portion of their load to be interrupted during periods of peak demand.

On a national basis, DSM has shown great potential in reducing peak demand (maximum power requirement of a system at a given time). In 2008, a peak load reduction of 32,741 MWe was achieved nationally, which is an increase of 8.2% from 2007; however, since these DSM costs increased by 47.4%. DSM costs can vary significantly from year to year because of business cycle fluctuations and regulatory changes. Since costs are reported as they occur, while program effects may appear in future years, DSM costs and effects may not always show a direct relationship. Since 2003, nominal DSM expenditures have increased at 22.9% average annual growth rate. During the same period, actual peak load reductions have grown at a 6.2% average annual rate from, 22,904 MW to 32,741 MW (**EIA 2010**, Page 9).

In Ohio, as part of Senate Bill 221, utilities must implement energy efficiency programs that, beginning in 2009, achieve energy savings of at least 0.3% of the utility's three-year average annual kilowatt-hour (kWh) sales, with energy savings increasing to 22.5% by the end of 2025. Peak demand reductions of 1% in 2009 and increasing to 7.75% by the end of 2018 are also required. (**FirstEnergy 2009a**, Page 100) However, since these DSM-induced load reductions typically are considered in load forecasts, the reductions do not offset the projected power demands that are expected to be supplied with the power generated by Davis-Besse.

Although FENOC believes that energy generation savings can increase from DSM practices, it would be unrealistic to increase those energy savings to completely and consistently replace the Davis-Besse generating capability. The variability in associated costs also makes DSM a less desirable option. Consequently, FENOC does not see DSM as a practicable offset for the base-load capacity of Davis-Besse.

Delayed Retirement

Extending the lives of existing non-nuclear generating plants beyond the time they were originally scheduled to be retired, as described in the GEIS (**NRC 1996**, Section 8.3.13), does not represent a realistic option with respect to FirstEnergy's generating assets.

Approximately 56% of FirstEnergy's generating capacity consists of coal-fired plants which, due to a lower cost of generation, are used at capacity factors higher than other fossil-fuel generating units (**FirstEnergy 2008b**). Virtually all of FirstEnergy's non-nuclear base-load generating capability is from coal firing. These coal-fired plants were developed in the 1980s or earlier and represent the only plants in FirstEnergy's portfolio that would have any potential for continued operation to replace the base-load generation represented by Davis-Besse. However, older plants that do become candidates for retirement generally represent less efficient generation and pollution control technologies than are available in more modern plants, and continued operation typically would require substantial upgrades to be economically competitive and meet applicable environmental standards. In many cases, it is unlikely that such upgrades would be economically viable. FENOC believes that the environmental impacts of implementing such upgrades and operating the upgraded plants are bounded by the assessments presented in Section 7.3 for the gas-fired and coal-fired alternatives.

For these reasons, the delayed retirement of non-nuclear generating units is not considered by FENOC as a reasonable alternative to the renewal of Davis-Besse's license.

Purchased Power

Each of the states (Ohio, Pennsylvania, and New Jersey) in which FirstEnergy serves load have undertaken electric industry restructuring initiatives that promote competition in retail energy markets by allowing participation of non-utility suppliers. Retail customers historically served by the regulated operating subsidiaries of FirstEnergy now have the option to choose between FirstEnergy-affiliated suppliers and other state-qualified energy suppliers. (**FENOC 2007**, Section 7.2.3.2)

In theory, purchased power is a feasible alternative to Davis-Besse license renewal. There is no assurance, however, that sufficient capacity or energy would be available during the entire license renewal time frame to replace the approximately 910 MWe of base-load generation. In addition, even if power to replace Davis-Besse capacity were to be purchased, FENOC assumes that the generating technology used to produce the purchased power would be one of those described in the GEIS. Thus, the environmental impacts of purchased power would still occur, but would be located elsewhere within the region.

As a result, FENOC has determined that purchased power would not be a reasonable alternative to replace power lost in the event the Davis-Besse operating license is not renewed.

7.2.2.2 Alternatives Requiring New Generating Capacity

The following conventional power plant types are evaluated in this section as potential alternatives to license renewal:

- New Nuclear Reactor
- Petroleum Liquids (Oil)

In addition, with the passage of Ohio's Senate Bill 221 in 2008, at least 25% of electricity supply for retail customers must come from renewable and advanced energy resources by 2025 **OHPUCO 2009**, Pages 3 and 4). Accordingly, the following alternative energy sources are evaluated.

- Hydropower
- Solar
- Geothermal
- Biomass (Wood Waste)
- Municipal Solid Waste
- Other Biomass-Derived Fuels (Energy Crops)
- Fuel Cells

Criteria used to determine if the potential energy alternatives represent a reasonable alternative include whether the alternative is developed and proven, can provide generation of approximately 910 MWe of electricity as a base-load supply, is economically feasible, and does not impact the environment more than Davis-Besse.

<u>New Nuclear Reactor</u>

Increased interest in the development of advanced reactor technology has been expressed by members of both industry and government. With energy demands forecasted to increase and public opposition to new carbon-fueled power plants, some companies are pursuing permits and licenses to build and operate new nuclear reactors to meet the country's future energy needs. As of June 2010, for example, 18 applications, for 28 units, for combined licenses have been submitted to the NRC for review (**NRC 2010**).

Nonetheless, there is ongoing uncertainty with respect to future electric demand due to the potential impacts of policy changes that could be enacted to limit or reduce greenhouse gas emissions. The downturn in the world economy also has had a significant impact on energy demand as well. The recovery of the world's financial markets is especially important for the energy supply outlook, because the capital-intensive nature of most large energy projects makes access to financing a critical necessity. (**EIA 2010**, Pages 5). Moreover, the economics of new nuclear plants remain uncertain with escalating fuel and construction costs emerging as forces which could affect this option.

In consideration of the extended schedule for construction of a new nuclear reactor, access to capital, and the schedule for the new reactor licensing process, construction of a new nuclear reactor at the Davis-Besse site or at an alternative site is not feasible prior to the period of extended operation for Davis-Besse, i.e., in this case, 2017. Therefore, a new nuclear reactor is not considered a reasonable alternative to renewal of Davis-Besse's operating license..

Petroleum Liquids (Oil)

Oil-fired generation has experienced a significant decline since the early 1970s. Increases in world oil prices have forced utilities to use less expensive fuels (**NRC 1996**, Section 8.3.11). From 2002 to 2008, for example, the average cost of petroleum for power generation increased by more than a factor of three (**EIA 2010**, Table 3.5).

This high cost of oil has prompted a steady decline in its use for electricity generation. Within Ohio, for example, oil-fired units produce only 0.2% of power generation (**NEI 2008**). Increasing domestic concerns over oil security also will intensify the move away from oil-fired electricity generation.

Therefore, FENOC does not consider oil-fired generation a viable alternative to renewal of Davis-Besse's operating license.

Hydropower

Considering the FirstEnergy transmission and distribution territory, Ohio and Pennsylvania have a combined potential for 1,758 MWe of additional undeveloped hydroelectric capacity, with Ohio contributing 57 MWe (**INEEL 1998**, Table 4). Thus, hydropower is a feasible alternative to Davis-Besse license renewal in theory.

However, as noted in the GEIS, hydropower's percentage of United States generating capacity is expected to decline because the facilities have become difficult to site as a result of public concern about flooding, destruction of natural habitat, and alteration of natural river courses (**NRC 1996**, Section 8.3.4). For example, the GEIS estimated that land requirements for hydroelectric power are approximately 1 million acres per 1,000 MWe. Replacement of the Davis-Besse generating capacity would therefore require flooding a substantial amount of land (910,000 acres). Consequently, even if the capacity for development were available in Ohio-Pennsylvania, there would be large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to replace Davis-Besse.

As a result, developing a hydropower base-load capacity of approximately 910 MWe is not considered by FENOC to be a reasonable alternative to renewal of Davis-Besse's operating license.

Solar Power

Solar power technologies, both thermal and photovoltaic (PV), have been commercially demonstrated. However, because the sun only shines during the day, solar arrays cannot, by themselves, provide consistent electrical output . Therefore, solar arrays alone are not considered in this ER as a reasonable alternative to the license renewal of Davis-Besse. Solar energy in combination with interconnected wind farms and CAES is discussed in Section 7.2.1.3.

Geothermal Energy

Geothermal energy has an average capacity factor of 90 percent and can be used for base-load power where available (**NRC 2009b** Section 8.2.5.5). However, geothermal electric generation is limited by the geographical availability of geothermal resources. As illustrated by Figure 8.4 in the GEIS, no feasible eastern location for geothermal capacity exists to serve as an alternative to Davis-Besse (**NRC 1996**, Section 8.3.5). As a result, FENOC does not consider geothermal energy to be a reasonable alternative to renewal of the Davis-Besse operating license.

Biomass Energy

Biomass is any organic material made from plants or animals. Agricultural and wood wastes such as forestry residues, particularly paper mill residues, are the most common biomass resources used for generating electricity. Regionally, eastern Ohio and most of Pennsylvania provide the largest biomass resources (**EERE 2009a, b**). The costs of these fuels, however, are highly variable and very site specific (**NRC 1996**, Section 8.3.6).

Most biomass plants use direct-fired systems by burning biomass feedstocks to produce steam directly for conventional steam turbine conversion technology. Although the technology is relatively simple to operate, it is expensive and inefficient. Conversion efficiencies of wood-fired power plants are typically 20-25%, with capacity factors of around 70-80%. As a result, biomass plants at modest scales (≤50 MWe) make economic sense if there is a readily available supply of low-cost wood wastes and residues nearby so that feedstock delivery costs are minimal. (**NRC 1996**, Section 8.3.6)

The construction impacts of a wood-fired plant would be similar to those for a coal-fired plant, although most facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, biomass and wood-waste plants require large areas for fuel storage and processing. They also create impacts to land and water resources, primarily associated with soil disturbance and runoff, in addition to air emissions which must be managed. However, unlike coal-fired plants, biomass and wood-waste plants have very low levels of sulfur oxide emissions. (**NRC 1996**, Section 8.3.6)

Due to the relatively small scale of potential projects and uncertainties in securing long-term fuel supplies, biomass is not considered by FENOC to be a reasonable alternative to replace Davis-Besse's base-load power generation.

Municipal Solid Waste

Municipal solid waste (MSW) facilities that convert waste to energy use technology comparable to steam-turbine technology for wood waste plants, although the capital costs are greater due to the need for specialized separation and handling equipment (**NRC 1996**, Section 8.3.7). The decision to burn MSW for energy is typically made due to insufficient landfill space, rather than energy considerations.

There are 89 operational MSW energy conversion plants in the United States (**USEPA 2009a**), none of which were located in Ohio as of 2007 (**WTE 2007**). These plants generate approximately 2,500 MWe, or about 0.3% of total national power generation (**USEPA 2009a**). At an average capacity of about 28 MWe, numerous MSW-fired power plants would be needed to replace the base-load capacity of Davis-Besse.

Construction impacts for a waste-to-energy plant are estimated to be similar to those for a coal-fired plant. Air emissions are potentially harmful. Increased construction costs for new plants and economic factors (i.e., strict regulations and public opposition) may limit the growth of MSW energy generation (**NRC 1996**, Section 8.3.7; **USEPA 2009a**).

For reasons stated, MSW is not considered by FENOC to be a reasonable alternative to renewal of Davis-Besse's operating license.

Other Biomass-Derived Fuels

In addition to biomass energy such as wood and municipal solid-waste fuels, there are other concepts for biomass-fired electric generators, including direct burning of energy crops, conversion to liquid biofuels, and biomass gasification. The GEIS indicated that none of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a base-load plant (**NRC 1996**, Section 8.3.8). After recently re-evaluating current technologies, the NRC staff believes other biomass-fired alternatives are still unable to reliably replace base-load capacity (**NRC 2009b**, Section 8.2.5.8). For this reason, FENOC does not consider biomass-derived fuels to be a reasonable alternative to renewal of Davis-Besse's operating license.

Fuel Cells

Fuel cells are electrochemical devices that generate electricity without combustion and without water and air pollution. Fuel cells began supplying electric power for the space program in the 1960s. Today, they are being developed for more commercial applications. The U.S. Department of Energy (USDOE) is currently partnering with several fuel cell manufacturers to develop more practical and affordable designs for the stationary power generation sector. If successful, fuel cell power generation should prove to be efficient, reliable, and virtually pollution free. At present, progress has been slow and costs are high. The most widely marketed fuel cell is currently about $4,500 per kilowatt (kW) compared to $800 to $1,500 per kW for a diesel generator and about $400 per kW or less for a natural gas turbine. By the end of this decade, the USDOE goal is to reduce costs to as low as $400 per kW. **(USDOE 2009b)**

However, fuel cells presently are not economically or technologically competitive with other alternatives for base-load capacity. Therefore, FENOC does not consider fuel cells to be a reasonable alternative to renewal of Davis-Besse's operating license.

Table 7.2-1 Coal-Fired Alternative Emission Control Characteristics

Characteristic	Basis
Net capacity = 910 MW	Equivalent to Davis-Besse.
Capacity factor = 80%	From **FENOC 2007**, Table 7.2-2
Firing mode: subcritical, tangential, dry-bottom pulverized coal	Widely demonstrated, reliable, economical; tangential firing minimizes NO_X emissions (**FENOC 2007**, Table 7.2-2)
Fuel type = bituminous coal	Type used in FirstEnergy Ohio River plants (**FENOC 2007**, Table 7.2-2)
Fuel heating value = 12,285 Btu/lb	FirstEnergy Bruce Mansfield Plant average (**FENOC 2007**, Table 7.2-2)
Heat rate = 9,800 Btu/kWh at full load	FirstEnergy experience (**FENOC 2007**, Table 7.2-2)
Fuel sulfur content = 3.52 wt% ; 2.86 lb/MMBtu	FirstEnergy Bruce Mansfield Plant average (**FENOC 2007**, Table 7.2-2)
Fuel ash content = 11.88 wt%	FirstEnergy Bruce Mansfield Plant average (**FENOC 2007**, Table 7.2-2)
Uncontrolled SO_X emissions = 130 lb/ton coal	USEPA estimate calculated as 38 x wt% sulfur in coal (**FENOC 2007**, Table 7.2-2)
Uncontrolled NO_X emissions = 10 lb/ton coal	USEPA estimate (**FENOC 2007**, Table 7.2-2)
Uncontrolled CO emission = 0.5 lb/ton coal	USEPA estimate (**FENOC 2007**, Table 7.2-2)
Uncontrolled PM emission = 120 lb/ton coal	USEPA estimate calculated as 10 x wt% ash in coal (**FENOC 2007**, Table 7.2-2)
Uncontrolled PM_{10} emission = 27 lb/ton coal	USEPA estimate calculated as 2.3 x wt% of ash in coal (**FENOC 2007**, Table 7.2-2)
CO_2 emissions = 6,000 lb/ton	Approximate average for bituminous coal combustion (**FENOC 2007**, Table 7.2-2)
SO_X control = wet limestone flue gas desulphurization (95% removal)	Best available technology for minimizing SO_X emissions (**FENOC 2007**, Table 7.2-2)
NOX control = low NOX burners, overfire air, selective catalytic reduction (95% reduction)	Best available technology for minimizing NO_X emissions (**FENOC 2007**, Table 7.2-2)
Particulate control = fabric filters (99.9% removal)	Best available technology for minimizing particulate emissions (**FENOC 2007**, Table 7.2-2)

Btu = British thermal unit
CO = carbon monoxide
CO_2 = carbon dioxide
ft^3 = cubic feet
kWh = kilowatt-hour
lb = pound
MMBtu = million Btu
MW = megawatt
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = PM with diameter less than 10 microns
SO_X = sulfur oxides
USEPA = U.S. Environmental Protection Agency
wt% = percent by weight

Table 7.2-2: Gas-Fired Alternative Emission Control Characteristics

Characteristic	Basis
Net capacity = 910 MW	Equivalent to Davis-Besse.
Capacity factor = 80%	From **FENOC 2007**, Table 7.2-1
Fuel type = natural gas	Assumed
Heat rate = 6,500 Btu/kWh	FENOC Estimate (**FENOC 2007**, Table 7.2-1)
Fuel heating value = 1,025 Btu/ft^3	From **FENOC 2007**, Table 7.2-1
Fuel sulfur content = 0.2 grains/100 scf (0.00068 wt%)	From **FENOC 2007**, Table 7.2-1
SO_2 emissions = 0.00064 lb/MMBtu (0.94 x wt% sulfur in fuel)	USEPA estimate for natural gas-fired turbines (**FENOC 2007**, Table 7.2-1)
NO_X emissions (assuming dry low-NO_X combustors) = 0.099 lb/MMBtu	USEPA estimate for best available NO_X combustion control (**FENOC 2007**, Table 7.2-1)
NO_X post-combustion control: selective catalytic reduction (90% reduction)	USEPA estimate for best available NO_X post-combustion control (**FENOC 2007**, Table 7.2-1)
CO emissions (assuming dry low-NO_X combustors) = 0.015 lb/MMBtu	USEPA estimate (**FENOC 2007**, Table 7.2-1)
PM emissions (all PM_{10}) = 0.0019 lb/MMBtu	USEPA estimate (**FENOC 2007**, Table 7.2-1)
CO_2 emissions = 110 lb/MMBtu	USEPA estimate (**FENOC 2007**, Table 7.2-1)

Btu = British thermal unit
CO = carbon monoxide
CO_2 = carbon dioxide
ft^3 = cubic feet
kWh = kilowatt-hour
lb = pound
MMBtu = million Btu
MW = megawatt
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = PM with diameter less than 10 microns
scf = standard cubic feet
SO_X = sulfur oxides
USEPA = U.S. Environmental Protection Agency
wt% = percent by weight

Table 7.2-3: CAES Alternative Emission Control Characteristics

Characteristic	Basis
Net capacity = 804 MW	Six trains at 134 MW per train (maximum authorized under existing air permit, although only 536 MW could be online by 2017)
Capacity factor = 80%	Within typical range of base-load plant; results in approximate annual output near that of Davis-Besse.
Fuel type = natural gas	Assumed
Heat rate (HHV) = 4,395 Btu/kWh	From OEPA Air Permit P0106714; Norton CAES
Fuel heating value = 1,025 Btu/ft^3	From **FENOC 2007**, Table 7.2-1
Fuel sulfur content = 2 grains/100 scf (0.0066 wt%)	From OEPA Air Permit P0106714; Norton CAES
SO_2 emissions = 0.006 lb/MMBtu	From OEPA Air Permit P0106714; Norton CAES
NO_X emissions (assuming water injection & selective catalytic reduction) = 3.0 ppmvd @ 15% oxygen and 43.08 lbs/hr (6 units at 7.18 lbs/hr each)	From OEPA Air Permit P0106714; Norton CAES
CO emissions (assuming dry low-NO_X combustors & CO catalytic oxidation) = 5 ppmvd @ 15% oxygen and 43.68 lbs/hr (6 units at 7.28 lbs/hr each)	From OEPA Air Permit P0106714; Norton CAES
PM emissions (all PM_{10}) = 0.0066 lb/MMBtu and 23.34 lbs/hr (6 units at 3.89 lbs/hr each)	From OEPA Air Permit P0106714; Norton CAES
CO_2 emissions = 110 lb/MMBtu	USEPA estimate (**FENOC 2007**, Table 7.2-1)
VOC emissions = 13.2 lbs/hr (6 units at 2.2 lbs/hr each)	From OEPA Air Permit P0106714; Norton CAES

Btu = British thermal unit
CO = carbon monoxide
CO_2 = carbon dioxide
CAES = compressed air energy storage
ft^3 = cubic feet
HHV = higher heating value
kWh = kilowatt-hour
lb = pound
lbs/hr = pounds per hour
MMBtu = million Btu
MW = megawatt
NO_X = nitrogen oxides
OEPA = Ohio Environmental Protection Agency
PM = particulate matter
PM_{10} = PM with diameter less than 10 microns
ppmvd = parts per million volumetric dry
scf = standard cubic feet
SO_X = sulfur oxides
USEPA = U.S. Environmental Protection Agency
wt% = percent by weight
VOC = volatile organic compound

7.3 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

Environmental impacts are evaluated in this section for the coal- and gas-fired generation alternatives determined by FENOC to be reasonable in Section 7.2.1 compared to renewal of Davis-Besse's operating license.

The impacts are characterized as being SMALL, MODERATE, or LARGE. The definitions of these impact descriptions are the same as presented in the introduction to Chapter 4, which in turn are consistent with the criteria established in 10 CFR Part 51, Appendix B to Subpart A, Table B-1, Footnote 3. FENOC believes the environmental impacts associated with the construction and operation of new generating capacity at a greenfield site would exceed those for the same type plants located at Davis-Besse or at another existing disturbed site, i.e., brownfield site.

The new generating plants addressed in Section 7.2.1 would not be constructed only to operate for the period of extended operation of Davis-Besse. Therefore, FENOC assumes for this analysis a typical design life of 40 years for the coal-fired plant, 30 years for the combined-cycle natural gas-fired plant, and considers impacts associated with operation for the entire design life of the units in this analysis. The life span of a wind turbine is 20 years (**REN 2005**); however, turbines can be replaced and the tower would likely be in service for at least 40 years. The life span of a solar plant is estimated to be at least 30 years (**TEP 2005**).

Chapter 8 presents a summary comparison of the environmental impacts of license renewal and the alternatives discussed in this section.

7.3.1 COAL-FIRED GENERATION

This section presents the impact evaluation for the representative coal-fired generation alternative. As discussed in Section 7.2.1.1, FENOC assumed for purposes of this analysis that the representative plant would be located at a greenfield or (preferably) brownfield site along commercially navigable waterway or existing rail way. This assumption is a result of the space limitation at the Davis-Besse site.

Land Use

Land area requirements for a coal-fired plant of similar capacity to Davis-Besse, for example, would be approximately 1.7 acres per MWe (**NRC 1996**, Table 8.1), or 1,547 acres for a 910 MWe plant. This amount of land use will include plant structures and associated infrastructure. Additional acres would be needed offsite for transmission lines and possibly rail lines, depending on the location of the site relative to the nearest inter-tie connection or rail spur. This acreage could amount to a considerable loss of natural habitat or agricultural land for the plant site alone dependent upon whether a greenfield or brownfield site was used, excluding that required for mining and other fuel-cycle impacts. Some portion of the impacts could be mitigated by constructing new transmission line in existing rights-of-way (ROW) to as great an extent as possible.

Land-use changes also would occur offsite in an undetermined coal-mining area to supply coal for the plant. For example, the GEIS estimated that approximately 22 acres of land per MWe would be affected for mining the coal and disposing of the waste to support a coal-fired plant during its operational life (**NRC 1996**, Section 8.3.9). Therefore, for the 910 MWe plant used in this analysis, approximately 20,020 acres of land would be needed. Partially offsetting this offsite land use would be the elimination of the need for uranium mining and processing to supply fuel for Davis-Besse. The GEIS estimated that approximately one acre per MWe would be affected for mining and processing the uranium during the operating life of a nuclear power plant (**NRC 1996**, Section 8.3.12). Therefore, for Davis-Besse uranium mining and processing, approximately 910 acres of land would be required, resulting in offsite mining net land use of 19,110 acres for the representative coal-fired generation alternative.

In consideration of the above, FENOC considers that land use impacts associated with a coal-fired plant at an alternate site would depend on the location of the plant and be MODERATE to LARGE.

<u>Water Use and Quality – Surface Water</u>

Construction-phase impacts on water quality of greatest potential concern include erosion and sedimentation associated with land clearing and grading operations at the plant site and waste disposal site, and suspension of bottom sediments during construction of cooling water intake and discharge structures and facilities for barge delivery of coal and limestone. However, land clearing and grading activities would be subject to stormwater protections in accordance with the NPDES program, and work in waterways would be regulated by the USACE under the CWA Section 404 and Section 10 of the Rivers and Harbors Act. These activities would also be subject to corresponding state and local regulatory controls, as applicable. In addition, these adverse effects would be localized and temporary. As a result, FENOC considers that impacts on surface water quality associated with construction of the representative plant at an alternative site would be SMALL.

FENOC expects that potential impacts on water quality and use associated with operation of the representative plant would be similar to impacts associated with Davis-Besse operation. Cooling water and other wastewater discharges would be regulated by an NPDES permit, regardless of location. Cooling water intake, evaporative losses, and discharge flows for the representative coal-fired plant, assumed to use a closed-cycle cooling system, would be similar to or lower than those resulting from Davis-Besse operation (see Chapter 4). As a result, FENOC considers that impacts on surface water quality associated with operation of the representative plant at an alternative site would be SMALL.

In view of the environmental review afforded under OPSB rules or a similar program, FENOC considers the impacts of surface water use and quality from construction and operation of the representative plant at an alternative site would be SMALL.

Water Use and Quality – Ground Water

Impacts will depend on whether the plant will use ground water for any purposes, as well as the characteristics of local aquifers. Effects to ground water quality can also depend on waste-management and coal-storage practices, although proper disposal and material handling should reduce the likelihood of an effect, as would recycling a greater percentage of waste products. Regardless of location, FENOC believes it highly unlikely that a coal-fired power plant at an alternate site will rely on ground water for plant cooling, and that ground water and waste-management regulations will limit impacts to SMALL.

Air Quality

Air quality impacts of coal-fired generation differ considerably from those of nuclear generation. A coal-fired plant emits sulfur oxides (SO_x), nitrogen oxides (NO_x), particulate matter (PM), and carbon monoxide (CO), all of which are regulated pollutants. Additionally, there are substantial emissions of carbon dioxide (CO_2), a greenhouse gas, although future developments such as carbon capture and storage and co-firing with biomass have the potential to reduce the carbon footprint of coal-fired electricity generation (**POST 2006**). Coal also contains other constituents (e.g., mercury, beryllium) that are potentially emitted as hazardous air pollutants, which are also of concern from a human health standpoint. (**NRC 1996**, Section 8.3.9)

As noted in Section 7.2.1.1, FENOC has assumed a plant design that includes controls to minimize emissions of regulated air pollutants effectively. Based on emission factors, estimated efficiencies for emission controls, and assumed design parameters listed in Table 7.2-1, operation of the plant would result in the following annual air emissions for criteria pollutants:

- Sulfur dioxide = 8,267 tons
- Nitrogen oxides = 5,087 tons
- Carbon monoxide = 636 tons
- Total filterable particulates = 153 tons
- PM_{10} = 34.3 tons.

The annual emissions of carbon dioxide, which is currently unregulated, would be approximately 7.63 million tons. See Table 7.3-1 for details.

FENOC expects that these emissions would result in a decrease in local air quality compared to operation of a nuclear plant. However, FENOC anticipates that both sulfur dioxide and nitrogen oxide emissions will be subject to cap and trade programs (**FENOC 2007**, Section 7.2.1.3). As a result, the plant would not be expected to add to regional sulfur dioxide emissions and may not add to regional nitrogen oxide emissions, at least during the ozone season (**FENOC 2007**, Section 7.3.2, Air Quality). The representative plant would add to regional concentrations of other pollutants, including the criteria pollutants carbon monoxide and particulates; hazardous air pollutants; and carbon dioxide, which is a greenhouse gas.

Subject to regulatory controls, FENOC anticipates that the overall air quality would be noticeable, but not destabilizing. As a result, FENOC considers that the impacts to air quality from operation of the representative plant at an alternative site would be MODERATE.

Ecological Resources

Onsite and offsite land disturbances form the basis for impacts to terrestrial ecology. Constructing a coal-fired plant at an alternate site could alter onsite ecological resources because of the need to convert about 1,547 acres of land at the site to industrial use for the plant, coal storage, and ash and scrubber sludge disposal (see the Land Use subsection above). Coal-mining operations will also affect terrestrial ecology in offsite mining areas, although some of this land is likely already disturbed by mining operations.

Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Impacts, however, will vary based on the degree to which the proposed plant site is already disturbed. On a previous industrial site, impacts to terrestrial ecology will be minor, unless substantial transmission line ROWs, a lengthy rail spur, or additional roads need to be constructed through undisturbed or less-disturbed areas. Any onsite or offsite waste disposal by landfilling will also affect terrestrial ecology at least through the time period when the disposal area is reclaimed.

During construction, impacts to aquatic ecology are likely. Regardless of where the plant is constructed, site disturbance will likely increase erosion and sedimentation runoff into nearby waterways, increasing turbidity. While site procedures and management practices may limit this effect, the impact will likely be noticeable. This is particularly true when intake and outfall structures are constructed alongside or in the body of water, as well as when any ROWs, roads, or rail lines require in-stream structures to support stream crossings. Noise and disturbance from construction, in addition to increased turbidity, may have a noticeable effect. Required regulatory permits, however, will help to mitigate these impacts.

During operations, the cooling water system would have a potential impact to aquatic communities. However, this system would be designed and operated in compliance with the CWA, including NPDES limitations to ensure appropriate protection of aquatic communities from thermal discharges and cooling water intakes. The cooling water intake and discharge flows would be comparable to or less than for Davis-Besse, the impact from which is considered to be SMALL (see Chapter 4). Therefore, associated impacts at a comparable site on commercially navigable waterway would also be expected to be SMALL.

Management of runoff from coal piles will also be necessary. However, subject to regulatory oversight, as afforded under OPSB rules or a similar program, FENOC considers the impacts to ecological resources from construction and operation of the representative plant at an alternative site may be noticeable, but not destabilizing.

On this basis, FENOC considers that the overall impact to ecological resources of constructing a coal-fired plant with a closed-cycle cooling system at an alternate site would be MODERATE.

Human Health

Coal-fired power generation introduces worker risk from coal and limestone mining, worker and public risk from coal and lime/limestone transportation, worker and public risk from disposal of coal combustion wastes, and public risk from inhalation of stack emissions. For example, the GEIS noted that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates from a coal-fired plant, but the GEIS does not identify the significance of these impacts (**NRC 1996**, Section 8.3.9). In addition, the coal-fired alternative also introduces the risk of coal pile fires and attendant inhalation risks, though these types of events are relatively rare. (**NRC 2009b**, Section 8.2.1, Human Health)

Regulatory agencies, including the USEPA, USOSHA, and state agencies, set air emission standards requirements for workers and the public based on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health.

Given these extensive health-based regulatory controls, FENOC considers that operating the representative coal-fired plant at an alternate site would be SMALL.

Socioeconomics

The peak workforce during construction of the coal-fired plant alternative is estimated to range between 1.2 to 2.5 workers per MWe and the workforce required during operation is estimated to be 0.25 workers per MWe (**NRC 1996**, Section 8.3.9, Table 8.1 and

Table 8.2). For a plant with a capacity of 910 MWe, workforces of approximately 1,092 to 2,275 construction workers and 228 permanent employees would be required.

Potential impacts from construction of the coal-fired alternative would be highly location dependent. As noted in the GEIS, socioeconomic impacts are expected to be larger at a rural site than at an urban site, because more of the peak construction work force would need to move to the area to work (**NRC 1996**, Section 8.3.9). Not considering impacts of terminating Davis-Besse operations, socioeconomic impacts at a remote rural site could be LARGE, while impacts at a site in the vicinity of a more populated metropolitan area (e.g., Toledo) could be SMALL to MODERATE. FENOC assumed that the OPSB or comparable review process, including application of appropriate mitigation found to be needed as a result, would ensure that these construction impacts would not be destabilizing to local communities.

At most alternate sites, coal and lime would be delivered by barge, although delivery is feasible for a location near a railway. Transportation impacts would depend upon the site location. Socioeconomic impacts associated with rail transportation would be MODERATE to LARGE. Barge delivery of coal and lime/limestone would have SMALL socioeconomic impacts.

As noted in Section 4.17, communities in Ottawa County, particularly those within the tax jurisdiction of Carroll Township and the Carroll-Benton-Salem School District, would experience losses in both employment and tax revenues due to Davis-Besse closure, assuming the plant is constructed outside the area.

Based on the above, FENOC considers that the overall socioeconomic impacts of construction and operation of the representative coal-fired plant at an alternate site would be MODERATE.

Waste Management

The representative coal-fired plant would produce substantial solid waste, especially fly ash and scrubber sludge. Based on emission factors and controls scaled from Beaver Valley (**FENOC 2007**, Section 7.3.2 and Table 7.2-2)*, the plant annual waste generation amounts would be approximately 300,000 tons/year of ash and 470,100 tons of flue gas desulphurization waste (dry basis), consisting primarily of hydrated calcium sulfate (gypsum) and excess limestone reactant. Although these wastes represent potentially usable products, FENOC assumed the total waste generated would be disposed of at an offsite landfill. Based on a fill depth of 30 feet and scaling from Beaver Valley (**FENOC 2007**, Section 7.3.2), approximately 644 acres would be required for the landfill over an assumed plant operating life of 40 years.

* The scale factor for coal is the ratio of total electric capability, 910 MWe/1980 Mwe, or 0.460.

Disposal of the waste could noticeably affect land use and ground water quality. In addition, the December 2008 failure of the dike used to contain fly ash at the Tennessee Valley Authority Kingston Fossil Plant in Roane County, Tennessee, and subsequent cleanup, highlight other waste management issues (**USEPA 2009b**). However, environmental impacts related to the location, design, and operational aspects of waste disposal for the plant would be subject to regulatory review under OPSB rules or similar programs. As a result, FENOC believes that with proper disposal siting, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources.

On this basis, FENOC considers that waste management impacts from operation of the representative coal-fired plant at an alternate site would be MODERATE.

Aesthetics

Potential aesthetic impacts of construction and operation of the representative coal-fired plant include visual impairment resulting from the presence of a large industrial facility, including 500-foot-high stacks, and cooling towers up to approximately 500 feet high with associated condensate plumes. The stacks and condensate plumes from the cooling towers could be visible some distance from the plant. There would also be an aesthetic impact if construction of a new transmission line or rail spur were needed. Similarly, noise impacts associated with rail delivery of coal and lime/limestone if used would be most significant for residents living in the vicinity of the facility and along the rail route.

These impacts, however, are highly site-specific. Site locations could reduce the aesthetic impact of a coal-fired generation, for example, if siting were in an area that was already industrialized versus locating at largely undeveloped sites.

In view of the environmental review afforded under OPSB rules or a similar program, FENOC considers that the impacts to aesthetics from construction and operation of the representative plant at an alternative site would depend on location and be SMALL to MODERATE.

Cultural Resources

FENOC assumed that the representative coal-fired plant, associated infrastructure (e.g., roads, transmission corridors, rail lines, or other rights-of-way), and associated waste disposal site would be located with consideration of cultural resources afforded under OPSB or comparable rules. FENOC further assumed that appropriate measures would be taken to recover or provide other mitigation for loss of any resources discovered during onsite or offsite construction.

On this basis, FENOC considers that the potential impact on cultural resources from construction and operation of the representative plant at an alternative site would be SMALL.

7.3.2 Gas-Fired Generation

This section presents the impact evaluation for the representative gas-fired generation alternative. As discussed in Section 7.2.1.2, FENOC assumed for purposes of this analysis that the representative plant would be located at a greenfield or (preferably) brownfield site in northwestern Ohio. This assumption is a result of the space limitation at the Davis-Besse site.

Land Use

Land-use requirements for gas-fired plants are relatively small, at about 100 acres for a 910 MWe plant (Section 7.2.1.2). An estimated 240 – 270 additional acres would be needed offsite at a greenfield location for new gas and electric transmission lines (**FENOC 2007**, Section 7.3.1, Land Use) and increased land-related impacts, which in turn would be location-specific.

Land use in northwestern Ohio is predominantly rural agricultural cropland with scattered rural residences and woodlots. Located in a rural area, the change in land use would be locally apparent and could include displacement of cropland, which is highly productive for corn, wheat, and soybeans relative to other areas of the state; however, substantial buffer with respect to highly incompatible land uses (e.g., residential use) could be provided and destabilization of overall land use would not be expected. If the plant were located in an area designated for industrial use, associated land-use impacts would not be significant. Agricultural practices could continue along most of the area occupied by offsite rights-of-way. (**FENOC 2007**, Section 7.3.1, Land Use)

Regardless of where the natural gas-fired plant is built, additional land would be required for natural gas wells and collection stations. Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for Davis-Besse. The GEIS estimated that approximately one acre per MWe would be affected for mining and processing the uranium during the operating life of a nuclear power plant (**NRC 1996**, Section 8.3.12). Therefore, for Davis-Besse uranium mining and processing, approximately 910 acres of land would be required, resulting in a net gain in reclaimed land for the representative natural gas-fired generation alternative.

In view of the environmental review afforded under OPSB rules or a similar program, FENOC considers that the overall impacts of land use from construction and operation of the representative plant at an alternative site would depend on plant location and be SMALL to MODERATE.

Water Use and Quality – Surface Water

Cooling water intake, evaporative losses, and discharge flows for the plant would be less than that of Davis-Besse, primarily because less power would be derived from a steam cycle (**FENOC 2007**, Section 7.2.2.1).

During operation, cooling water and wastewater discharges would be regulated under the federal CWA and corresponding state programs by an NPDES permit. Construction activities would be similarly regulated to ensure protection of water resources. In addition, impacts on water use and quality would be subject to scrutiny in the planning stage under OPSB or similar governing authority rules.

Overall, FENOC considers that the impacts from construction and operation of the representative plant at an alternative site on surface water use and quality would be SMALL.

Water Use and Quality – Ground Water

Impacts will depend on whether the plant will use ground water for any purposes, as well as the characteristics of local aquifers. Regardless of location, FENOC assumes that a gas-fired power plant at an alternate site will not rely on ground water for plant cooling, and that regulations for ground water use for potable water will limit impacts to SMALL.

Air Quality

Natural gas is a relatively clean-burning fuel with nitrogen oxides being the primary focus of combustion emission controls. As noted in the GEIS, air quality impacts for all natural gas technologies are generally less than for fossil technologies of equal capacity because fewer pollutants are emitted (**NRC 1996**, Section 8.3.10).

As noted in Section 7.2.1.2, FENOC has assumed a plant design that includes controls to minimize emissions of regulated air pollutants effectively. Based on emission factors, estimated efficiencies for emission controls, and assumed design parameters listed in Table 7.2-2, operation of the plant would result in the following annual air emissions for criteria pollutants:

- Sulfur dioxide = 13.3 tons
- Nitrogen oxides = 205 tons
- Carbon monoxide = 311 tons
- Total filterable particulates = 39.4 tons

The annual emissions of carbon dioxide, which is currently unregulated, would be approximately 2.28 million tons. See Table 7.3-2 for details.

FENOC expects that these emissions may result in a noticeable reduction in local air quality. However, FENOC anticipates that both sulfur dioxide and nitrogen oxide emissions will be subject to cap and trade programs (**FENOC 2007**, Section 7.2.1.3). As a result, the plant would not be expected to add to regional sulfur dioxide emissions and may not add to regional nitrogen oxide emissions, at least during the ozone season (**FENOC 2007**, Section 7.3.1, Air Quality). The representative plant would add to regional concentrations of other pollutants, including the criteria pollutants carbon monoxide and particulates; hazardous air pollutants such as mercury; and carbon dioxide, which is presently unregulated.

Subject to regulatory controls, FENOC anticipates that the overall air quality would be noticeable, but not destabilizing. As a result, FENOC considers that the impacts to air quality from operation of the representative plant at an alternative site would be MODERATE, but smaller than those of coal-fired generation.

Ecological Resources

As noted in the Land Use subsection above, development of the representative combined-cycle natural gas-fired plant may require approximately 100 acres for the plant site and approximately 240 – 270 additional acres for offsite infrastructure. Although the GEIS noted that land-dependent ecological impacts from construction from gas-fired plants would be smaller than for other fossil fuel technologies of equal capacity (**NRC 1996**, Section 8.3.10), the type and quality of terrestrial habitat that would be displaced is location-specific.

However, FENOC considers it likely that most of the area required for construction would consist of agricultural cropland with relatively low habitat value. Stream crossings and wetland disturbance, if any, would be subject to provisions of a USACE permit (CWA Section 404) and relevant state and local requirements. (**FENOC 2007**, Section 7.3.1, Ecology)

The most significant potential impacts to aquatic communities relate to operation of the cooling water system. However, the cooling system for the plant would be designed and operated in compliance with the CWA, including NPDES limitations for physical and chemical parameters of potential concern and provisions of CWA Sections 316(a) and 316(b), which are respectively established to ensure appropriate protection of aquatic communities from thermal discharges and cooling water intakes. Also, the siting, design, and operation of the plant would be subject to the environmental protections under OPSB rules.

Overall, FENOC expects that development of the representative natural gas-fired plant would likely have little noticeable impact on ecological resources of the area. As a result, FENOC considers that the overall impacts to ecology resources from construction and operation of the representative plant at an alternative site would depend on plant location and be SMALL to MODERATE.

Human Health

The GEIS cites risk of accidents to workers and public health risks (e.g., cancer, or emphysema) from the inhalation of toxics and particulates associated with air emissions as potential risks to human health associated with the gas-fired generation alternative (**NRC 1996**, Table 8.2). However, regulatory requirements imposed on facility design, construction, and operations under the authority of the Occupational Safety and Health Act, Clean Air Act, and related statutes are designed to provide an appropriate level of protection to workers and the public. Additionally, regulatory agencies, including the USEPA, USOSHA, and state agencies, set air emission standards requirements for workers and the public based on human health impacts.

Given the extensive health-based regulatory control, FENOC considers that operating the representative gas-fired plant at an alternate site, regardless of plant location, would be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from the representative gas-fired generation alternative include temporary increases in jobs, economic activity, and demand for housing and public services in communities surrounding the site during the construction period. Countering these increases are losses in permanent jobs, tax revenues, and economic activity attributable to gas-fired plant operation and termination of operations of Davis-Besse.

The estimated number of peak construction workers expected to build a gas-fired plant with a capacity of 910 MWe is 1,092 – 2,275 (**NRC 1996**, Tables 8.1). To operate the plant would require 137 workers (**NRC 1996**, Tables 8.2). Although northwestern Ohio is predominantly rural, most areas are within commuting distance of the metropolitan areas like Toledo and Cleveland, Ohio. Considering the proximity of these sources of labor and services, FENOC expects that most of the construction workforce would commute and relatively few would relocate into the area, and associated socioeconomic impacts during construction would be SMALL.

Communities in Ottawa County, however, particularly those within the taxing jurisdiction of Carroll Township and the Benton-Carroll-Salem School District, would experience losses in both employment and tax revenues due to Davis-Besse closure that could constitute MODERATE impact (see Section 4.17).

FENOC believes that these impacts, although noticeable, would not be destabilizing. As a result, FENOC considers that the overall socioeconomic impact of construction and operation of the representative gas-fired at an alternative site would be MODERATE.

Waste Management

Gas-fired generation would result in minimal waste generation, producing minor (if any) impacts (**NRC 1996**, Section 8.3.10). As a result, FENOC considers waste management impacts from the operation of the representative plant at an alternative site would be SMALL.

Aesthetics

Potential aesthetic impacts of construction and operation of a gas-fired plant include visual impairment resulting from the presence of a large industrial facility, including multiple exhaust stacks at least 150 feet high, and mechanical-draft cooling towers with associated condensate plumes. Considering the flat topography in northwestern Ohio, the stacks and condensate plumes would likely be visible for several miles from the site; new transmission lines constructed to connect the plant to the grid would also be relatively visible for the same reason, though would not be out of character for the rural northwestern Ohio landscape. (**FENOC 2007**, Section 7.3.1, Aesthetics) FENOC expects that the plant likely would be located in a rural area, and assumed that adequate buffer and vegetation screens would be provided at the plant site as needed to moderate visual and noise impacts.

In view of the environmental review afforded under OPSB rules, FENOC considers that the impacts to aesthetics from construction and operation of the representative plant at an alternative site would depend on location and be SMALL to MODERATE.

Cultural Resources

FENOC assumed that the representative gas-fired plant and associated gas-supply pipeline and transmission line would be located with consideration of cultural resources under OPSB or comparable program rules. FENOC further assumed that appropriate measures would be taken to avoid, recover, or provide other mitigation for loss of any resources discovered during onsite or offsite construction.

On this basis, FENOC concludes that the potential adverse impact on cultural resources of the representative plant at an alternative site, regardless of location, would be SMALL.

7.3.3 RENEWABLE ENERGY

This section presents the impact evaluation for wind power in the form of interconnected wind farms and/or solar photovoltaic power, in combination with CAES. To be specific, FENOC evaluated for purposes of this NEPA analysis electricity generation coming from: wind power in the form of interconnected wind farms; or wind power in the form of interconnected wind farms with CAES; or solar (photovoltaic) power with CAES; or a combination of interconnected wind farms and solar power with CAES, as described in Sections 7.2.1 and 7.2.1.3.

Wind and solar energy are renewable energy sources that produce electricity without releasing air or water pollutants; however, these advantages are offset by environmental impacts such as large land requirements (both wind and solar), potential harm to birds and bats (wind), aesthetic concerns (wind and solar), noise concerns (wind); radar interference (wind), and generation of hazardous waste streams (solar).

In addition, there would be environmental impacts associated with the construction and operation of new transmission lines associated with new renewable energy sources. These impacts are not evaluated as part of this analysis because the scope of new transmission would not be determined until the energy sources were sited.

The environmental impacts related to interconnected wind farms are discussed in Section 7.3.3.1. The environmental impacts of interconnected wind farms with CAES are discussed in Section 7.3.3.2. The environmental impacts of solar PV power with CAES are discussed in Section 7.3.3.3. Finally, a summary of the combined environmental impacts of wind farms, solar PV power, and CAES are provided in Section 7.3.3.4.

7.3.3.1 Interconnected Wind Energy

Using the assumptions and disclaimers in Section 7.2.1, development of a series of wind farms would be required to provide replacement power for Davis-Besse. Transmission impacts associated with an interconnected grid that would serve renewable energy sources would have to be evaluated once the renewable energy sources have been sited.

Development of large-scale, land-based wind power facilities could have MODERATE to LARGE impacts on aesthetics, land use, and terrestrial ecology. The environmental impacts of a large-scale wind farm are described in the GEIS (**NRC 1996,** Section 8.3.1). In summary, the construction of roads and turbine tower supports would result in short-term impacts, such as increases in noise, erosion, and sedimentation, and decreases in air quality from fugitive dust and equipment emissions. Construction in undeveloped areas would have the potential to disturb and impact cultural resources or habitat for sensitive species. During operation, some land near wind turbines could be available for compatible uses such as agriculture. There is some continuing noise from wind turbine operation, light flicker caused by reflection of the sun, and aesthetic impacts, although whether a wind farm improves the landscape is in the eye of the beholder. Wind farms generate very little waste and pose limited human health risk other than from occupational injuries. There is a potential for bird and bat collisions with turbine blades, which is discussed in this subsection.

Although most environmental impacts associated with a single wind farm are SMALL or can be mitigated, the cumulative impacts from the many wind farms that would be needed to support an interconnected grid system, such as impacts to sensitive habitats and endangered species, could be LARGE, depending on the locations.

The incorporation of offshore wind resources from Lake Erie could reduce the amount of land use impacts; however, a new set of impacts related to offshore wind would be created. Placing wind farms offshore eliminates some of the obstacles encountered when siting wind farms on shore and limits conflicts with other planning interests. However, other impacts are created, including influence on birds, marine life, hydrography, and marine traffic. (**IEAWIND 2002**)

A detailed discussion of impacts is presented below.

<u>Land Use</u>

The land use requirement for interconnected wind farms in open and flat terrain is about 50 acres per megawatt (MW) of installed capacity. Approximately 5% (2.5 acres) of this area is occupied by turbines, access roads, and other equipment. The remaining land area can be used for compatible activities such as farming or ranching (**AWEA 2002**), except if the wind farms are located offshore. The Roscoe Wind Farm near Roscoe, Texas has the capacity of 209 MW and is spread-out across 30,000 acres (**RWC 2010**), or 143 acres per MW. When complete, the entire Roscoe Wind Complex project is expect to have the capacity of 781 MW on approximately 100,000 acres (**CBS 2010**) or 128 acres per MW.

Assuming the use of interconnected wind as the only renewable source to generate the equivalent of Davis-Besse's net output of 910 MWe base-load power plus 910 MWe of energy storage to be used when wind power is not available, a series of wind farms with 2.0-MWe turbines with an average capacity factor of 30% as specified by PJM and USDOE (**PJM 2011** and **USDOE 2011**) would require approximately 3030 turbines to produce 1820 MWe. At 50 acres per MW, the land use potential would be as much as 91,000 acres (142 square miles), with about 4550 acres (7.1 square miles) occupied by turbines and support facilities.

Land use in Ohio, where additional wind generation would likely be developed, is predominantly rural agricultural cropland with scattered rural residences and woodlots.

In such a location, the change in land use would be locally apparent and could include some initial displacement of highly productive cropland for corn, wheat, and soybeans. However, a substantial buffer with respect to highly incompatible land uses (e.g., residential use) could be provided, and destabilization of overall land use would not be expected. Agricultural practices could continue along most of the area occupied by offsite rights-of-way. (**FENOC 2007**, Section 7.3.1, Land Use)

Offshore impacts have been extensively studied in Europe. An environmental impact report has been prepared by the Cape Wind Project (CWP) and a feasibility study was conducted by the Great Lakes Wind Energy Center (GLWEC) for an offshore area in Lake Erie near Cleveland, Ohio (**GLWEC 2009**). Based on the findings in the CWP Environmental Impact Report (EIR) (**CWP 2007**) and the study completed by GLWEC, land use impacts associated with offshore wind generation would be SMALL.

Regardless of where the wind generation facilities are built, additional land would be required for an interconnected grid system as described in Section 7.2.2.3. Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for Davis-Besse. The GEIS estimates that approximately one acre per MWe would be affected for mining and processing the uranium during the operating life of a nuclear power plant (**NRC 1996**, Section 8.3.12). Therefore, for the uranium mining and processing associated with fuel for Davis-Besse, approximately 910 acres of land would be required, resulting in a net avoidance of potentially disturbing 3640 (4550-910) acres of land when compared to wind generation land use.

Based on these data, FENOC considers that the overall impacts of land use from construction and operation of interconnected wind farms would depend on their locations, and be MODERATE to LARGE.

Water Use and Quality – Surface Water

Wind generation does not require cooling water or intake structures. Therefore, there would be no impact on water use and the only potential impact on local water quality would be erosion or sedimentation issues during construction. These impacts would be minimized by using best management practices during construction activities and are considered SMALL.

Water Use and Quality – Ground Water

A limited amount of ground water may be used during construction activities if other potable water supplies are limited. Minor amounts of water may be needed for operating wind generation facilities if surface water resources were not available. The potential impact to ground water is SMALL.

Air Quality

There are no air quality impacts associated with the operation of onshore or offshore interconnected wind farms. The construction of roads and turbine tower supports would result in short-term impacts in air quality from fugitive dust and equipment emissions and the overall impacts would be SMALL.

Ecological Resources

As noted in the Land Use subsection above, development of onshore interconnected wind farms would have a MODERATE to LARGE impact on land resources which could have a LARGE impact on the ecological resources, especially during construction.

Migratory bird, eagle and raptor, and bat mortality are potential impacts related to wind turbines. The deaths of birds and bats at wind farm sites have raised concerns by fish and wildlife agencies and conservation groups. United States Fish and Wildlife Service (USFWS) estimates indicate that wind turbine rotors kill 33,000 birds annually (**USFWS 2002**). Concerns of the potential impacts of wind power deployment have led the USFWS to release draft guidance that provides agency employees, developers, federal agencies, and state organizations information for reviewing and selecting sites for interconnected and community-scale wind energy facilities to avoid and minimize negative impacts to fish, wildlife, plants and their habitats (**USDOI 2011**). Direct effects include blade strikes, barotrauma, loss of habitat, and "displacement". Indirect effects occur later in time and include introduction of invasive vegetation that result in alteration of fire cycles; increase in predators or predation pressure; decreased survival or reproduction of the species; and decreased use of the habitat that may result from effects of the project or resulting "habitat fragmentation." (**USFWS 2011**)

Although wind turbine/bird collision studies seem to indicate that wind generating facilities in some locations of the United States have a minor impact on birds compared to other sources of collision mortality, one cannot assume that similar impacts would occur among birds using wind-generating sites built in Ohio or offshore in Lake Erie. Based on a feasibility study conducted by Great Lakes Wind Energy Center (GLWEC) the avian morality rate of this proposed offshore project is expected to be minimal. (**GLWEC 2009**) FENOC assumed that construction best management practices and awareness of critical habitat during operations would minimize impacts to ecological resources. Therefore, impacts to migrating species would depend on the location of the wind farms and could be SMALL to MODERATE.

Human Health

The only major health risk for the construction and operation of a series of wind farms (onshore or offshore) would be accidents. FENOC assumed that all Occupational

Safety and Health Act requirements would be complied with during construction and operation of these facilities and the impacts should be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from interconnected wind farms include temporary increases in jobs, economic activity, and demand for housing and public services in communities surrounding the sites during the construction period. These impacts would be spread throughout the region. Countering these increases are losses in permanent jobs, tax revenues, and economic activity attributable to the termination of operations of Davis-Besse. Typically, renewable energy sources are not subject to the tax rate of conventional energy-generating facilities, so the loss of permanent jobs and tax revenue could be significant to the communities near Davis-Besse and thus have a SMALL to MODERATE impact.

Communities in Ottawa County, however, particularly those within the taxing jurisdiction of Carroll Township and the Benton-Carroll-Salem School District, would experience losses in both employment and tax revenues due to Davis-Besse closure that could constitute MODERATE impacts.

The number of peak construction workers expected to build the wind farms is unknown at this time; however, it is likely similar to a gas-fired plant with a capacity of 910 MWe, which is 1200 (**NRC 1996**, Tables 8.1). To operate and maintain the wind farms would require approximately 150 to 200 workers. FENOC expects that most of the construction workforce would commute and relatively few would relocate into the area, and associated socioeconomic impacts during construction would be SMALL.

Waste Management

Construction of wind farms could result in generation of large amounts of vegetation from land clearing activities. If this material is managed correctly (e.g., recycled or composted) the impacts should be SMALL. Minor amounts of waste may be generated during the operations and maintenance of the wind turbines (onshore or offshore) which, if waste streams are managed correctly, the impacts would likely be SMALL.

Aesthetics

Most wind farms are located in remote areas and may generate large aesthetic concerns, particularly if sited on highlands or in recreational areas and could have some effect on the local aesthetic quality. The aesthetic impacts from wind farms located in flat-lying rural areas would likely be SMALL.

Offshore wind turbines would likely have a lesser aesthetic impact than onshore wind turbines and be limited to those individuals who reside close to the shoreline or participate in recreational activities close to the wind facilities. There have been concerns related to the related to aesthetic impacts. (**CA 2011**) The overall aesthetic impacts from wind turbines would be SMALL to MODERATE.

Cultural Resources

Due to the large amount of land needed to construct the necessary wind farms, the potential for impacting cultural resources could be LARGE. To minimize these impacts, FENOC assumed construction activities would consider cultural resources under OPSB or comparable program rules. FENOC further assumed that appropriate measures for both onshore and offshore construction activities would be taken to avoid, recover, or provide other mitigation for loss of any resources discovered during onsite or offsite construction.

On this basis, FENOC concludes that the potential adverse impact on cultural resources of the wind farms, regardless of location, would be SMALL.

7.3.3.2 Wind with Compressed Air Energy Storage

Environmental impacts associated with wind farms are discussed above in Section 7.3.3.1, and are not repeated here in detail. Impacts associated with the compressed air energy storage (CAES) facility are discussed below.

By combining CAES with interconnected wind farms, the anticipated environmental impacts would be greater than the impacts from interconnected wind farms alone. Therefore, wind farms with CAES generating 1820 MW * of power are expected to have greater environmental impacts than Davis-Besse during the proposed 20 year license extension.

Land Use

The overall land use impact for wind generation in this energy alternative, as discussed in Section 7.3.3.1, is MODERATE to LARGE.

Land use associated with the NES facility would be limited to the facility's 92 surface acres. There would be some land impacted during construction, but this site has been previously disturbed so the impact should be SMALL. However, if another site is

* Wind generation source is assumed to be available for 12 hours every day, and a CAES facility assumed to be 100% efficient (i.e., 910 MWe of energy input from wind and/or solar to the CAES facility results in 910 MWe of generation from the CAES facility), would require that generation source to be rated at 1820 MW in order to provide 24-hours of baseload electricity when integrated with a 910 MW CAES facility (i.e., 12 hours to provide 910 MW of base-load generation onto the grid, and the same 12 hours to provide 910 MW to recharge the CAES facility, so that the CAES facility could feed the grid the remainder of the day).

chosen for the CAES or an additional CAES facility is needed to meet base-load power requirements then there could be a MODERATE to LARGE land use impact.

Water Use and Quality – Surface Water

CAES facilities have cooling towers associated with the use of gas turbines to produce electricity and compressors to recharge the storage structure. These cooling towers are much smaller than those typically used for coal and gas generation plants. Cooling makeup water evaporative losses, and discharge flows for the plant would be considerably less than that of Davis-Besse, primarily because less power would be derived from a steam cycle. (**FENOC 2007**, Section 7.2.2.1)

During CAES operation, cooling water and wastewater discharges would be regulated under the federal CWA and corresponding state programs by an NPDES permit. Construction activities would be similarly regulated to ensure protection of water resources. In addition, impacts on water use and quality would be subject to scrutiny in the planning stage under OPSB or similar governing authority rules.

Overall, FENOC considers that the impacts from construction and operation of interconnected wind farms (onshore and offshore) combined with a CAES facility on surface water use and quality would be SMALL.

Water Use and Quality – Ground Water

Impacts would depend on whether the plant would use ground water for any purposes, as well as the characteristics of local aquifers. Regardless of location, FENOC assumed that the NES plant or a CAES plant at an alternate site would not rely on ground water for plant cooling, and that regulations for ground water use for potable water would limit impacts to SMALL.

Air Quality

CAES facilities use natural gas, which is a relatively clean-burning fuel with nitrogen oxides being the primary focus of combustion emission controls. As noted in the GEIS, air quality impacts for all natural gas technologies are generally less than for fossil technologies of equal capacity because fewer pollutants are emitted (**NRC 1996**, Section 8.3.10).

FirstEnergy Generation Corp. has applied for and received an Air Pollution Permit to Install and Operate (PTIO) proposed emission units for the Norton CAES facility (Facility ID 1677105001) (see Table 7.2-3). The permit (Number P0106714) was issued on September 7, 2010 by the Ohio EPA. The permit establishes emission limitations, air emission controls, monitoring, reporting, and recordkeeping requirements. The proposed emission units established in the PTIO are based on the original design of the facility and include six combustion trains and one cooling tower. Each combustion train includes a 589 mmBtu/hr (134 MWe) combustion turbine and a 1 mmBtu/hr in-line heater to remove moisture from the compressed air. (**NES 2010**) The combustion turbines and in-line heaters would fire only pipeline-quality natural gas. The only other sources associated with this facility are an emergency generator and a back-up firewater pump; both of these units would be diesel-fired.

The permitted annual air emission limits from this facility with six combustion trains (i.e., 804 Mwe) are as follows:

- Sulfur dioxide (SO_2) = 42.41 tons
- Nitrogen oxides (NO_x) = 93.67 tons
- Carbon monoxide = 90.36 tons
- PM_{10} = 46.65 tons
- Volatile Organic Compounds (VOCs) = 26.40 tons

The annual emissions of carbon dioxide from all sources would be approximately 681,100 tons. These emissions are based on the current air permit for NES and could change if different equipment is used during plants operations. A list of air emissions for the six combustion trains is presented in Table 7.3-4.

FENOC anticipates that both sulfur dioxide and nitrogen oxide emissions would be subject to cap and trade programs (**FENOC 2007**, Section 7.2.1.3). As a result, the plant would not be expected to add to regional sulfur dioxide emissions and may not add to regional nitrogen oxide emissions, at least during the ozone season (**FENOC 2007**, Section 7.3.1, Air Quality). The plant would add to regional concentrations of other pollutants, including the criteria pollutants carbon monoxide and particulates; hazardous air pollutants such as mercury; and carbon dioxide, which is presently unregulated.

Subject to regulatory controls, FENOC anticipates that the impacts to air quality from operation of the CAES plant at an alternative site would be MODERATE.

Ecological Resources

As noted in Section 7.3.3.1, development of the interconnected wind farms would have a MODERATE to LARGE impact on land resources which could have a LARGE impact on ecological resources, especially during construction.

Since the NES has an existing underground storage space and only has 92 acres of land use at the surface, the potential impact to ecological resources is SMALL. However, if another CAES site with compressed air storage on the land surface is chosen or needed to provide additional stored energy capacity the ecological impacts could be MODERATE to LARGE.

For an alternative CAES site, FENOC considers it likely that most of the area required for construction would consist of agricultural cropland with relatively low habitat value. Stream crossings and wetland disturbance, if any, would be subject to provisions of a USACE permit (CWA Section 404) and relevant state and local requirements. (**FENOC 2007**, Section 7.3.1, Ecology)

The most significant potential impacts to aquatic communities relate to operation of the cooling water system. However, the NES site (or alternative site) cooling system for the plant would be designed and operated in compliance with the CWA, including NPDES limitations for physical and chemical parameters of potential concern and provisions of CWA Sections 316(a) and 316(b), which are respectively established to ensure appropriate protection of aquatic communities from thermal discharges and cooling water intakes. Also, the siting, design, and operation of the plant would be subject to the environmental protections under OPSB or other state agency's rules.

Overall, FENOC expects that development of the CAES plant would likely have little noticeable impact on ecological resources of the area. As a result, FENOC considers that the overall impacts to ecology resources from construction and operation of the representative plant at an alternative site would depend on plant location and be SMALL to LARGE.

<u>Human Health</u>

The only major health risk for the construction and operation of a series of wind farms (onshore or offshore) would be accidents. FENOC assumed that all Occupational Safety and Health Act requirements would be complied with during construction and operation of these facilities and the impacts should be SMALL.

The NES or an alternative CAES facility would use natural gas in its power generation mode. The GEIS cites risk of accidents to workers and public health risks (e.g., cancer, or emphysema) from the inhalation of toxics and particulates associated with air emissions as potential risks to human health associated with the gas-fired generation alternative (**NRC 1996**, Table 8.2). However, regulatory requirements imposed on facility design, construction, and operations under the authority of the Occupational Safety and Health Act, Clean Air Act, and related statutes are designed to provide an appropriate level of protection to workers and the public. Additionally, regulatory agencies, including the USEPA, USOSHA, and state agencies, set air emission standards requirements for workers and the public based on human health impacts.

Given the extensive health-based regulatory control, FENOC considers that human health impacts from operating a CAES plant at NES or an alternate site, regardless of plant location, would be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from interconnected wind farms with CAES would be similar to those discussed in Section 7.3.3.1. The number of peak construction workers expected to build the NES facility is unknown at this time; however, it is likely not to exceed the number for a gas-fired plant with a capacity of 910 MWe, which is 1200 (**NRC 1996**, Table 8.1). FENOC expects that most of the construction workforce would commute and relatively few would relocate into the area, and associated socioeconomic impacts during construction would be SMALL. To operate and maintain the NES plant would require approximately 50 to 100 workers.

FENOC believes that the construction impacts, although noticeable, would be spread throughout the State and should not impact any one local community over another. The financial impacts from closing Davis-Besse, however, could be significant to the areas surrounding the station. The addition of an operational workforce for the CAES facility and new tax revenue for the local community near the CAES facility would be a beneficial impact in that local community. As a result, FENOC considers that the overall socioeconomic impact of construction and operation of the NES or an alternative CAES site would be SMALL to MODERATE.

Waste Management

Construction of interconnected wind farms could result in generation of large amounts of vegetation from land clearing activities. If this material is managed correctly (e.g. recycled or composted) then the impacts should be SMALL. Like gas-fired generation, NES or an alternative CAES site would result in minimal waste generation, producing minor (if any) impacts (**NRC 1996**, Section 8.3.10). As a result, FENOC considers waste management impacts from the operation of a CAES plant at an alternative site would be SMALL.

Aesthetics

Most wind farms are located in remote areas and may generate large aesthetic concerns, particularly if sited on highlands or in recreational areas and could have some effect on the aesthetic quality. In general, impact on aesthetic quality for wind farms located in flat-lying rural areas would be SMALL

Potential aesthetic impacts of construction and operation of NES or an alternative CAES plant may include visual impairment resulting from the presence of a large industrial facility, including multiple exhaust stacks and mechanical-draft cooling towers with associated condensate plumes. Considering the flat topography in northwestern Ohio and other areas where an alternative CAES may be placed, the stacks and condensate plumes would likely be visible for several miles from the site; new transmission lines constructed to connect the plant to the grid would also be relatively visible for the same reason, though would not be out of character for most rural areas including the northwestern Ohio landscape. (**FENOC 2007**, Section 7.3.1, Aesthetics)

The NES site is on a brownfield area located just south of Norton, Ohio. The construction of the facility would cause a minor change in the appearance of the area, but aesthetic impacts would be SMALL. FENOC expects that an alternative CAES plant likely would be located in a rural area, and assumed that adequate buffer and vegetation screens would be provided at the plant site as needed to moderate visual and noise impacts.

In view of the environmental review afforded under OPSB rules, FENOC considers that the impacts to aesthetics from construction and operation of interconnected wind farms and NES or an alternative CAES site would depend on location and be SMALL to MODERATE.

Cultural Resources

As discussed in Section 7.3.3.1, FENOC concludes that the potential adverse impact on cultural resources of the interconnected wind farms, regardless of location, would be SMALL.

FENOC assumed that the NES facility or alternative CAES plant and associated gas-supply pipeline and transmission lines would be located with consideration of cultural resources under OPSB or comparable program rules, and the impact would be SMALL.

7.3.3.3 Photovoltaic Power Combined with CAES

Environmental impacts of solar power systems can vary based on site-specific conditions. Land use and aesthetics are the primary environmental impacts of solar power. Land requirements for PV facilities are large, compared to the land currently used by Davis-Besse. During operation, however, PV technologies produce no air pollution, little or no noise, and require no transportable fuels.

Land Use

As stated in the GEIS, land requirements are high: 35,000 ac (14,000 ha) [i.e., 54.7 square miles] per 1,000 MWe for PV cells (**NRC, 1996**).

An NREL study (for the western United States) has indicated the amount of land required depends on the available solar insolation and ranges from about 3.8 to 7.6 acres per MW for photovoltaic systems with a capacity factor ranging from 20 to 25%. (**NREL 2002**) Assuming an average capacity factor of 24% from **NREL 2002**, and 5 acres per MW, plus an additional 910 MWe needed for energy storage, and the estimated required land would be approximately 37,900 acres (59.2 square miles).

Unlike wind power generation, all the land used to construct the solar generation facilities would be permanently disturbed and could not be used for other purposes.

To reduce the amount of land use, the solar facilities could be placed in the same locations as the wind generation facilities, or brownfield locations assuming these are flat areas with sufficient sunlight. PV arrays are placed on the rooftops of businesses and residential dwellings to generate electricity or to heat water. These units are usually small and are designed to provide energy directly to the facility or residence to which they are attached. Only in a few cases are these PV arrays large enough to provide excess energy to the grid.

Based on these data, FENOC considers that the overall impacts of land use from construction and operation of the representative solar power facilities alone would be LARGE.

Land use associated with the NES facility would be limited to the facilities' 92 surface acres. There would be some land impacted during construction but this site has been previously disturbed so the impact should be SMALL. However, if another site is chosen for the CAES or an additional CAES facility is needed to meet base-load power requirements then the potential impacts to land resources could be MODERATE to LARGE.

Water Use and Quality – Surface Water

Solar generation using PV technology does not require cooling water or intake structures. Therefore, there would be no impact on water use and the only potential impact on local water quality would be erosion or sedimentation issues during construction. These impacts would be minimized by using best management practices during construction activities. Significant amounts of water could be used to keep the solar panels clean so they remain effective in collecting the maximum amount of sunlight possible. Since the areas where these solar facilities would be located are not in a desert or semi-arid environment, the demands on water resources should be reduced. Overall, the impacts on water use and quality should be SMALL to MODERATE.

Surface water impacts associated with the CAES cooling systems are discussed in detail in Section 7.3.3.2, and are SMALL.

Overall, FENOC considers that the impacts from construction and operation of solar generation facilities and a CAES plant at alternative sites on surface water use and quality would be SMALL to MODERATE.

Water Use and Quality – Ground Water

Impacts would depend on whether the plant would use ground water for any purposes, as well as the characteristics of local aquifers. Regardless of location, FENOC assumed that the NES plant or a CAES plant at an alternate site would not rely on ground water for plant cooling, and that regulations for ground water use for potable water would limit impacts to SMALL.

Air Quality

There are no air quality impacts associated with the operation of solar generation facilities.

Potential emissions from NES are discussed in Section 7.3.3.2 and Table 7.3-3. FENOC considers that the impacts to air quality from operation of a CAES facility at an alternative site would be MODERATE.

Ecological Resources

As noted in the Land Use subsection above, development of solar generation facilities would have a major impact on land resources, which could have a significant impact on the ecological resources during construction and operation of these facilities. As stated in the Land Use subsection, approximately 37,900 acres would be permanently disturbed, and with the possible loss of important habitat. Although FENOC assumed that construction best management practices and awareness to critical habitat during operations would minimize effects to ecological resources, the potential for significant impacts would be MODERATE to LARGE.

As discussed in Section 7.3.3.2, since the NES is a former underground limestone mine and only has 92 acres of land use at the surface, the potential impact to ecological resources is SMALL. However, if another CAES site with compressed air storage on the land surface is chosen or needed to provide additional stored energy capacity, then the ecological impacts could be MODERATE to LARGE.

Human Health

The health risks for the construction and operation of a series of solar generation facilities would be accidents and potential exposure to hazardous materials. FENOC assumed that all Occupational Safety and Health Act requirements would be complied with during construction and operation of these facilities and the impacts should be SMALL.

As discussed in Section 7.3.3.2, given the extensive health-based regulatory control, FENOC considers that operating the CAES plant at NES or an alternate site, regardless of plant location, would be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from the solar power with associated NES or CAES facility alternative include temporary increases in jobs, economic activity, and demand for housing and public services in communities surrounding the sites during the construction period. These impacts would be spread throughout the state and should not impact any one local community over another. Countering these increases are losses in permanent jobs, tax revenues, and economic activity attributable to operation of the alternative generation facilities and termination of operations of Davis-Besse. Typically, renewable energy sources are not subject to the tax rate of conventional energy generating facilities, so the loss of permanent jobs and tax revenue could be significant to the communities near Davis-Besse and thus the impacts could be SMALL to MODERATE.

Communities in Ottawa County, however, particularly those within the taxing jurisdiction of Carroll Township and the Benton-Carroll-Salem School District, would experience losses in both employment and tax revenues due to Davis-Besse's closure that could constitute MODERATE impacts.

The number of peak construction workers expected to build the solar power facilities and the NES facility is unknown at this time. However, it is likely not to exceed that of a gas-fired plant with a capacity of 910 MWe, which is 1200 (**NRC 1996**, Table 8.1). To operate and maintain the solar facilities and NES plant would require approximately 150 to 200 workers. FENOC expects that most of the construction workforce would commute and relatively few would relocate into the area, and associated socioeconomic impacts during construction would be SMALL.

In summary, FENOC considers that the overall socioeconomic impact of construction and operation of the representative solar generation combined with CAES generation facility would be SMALL to MODERATE.

Waste Management

PV technology creates environmental impacts related to manufacture and disposal. 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. The cumulative and long-range impacts from transporting and disposing of hazardous waste could be SMALL to MODERATE.

Aesthetics

Most solar facilities are located in remote areas and would likely not generate large aesthetic concerns and would likely meet minor public resistance. Overall, the impacts from the construction and operation of solar power facilities would be SMALL.

Cultural Resources

Due to the large land use to construct the necessary solar generation facilities and for the CAES facility, the potential for impacting cultural resources could be LARGE. To minimize these impacts, FENOC assumed construction activities would consider cultural resources under OPSB or comparable program rules. FENOC further assumed that appropriate measures would be taken to avoid, recover, or provide other mitigation for loss of any resources discovered during onsite or offsite construction.

On this basis, FENOC concludes that the potential adverse impact on cultural resources of the solar generating facilities, regardless of location, would be SMALL.

FENOC assumed that the NES facility or alternative CAES plant and associated gas-supply pipeline and transmission line would be located considering cultural resources under OPSB or comparable program rules and, therefore, any impacts would be SMALL.

7.3.3.4 Combinations of Wind and Solar with CAES

As discussed in Sections 7.2.1 and 7.2.1.3, FENOC evaluated a combination of wind and solar generation along with CAES as an alternative to replace the rated electrical output of Davis-Besse.

The environmental impact results for interconnected wind farms and PV solar and CAES facilities are discussed in detail in Sections 7.3.3.1 through 7.3.3.3. A summary of these results is described below and listed in Table 8.0-1.

Land Use

The amount of territory required for the construction and operation of a series of wind farms and solar PV facilities would result in LARGE land use impacts. Most of this land would be in greenfield or agricultural areas. Although some land used to develop wind farms could be used to generate solar power, there could be several issues including agriculture needs, transmission capacity and sunlight duration that may limit the multiuse of this land.

Land use associated with the NES facility would be limited to the facility's 92 surface acres. There would be some land impacted during construction, but this site has been previously disturbed so the impact should be SMALL. However, if another site is chosen for the CAES or an additional CAES facility is needed to meet base-load power requirements, then the land use impact could be MODERATE to LARGE.

Water Use and Quality – Surface Water

Wind farms and solar generation using PV technology do not require cooling water or intake structures. Therefore, there would be no impact on water use and the only potential impact on local water quality would be erosion or sedimentation issues during construction. These impacts would be minimized by using best management practices during construction activities.

Significant amounts of water could be used to keep the solar panels clean so they remain effective in collecting the maximum amount of sunlight as possible. Since the areas where these solar facilities would be located are not in a desert or semi-arid environment, the demands on water resources should be reduced. Overall, the impacts on water use and quality should be SMALL to MODERATE.

CAES have cooling towers associated with the use of gas turbines to produce electricity and compressors to recharge the storage structure. These cooling towers are much smaller than those typically used for coal and gas generation plants. Cooling makeup water evaporative losses and discharge flows for the plant would be considerably less than that of Davis-Besse, primarily because less power would be derived from a steam cycle. (**FENOC 2007**, Section 7.2.2.1)

During CAES operation, cooling water and wastewater discharges would be regulated under the federal CWA and corresponding state programs by an NPDES permit. Construction activities would be similarly regulated to ensure protection of water resources. In addition, impacts on water use and quality would be subject to scrutiny in the planning stage under OPSB or similar governing authority rules.

Overall, FENOC considers that the impacts from construction and operation of this combined energy alternative on surface water use and quality to be SMALL to MODERATE.

Water Use and Quality – Ground Water

Impacts would depend on whether the combined energy alternative facilities would use ground water for any purposes, as well as the characteristics of local aquifers. Regardless of location, FENOC assumed that the NES plant or a CAES plant at an alternate site would not rely on ground water for plant cooling, and that regulations for ground water use for potable water would limit impacts to SMALL. FENOC also assumed that construction of the facilities would employ best management practices to keep the impact to groundwater quality SMALL.

Air Quality

The construction of roads and turbine tower supports would result in short-term impacts in air quality from fugitive dust and equipment emissions. There are no air quality impacts associated with the operation of wind farms and solar PV facilities, therefore the overall impacts would be SMALL.

CAES facilities use natural gas, which is a relatively clean-burning fuel with nitrogen oxides being the primary focus of combustion emission controls. The NES facility has been issued an air permit by the Ohio EPA, and emission details are discussed in Section 7.3.3.2 and Table 7.3-3. FENOC assumed that best management practices would be utilized during construction activities to minimize impacts to air quality. In addition, FENOC assumed that the NES or alternate CAES facility would comply with its air permit, thus impacts to air quality should be MODERATE.

Ecological Resources

As noted in the Land Use subsection above, development of wind farms and solar PV facilities and CAES would have a MODERATE to LARGE impact on land resources which could have a MODERATE to LARGE impact on the ecological resources during construction and operation of these facilities. FENOC assumed that construction best management practices and awareness to critical habitat during operations would minimize impacts to ecological resources.

Human Health

The only major health risk for the construction and operation of a series of wind farms and solar PV facilities, and a CAES plant would be accidents. There may be minor health impacts from reduced air quality during construction and the operation of the CAES facility and from handling potential hazardous substances or waste materials. FENOC assumed that all air permits and Occupational Health and Safety Act requirements would be complied with during construction and operation of these facilities, and the impacts should be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from wind farms and solar PV systems with an associated NES or CAES facility include temporary increases in jobs, economic activity, and demand for housing and public services in communities surrounding the sites during the construction period. Socioeconomic impacts are similar to those discussed in Sections 7.3.3.1 to 7.3.3.3 and would be SMALL to MODERATE.

Waste Management

PV technology creates environmental impacts related to manufacture and disposal. 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. The cumulative and long range impacts from transporting and disposing of hazardous waste could be a MODERATE to LARGE impact. Minimal waste streams should be generated from the construction and operations of the wind power and CAES facilities. Therefore, the impacts should be SMALL.

Aesthetics

Most wind farms are located in remote areas and may generate large aesthetic concerns, particularly if sited on highlands or in recreational areas. Solar PV generation requires relatively flat land, which limits the view to the public. However, presence of overhead transmission lines may cause some moderate public resistance. To minimize these impacts, the renewable generation facilities would likely be located in rural areas as much as possible. The proposed NES facility is located in a brownfield area and should not change the aesthetic view of the area. Overall, the aesthetic impacts from these facilities should be SMALL.

Cultural Resources

Due to the large amount of land needed to construct the necessary wind farms and solar PV facilities, and for the CAES facility, the potential for impacting cultural resources could be LARGE. To minimize these impacts, FENOC assumed construction activities would consider cultural resources under OPSB or comparable program rules. FENOC further assumed that appropriate measures would be taken to avoid, recover, or provide other mitigation for loss of any resources discovered during onsite or offsite construction. On this basis, FENOC concludes that the potential adverse impact on cultural resources of this combined energy alternative regardless of location would be SMALL.

7.3.3.5 Conclusions of Combining New Generation Power Sources with Storage

The use of wind power in the form of interconnected wind farms and/or solar photovoltaic power, in combination with CAES to provide power to replace Davis-Besse's output by 2017 has been evaluated and discussed in the subsections above. The environmental impacts associated with renewable sources and CAES were evaluated in Subsections 7.3.3.1, 7.3.3.2, 7.3.3.3 and 7.3.3.4. The overall conclusion from this impact analysis is that the combination of these energy source alternatives has SMALL to LARGE impacts. These impacts are compared in Section 8.0 to the impacts from renewal of the Davis-Besse license for another 20 years as well as those for the alternative coal and natural gas fired plants.

Table 7.3-1: Air Emissions from Coal-Fired Alternative

Parameter[1]	Calculation	Result
Annual Coal Consumption	$\text{Total Gross Capability} \times \frac{\text{Heat Rate}}{\text{Heat Value}} \times \text{Conversion Factors} \times \text{Capacity Factor}$	tons/year
	$\frac{910\text{ MW} \times 9{,}800\text{ Btu}}{\text{kW x hr } 12{,}285\text{ Btu}} \times \frac{\text{lb}}{\text{MW}} \times \frac{1{,}000\text{ kW}}{\text{year}} \times \frac{8{,}760\text{ hr}}{\text{year}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times 0.80$	2,543,644
Emissions	Coal Consumption x Uncontrolled Emissions x Conversion Factors x [100 – removal efficiency (%)][2]	tons/year
SO_x	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{130\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-95}{100}$	8,267
NO_X	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{10\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-60}{100}$	5,087
CO	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{0.5\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}}$	636
PM	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{120\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-99.9}{100}$	152.6
PM_{10}	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{27\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-99.9}{100}$	34.34
CO_2	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{6{,}000\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}}$	7,630,933

Btu = British thermal units
CO = carbon monoxide
CO_2 = carbon dioxide
hr = hour
kW = kilowatt
lb = pound
MW = megawatt
NO_X = nitrogen oxides
PM = total filterable particulate matter
PM_{10} = PM having a diameter less than 10 microns
SO_X = sulfur oxides

Notes:
(1) Source: Table 7.2-1
(2) There are no emission controls for CO and CO_2.

Table 7.3-2: Air Emissions from Gas-Fired Alternative

Parameter[1]	Calculation	Result
Annual Gas Heat Input	Gross Capability × Heat Rate × Conversion Factors × Capacity Factor	MMBtu/year
	$910\ \text{MW} \times \frac{6{,}500\ \text{Btu}}{\text{kW}-\text{hr}} \times \frac{1{,}000\ \text{kW}}{\text{MW}} \times \frac{8{,}760\ \text{hr}}{\text{year}} \times 0.80$	41,452,320
Emissions	Annual Gas Heat Input x Uncontrolled Emissions x Conversion Factors x [100 – removal efficiency (%)] [2]	tons/year
SO_2	$\frac{41{,}452{,}320}{\text{year}} \times \frac{0.00064\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}}$	13.3
NO_X	$\frac{41{,}452{,}320}{\text{year}} \times \frac{0.099\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}} \times \frac{100-90}{100}$	205
CO	$\frac{41{,}452{,}320}{\text{year}} \times \frac{0.015\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}}$	311
PM (all PM_{10})	$\frac{41{,}452{,}320}{\text{year}} \times \frac{0.019\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}}$	39.4
CO_2	$\frac{41{,}452{,}320}{\text{year}} \times \frac{110\ \text{lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\ \text{lb}}$	2,279,878

Btu = British thermal units
CO = carbon monoxide
CO_2 = carbon dioxide
hr = hour
kW = kilowatt
lb/MMBtu = pounds per million British thermal units
MW = megawatt
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = PM having a diameter less than 10 microns
SO_X = sulfur oxides (mainly SO_2)

Notes:

(1) Source: Table 7.2-2
(2) There are no emission controls for SO_2, CO, PM, and CO_2.

Table 7.3-3 Permitted Air Emissions from the Proposed Norton Energy Storage Project

Parameter	Quantity	Volume
SO_2	42.41	tons/year*
NO_X	93.67	tons/year*
CO	90.36	tons/year*
PM (all PM_{10})	46.65	tons/year*
Volatile Organic Compounds	26.40	tons/year*
CO_2	681,100	tons/year*

CO = carbon monoxide
CO_2 = carbon dioxide
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = PM having a diameter less than 10 microns
SO_2 = sulfur dioxide

* Based on rolling, 12-month permits
Emissions are listed based on Permit information, and are from units P001 – P006, combined (including startups/shutdowns), which equates to 804 MW (134 MW x 6 units).
Equipment Description: Each Combustion Train - 589MMBtu/hr Dresser Rand natural gas fired combustion turbine (134 MW) operating in simple cycle mode with recuperator controlled by catalytic oxidation, water injection, and selective catalytic reduction.
As explained in Section 7.2.1.3, FirstEnergy estimates that only up to four units (i.e., 536 MW) could be online by 2017.

Source: **NES 2010**

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7.4 REFERENCES

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8.0 COMPARISON OF ENVIRONMENTAL IMPACT OF LICENSE RENEWAL WITH THE ALTERNATIVES

> Regulatory Requirement: 10 CFR 51.45(b)(3)
>
> "To the extent practicable, the environmental impacts of the proposal and the alternatives should be presented in comparative form." as adopted by 10 CFR 51.53(c)(2)."

FENOC presents its evaluations of the environmental impacts of Davis-Besse license renewal in Chapter 4 and reasonable alternatives in Chapter 7. In this chapter, FENOC provides a comparative summary of these impacts.

Table 8.0-1 summarizes environmental impacts of the proposed action (license renewal) and the alternatives, for comparison purposes. The environmental impacts compared in Table 8.0-2 are those that are either Category 2 issues for the proposed action or are issues that the GEIS (**NRC 1996**) identified as major considerations in an alternatives analysis. For example, although the NRC concluded that air quality impacts from the proposed action would be small (Category 1), the GEIS identified major human health concerns associated with air emissions from alternatives (Section 7.2.2). Therefore, Table 8.0-1 compares air quality impacts from the proposed action to the alternatives. Table 8.0-2 is a more detailed comparison of the alternatives.

As shown in Table 8.0-1 and Table 8.0-2, environmental impacts of the proposed action (Davis-Besse license renewal) are expected to be SMALL for all impact categories evaluated. In contrast, FENOC expects that environmental impacts in some impact categories would be MODERATE or MODERATE to LARGE for the no-action alternative (NRC decision not to renew Davis-Besse operating license), considered with or without development of replacement generation facilities.

As codified in the NRC regulations at 10 C.F.R. § 51.95(c)(4), "the NRC staff, adjudicatory officers, and Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision makers would be unreasonable."

The Commission explained this standard as follows:

> *Given the uncertainties involved and the lack of control that the NRC has in the choice of energy alternatives in the future, the Commission believes that it is reasonable to exercise its NEPA authority to reject license renewal applications only when it has determined that the impacts of*

> *license renewal sufficiently exceed the impacts of all or almost all of the alternatives that preserving the option of license renewal for future decision makers would be unreasonable.*

Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed. Reg. 28,467, 28,473 (June 5, 1996).

FENOC concludes that the environmental impacts of the continued operation of Davis-Besse, providing approximately 910 MWe of base-load power generation through 2037, when compared to alternatives discussed in Section 7.0 of this Environmental Report, demonstrate that preserving license renewal as an option is not unreasonable.

Table 8.0-1: Impacts Comparison Summary

Impact[(2)]	Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[(1)]			
			With Coal-Fired Generation	With Gas-Fired Generation	With Interconnected Wind	With Renewable & CAES Generation
Land Use	SMALL	SMALL	MODERATE to LARGE	SMALL to MODERATE	MODERATE to LARGE	LARGE
Water Quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Air Quality	SMALL	SMALL	MODERATE	MODERATE[(3)]	SMALL	MODERATE
Ecological Resources	SMALL	SMALL	MODERATE	SMALL to MODERATE	SMALL to LARGE	MODERATE to LARGE
Human Health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	SMALL	MODERATE	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Waste Management	SMALL	SMALL	MODERATE	SMALL	SMALL	SMALL
Aesthetics	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL
Cultural Resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

Notes:

(1) Environmental impacts associated with the construction and operation of new coal-fired or gas-fired generating capacity at a greenfield site would exceed those for a coal-fired or gas-fired plant located at a brownfield, i.e., existing disturbed site.

(2) From 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3:
- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE - Environmental effects are sufficient to alter noticeably, but not destabilize, any important attribute of the resource.
- LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

(3) Moderate, but less than with coal-fired generation.

Table 8.0-2: Impacts Comparison Detail

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Alternative Descriptions					
Davis-Besse license renewal for 20 years, followed by decommissioning	Decommissioning following expiration of current Davis-Besse license. Adopting by reference, as bounding Davis-Besse decommissioning, GEIS description (**NRC 1996**, Section 7.1).	New construction at greenfield (but preferably brownfield) site.	New construction at greenfield (but preferably brownfield) site.	New construction at greenfield locations.	New construction at greenfield (wind, and solar) CAES at brownfield site.
		Pulverized coal units, 910-MW (equivalent to Davis-Besse); capacity factor 0.80.	Combined-cycle units, 910-MW (equivalent to Davis-Besse); capacity factor 0.80.	Wind generation units, 910-MW (equivalent to Davis-Besse); capacity factor 0.80.	Assume CAES with natural gas units at electrical output of 804 MW (6 trains).
		Closed-cycle cooling with 500-foot-tall natural-draft cooling towers.	Closed-cycle cooling with mechanical-draft cooling towers.	No cooling required.	Closed-cycle cooling with mechanical-draft cooling towers for CAES.
		Coal and limestone delivery via waterway or rail.	Delivery of natural gas via a new 10-mile-long pipeline.	No fuel delivery system required.	Delivery of natural gas via a new 10-mile-long pipeline for CAES.

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
		Air emission controls: Particulates: fabric filter (99.9% removal) Sulfur oxide: wet limestone scrubber (95% removal) Nitrogen oxide: low-NO_X burners, overfire air, selective catalytic reduction (95% removal).	Air emission controls: Nitrogen oxides: dry low-NO_X burners; selective catalytic reduction (90% removal). Particulate matter and carbon monoxide emissions limited through proper combustion controls.	No air emission controls required.	Air emission controls: Nitrogen oxides: dry low-NO_X burners; selective catalytic reduction (90% removal). Particulate matter and carbon monoxide emissions limited through proper combustion controls for CAES.
		Emissions dispersed via 500-foot-tall stacks.	Exhaust dispersed via 150-foot-tall stacks.	No emissions or heat plume exhaust.	Exhaust dispersed via 150-foot-tall (or less) stacks.
825 permanent and 60 contract workers (Section 3.4)		Estimated workforce: Construction: 1,092 – 2,275; Operation: 228	Estimated workforce: Construction: 1,092 – 2,275; Operation: 137	Estimated workforce: Construction: 1,200 – 1,500; Operation: 150.	Estimated workforce: Construction: 1,200 – 1,500; Operation: 150.

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Land Use Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 52, 53).	SMALL – Adopting by reference applicable NRC impact conclusions in the GEIS Section 8.4 and Supplement 1 to NUREG-0586.	MODERATE to LARGE – 1,547 acres required for the powerblock and associated facilities; assumed 10 miles of 345-kV transmission line on a 150-foot right-of-way; 22 acres/MW for mining and disposal (Section 7.3.1).	SMALL to MODERATE – 100 acres for facility and 240 to 270 additional acres for gas pipeline and electric transmission lines (Section 7.3.2).	MODERATE to LARGE – Would be dependent on how many wind farms onshore verses offshore (Section 7.3.3).	LARGE – up to 91,000 acres required for wind and 37,900 acres for solar generation and associated facilities; (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Water Quality Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 1-3, 6-11, and 31). Five Category 2 water quality issues do not apply: Section 4.1, Issue 13; Section 4.6, Issue 34, Section 4.5, Issue 33; Section 4.7, Issue 35; and Section 4.8 Issue 39.	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 89) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	SMALL – Construction impacts minimized by regulatory controls; operation-phase impacts similar to those of Davis-Besse; cooling water and wastewater discharges subject to regulatory controls (Section 7.3.1).	SMALL – Construction impacts minimized by regulatory controls; cooling water and wastewater discharges subject to regulatory controls (Section 7.3.2).	SMALL – Construction impacts minimized by regulatory controls (Section 7.3.3).	SMALL to MODERATE - Construction impacts minimized by regulatory controls; cooling water and wastewater discharges subject to regulatory controls (Section7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)					
Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[(1), (2)]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Air Quality Impacts					
SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 51). One Category 2 issue does not apply: Section 4.11, Issue 50.	SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issue 88) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	MODERATE – 8,267 tons SO_X/year 5,087 tons NO_X/year 636 tons CO/year 153 tons PM/year 34.3 tons PM_{10}/year 7.63×10^6 tons CO_2/year (Section 7.3.1).	MODERATE – 13.3 tons SO_2/year 205 tons NO_X/year 311 tons CO/year 39.4 tons PM/year 2.28×10^6 tons CO_2/year (Section 7.3.2).	SMALL - Construction impacts minimized by regulatory controls (Section 7.3.3).	MODERATE – 42.41 tons SO_2/year 93.67 tons NO_X/year 90.36 tons CO/year 46.65 tons PE/year 26.40 tons VOCs/year 681.1×10^3 tons of CO_2/year (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)					
Proposed Action (License Renewal)	**Base (Decommissioning)**	**No-Action Alternatives[1], [2]**			
		With Coal-Fired Generation	**With Gas-Fired Generation**	**Interconnected Wind Generation**	**With Renewable & CAES Generation**
Ecological Resource Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 14-24, 28-30, 41-43, and 45-48). Three Category 2 issues do not apply: Section 4.2, Issue 25; Section 4.3, Issue 26; and Section 4.4, Issue 27.	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 90) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	MODERATE – Potential loss or alteration of more than 1,500 acres of habitat (e.g., transmission, waste disposal landfill); facilities siting would be subject to regulatory controls limiting impacts to ecological resources, including wetlands and threatened or endangered species. Impact on aquatic habitats and biota from dredging (e.g., for intake and discharge structures and, if applicable, barge terminal), cooling water withdrawal, and discharge would be	SMALL to MODERATE – Approximately 100 acres onsite and 240 to 270 acres offsite of largely agricultural land would be converted to industrial use for plant site and offsite infrastructure, respectively; facilities siting would be subject to regulatory controls limiting impacts to ecological resources, including wetlands and threatened or endangered species. Potential for impacts to aquatic resources from construction and operation (e.g., cooling water withdrawal and	SMALL to MODERATE – Habitat and migratory impacts would be greater for land based wind farms then offshore wind farms (e.g., wind facilities, transmission); facilities siting would be subject to regulatory controls limiting impacts to ecological resources, including wetlands and threatened or endangered species (Section 7.3.3).	MODERATE to LARGE– Potential loss or alteration of more than 90,000 acres of habitat (e.g., wind and solar facilities, transmission); facilities siting would be subject to regulatory controls limiting impacts to ecological resources, including wetlands and threatened or endangered species (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
		subject to regulatory controls (Section 7.3.1).	discharge) reduced by best management practices and regulatory controls (Section 7.3.2).		
Threatened or Endangered Species Impacts					
SMALL – Federally and state threatened or endangered species are protected through company and plant procedures. (Section 4.10, Issue 49)	SMALL – Not an impact evaluated by the GEIS.	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats.	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats.	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats.	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats.

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Human Health Impacts					
SMALL – Adopting by reference Category 1 issues (Table A-1, Issues 54-56, 58, 61, 62). One Category 2 issue does not apply: Section 4.12, Issue 57. Risk due to transmission-line induced currents minimal due to conformance with consensus code (Section 4.13, Issue 59).	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 86) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	SMALL – Some risk of cancer and emphysema from air emissions and risk of accidents to workers, as the NRC notes in the GEIS. Assumed that regulatory controls would reduce risks to acceptable levels (Section 7.3.1).	SMALL – Similar to the coal-fired alternative (Section 7.3.2).	SMALL (Section 7.3.3).	SMALL – Similar to the gas-fired alternative (CAES plant) (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives(1), (2)			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Socioeconomic Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 64, 67). Two Category 2 issues do not apply: Section 4.16, Issue 66 and Section 4.17.1, Issue 68. Location in high population area with no growth controls minimizes potential for housing impacts (Section 4.14, Issue 63). Capacity of public water supply as well as education and transportation infrastructures minimizes potential for related impacts (Section 4.15, Issue 65; Section 4.16, Issue 66; and Section	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 91) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	MODERATE to Reduction in permanent work force and tax base at Davis-Besse would adversely affect surrounding communities. Construction and operational impacts would depend upon the site location. Regulatory controls and appropriate mitigation would ensure that impacts are not destabilizing (Section 7.3.1).	MODERATE – Reduction in permanent work force and tax base at Davis-Besse would adversely affect surrounding communities. Impacts from construction would be mitigated by siting plant within commuting distance of large metropolitan areas (Section 7.3.2).	MODERATE – Reduction in permanent work force and tax base at Davis-Besse would adversely affect surrounding communities. Impacts from construction would be mitigated by siting renewable facilities within commuting distance of metropolitan areas when possible (Section 7.3.3).	MODERATE – Reduction in permanent work force and tax base at Davis-Besse would adversely affect surrounding communities. Impacts from construction would be mitigated by siting renewable facilities within commuting distance of metropolitan areas when possible (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
4.18, Issue 70). Plant tax payments range from <10% to nearly 20% of local jurisdictions tax revenues (Section 4.17.2, Issue 69).					
Waste Management Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 77-85).	SMALL – Adopting by reference Category 1 issue finding Table A-1, Issue 87) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	MODERATE – Annual waste of approximately 300,000 tons ash and 470,000 tons flue gas desulphurization waste, requiring disposal offsite in a 644-acre landfill over an assumed 40-year plant life (Section 7.3.1).	SMALL – Solid waste is minimal (Section 7.3.2).	SMALL – Solid waste is minimal (Section 7.3.3).	SMALL – Solid waste is minimal (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Aesthetic Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 73, 74).	SMALL – Adopting by reference conclusions in the GEIS Section 8.4 and Supplement 1 to NUREG-0586.	SMALL to MODERATE – Highly dependent on location. Stacks, cooling tower plumes likely would be visible for several miles. Operation of waste disposal site would have adverse impact potential (Section 7.3.1).	SMALL to MODERATE – Highly dependent on location. Stacks, cooling tower plumes would be visible offsite (Section 7.3.2).	SMALL to MODERATE – Highly dependent on location of wind farms (Section 7.3.3).	SMALL – Aesthetic impacts are minimal (Section 7.3.3).
Cultural Resource Impacts					
SMALL –License renewal does not require additional land disturbance (Section 4.19, Issue 71).	SMALL – Adopting by reference conclusions in the GEIS Section 8.4 and Supplement 1 to NUREG-0586.	SMALL – Siting of plant and offsite infrastructure (e.g., transmission line, natural gas pipeline) would be subject to regulatory review, and mitigation measures would be implemented (Section 7.3.1).	SMALL – Same as the coal-fired alternative (Section 7.3.2).	SMALL – Cultural resource impacts are minimal (Section 7.3.2).	SMALL – Cultural resource impacts are minimal (Section 7.3.2).

Btu = British thermal unit
CO = carbon monoxide
CO_2 = carbon dioxide
ft^3 = cubic foot
GEIS = Generic Environmental Impact Statement (NRC 1996)
kWh = kilowatt hour
lb = pound
MM = million
MW = megawatt
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = particulates having diameter less than 10 microns

Notes:

(1) Environmental impacts associated with the construction and operation of new coal-fired or gas-fired generating capacity at a greenfield site would exceed those described in the table for a coal-fired or gas-fired plant located at a brownfield, i.e., existing disturbed site.

(2) From 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3:
- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- 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 important attributes of the resource.

8.1 REFERENCES

NES 2010. Norton Energy Storage, LLC, Final Air Permit-To-Install and Operate, Ohio EPA, September 2010.

NRC 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants (GEIS), NUREG-1437, Volumes 1 and 2, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, May 1996.

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Enclosure B

Davis-Besse Nuclear Power Station, Unit No. 1 (DBNPS)

Letter L-11-289

FENOC Annotation of Amendment No. 16 to the DBNPS License Renewal Application to Facilitate NRC Review

86 Pages
(not including this cover page)

License Renewal Application Sections Affected

Appendix E, Chapter 7

Appendix E, Chapter 8

This Enclosure provides a copy of the Amendment provided in Enclosure A (Davis-Besse Nuclear Power Station, Unit No. 1, License Renewal Application, Appendix E, "Applicant's Environmental Report, Operating License Renewal Stage," Chapters 7 and 8) that shows the changes in redline (or tracked-changes) format to facilitate NRC review.

7.0 ALTERNATIVES TO THE PROPOSED ACTION

Regulatory Requirement: 10 CFR 51.45(b)(3)
The environmental report shall discuss "Alternatives to the proposed action." [adopted by reference at 10 CFR 51.53(c)(2)].

7.0.1 OVERVIEW

This chapter assesses alternatives to the proposed renewal of the Davis-Besse operating license. It includes discussions of the no-action alternative and alternatives that meet system generating needs. Descriptions are provided in sufficient detail to facilitate comparison of the impacts of the alternatives to those of the proposed action. In considering the level of detail and analysis that it should provide for each category, FENOC relied on the NRC decision-making standard for license renewal:

> *...the NRC staff, adjudicatory officers, and Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. [10 CFR 51.95(c)(4)]*

As noted in 10 CFR 51.53(c)(2), a discussion is not required of need for power or economic costs and benefits of the proposed action or of alternatives to the proposed action except insofar as such costs and benefits are either essential for a determination regarding the inclusion of an alternative in the range of alternatives considered or relevant to mitigation.

Section 7.1 addresses the "no-action" alternative in terms of the potential environmental impacts of not renewing the Davis-Besse operating license, independent of any actions taken to replace or compensate for the loss of generating capacity. Section 7.2 describes feasible alternative actions that could be taken, which FENOC also considers to be elements of the no-action alternative, and presents other alternatives that FENOC does not consider to be reasonable. Section 7.3 presents the environmental impacts for the reasonable alternatives.

The environmental impact evaluations of alternatives presented are intended to provide enough information to support NRC decision-making by demonstrating whether an alternative would have a smaller, comparable, or greater environmental impact than the proposed action. Additional detail or analysis was not considered useful or necessary if it would identify only additional adverse impacts of license renewal alternatives; i.e., information beyond that necessary for a decision. This approach is consistent with the CEQ regulations, which provide that the consideration of alternatives (including the proposed action) be adequately addressed so reviewers may evaluate their comparative merits (40 CFR 1502.14(b)).

The characterization of environmental impacts in this chapter applies the same definitions of "SMALL," "MODERATE," and "LARGE" used in Chapter 4 of this ER and by the NRC in the GEIS (**NRC 1996**). Chapter 8 presents a summary comparison of environmental impacts of the proposed action and alternatives.

7.0.2 REGION OF INTEREST

NRC environmental guidance for siting new reactors defines the "Region of interest" (ROI) as "the geographic area considered in searching for candidate sites." NUREG-1555, at 9.3-1 (1999). That definition is not directly applicable to this license renewal action because Davis-Besse is already sited as an operating reactor in Ohio. The application here is for license renewal, and not for initial plant siting, construction, or operation. However, that same environmental guidance explains that "the basis for an ROI is the State in which the proposed site is located or the relevant service area for the proposed plant." NUREG-1555, at 9.3-2. This explanation, or basis for selecting the ROI for siting new reactors, is applicable for defining the ROI for purposes of license renewal. Accordingly, FENOC is adopting an ROI for this Environmental Report as the State in which Davis-Besse is located: Ohio. The second portion of the explanation in NUREG-1555—"the relevant service area for the proposed plant"—is not applicable to Davis-Besse, because the electricity that Davis-Besse generates is sold on the wholesale power market. Accordingly, there is no "relevant service area" for the plant.

7.1 NO-ACTION ALTERNATIVE

FENOC considers the no-action alternative is not to renew the Davis-Besse operating license. With this alternative, FENOC expects Davis-Besse would continue to operate until the expiration of the existing operating license in 2017, at which time plant operations would cease, decommissioning would begin, and FirstEnergy or others would take the appropriate actions to meet system-generating needs created by discontinued operation of the plant.

Section 7.1.1 addresses the impacts of terminating operations and decommissioning, whereas Section 7.1.2 discusses the actions to replace power from Davis-Besse.

7.1.1 TERMINATING OPERATIONS AND DECOMMISSIONING

In the event the NRC does not renew the Davis-Besse operating license, FENOC assumes for this ER that it would operate the plant until the current license expires, then terminate operations and initiate decommissioning activities in accordance with NRC requirements. For purposes of this discussion, terminating operations includes those actions directly associated with permanent cessation of operations, which may result in more or less immediate environmental impacts (e.g., socioeconomic impacts from reduction in employment and tax revenues).

Decommissioning, as defined in the GEIS, is the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license (**NRC 1996**, Section 7.1). The two decommissioning options typically selected for United States reactors are rapid decontamination and dismantlement (DECON), and safe storage of the stabilized and de-fueled facility (SAFSTOR), followed by final decontamination and dismantlement (**NRC 1996**, Section 7.2.2). Under the DECON option, radioactively contaminated portions of the facility and site are decontaminated or removed promptly after cessation of operations to a level that permits termination of the license; these activities require several years for large light-water reactors like Davis-Besse (**NRC 1996**, Table 7.8). The SAFSTOR option involves safe storage of the stabilized and defueled facility for a period of time followed by decontamination to levels that permit license termination. Regardless of the option selected, decommissioning typically must be completed within 60 years after operations cease in accordance with NRC requirements at 10 CFR 50.82 (**NRC 1996**, Section 7.2.2).

FENOC has not selected a decommissioning method for Davis-Besse. The decommissioning method for Davis-Besse would be described in post-shutdown decommissioning plans for the plant, which must be submitted to NRC within two years following cessation of operations. For purposes of the present analysis, FENOC assumes that the DECON option would be employed upon license termination.

The NRC presents in Chapter 7 and Section 8.4 of the GEIS a summary of generic environmental impacts of the decommissioning process and an evaluation of potential changes in impact that could result from deferring the decommissioning process for up to 20 years (**NRC 1996**). For a pressurized water reactor decommissioning, NRC used a 1,175 MWe reference reactor. Although larger than Davis-Besse (910 MWe), FENOC considers the reference reactor to be representative of Davis-Besse. As a result, FENOC believes the decommissioning activities described in the GEIS to be representative of activities FENOC would perform for decommissioning at Davis-Besse.

The NRC concluded from its evaluation that decommissioning impacts would not be significantly greater as a result of the proposed action, assumed to result in 20 additional years of operation (**NRC 1996**, Sections 7.3 and 8.4). The NRC conclusions also indicate that the impacts of the decommissioning process itself, addressed in this ER as part of the no-action alternative, would have SMALL impacts with respect to radiation dose, waste management, air quality, water quality, and ecological resources (see 10 CFR Part 51, Subpart A, Appendix B, Table B-1). FENOC considers this generic evaluation and associated conclusions applicable to Davis-Besse as well.

The NRC has provided additional analysis of the environmental impacts associated with decommissioning in the Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (**NRC 2002**). Except for issues that require site-specific evaluation, environmental impacts, including radiological releases and doses from decommissioning activities, were assessed to be SMALL (**NRC 2002**, Sections 4.3 and 6.1).

Regardless of the NRC decision on license renewal, FENOC will have to decommission Davis-Besse; license renewal would only postpone decommissioning for an additional 20 years. In the GEIS, the NRC concludes that there should be little difference between the environmental impacts from decommissioning at the end of 40 years of operation versus those associated with decommissioning after an additional 20 years of operation under a renewed license (**NRC 1996**, Section 7.4).

By reference, FENOC adopts the NRC findings regarding environmental impacts of decommissioning in the license renewal GEIS (**NRC 1996**) and in the decommissioning GEIS (**NRC 2002**), and concludes that environmental impacts under the no-action alternative would be similar to those that occur following license renewal. Further, FENOC believes that decommissioning activities would not involve significant land-use disturbance offsite or significant activities beyond current operational areas that would offer potential for impacts on land use, ecological resources, or cultural resources. Decommissioning impacts would be temporary and occur at the same time as those associated with the operation of replacement generating sources.

7.1.2 REPLACEMENT CAPACITY

Davis-Besse is a base-load generator of electric power, with a net generating capability of 908 MWe (Section 3.1.2). In 2008, Davis-Besse generated approximately 8.3% of FirstEnergy's total base-load electricity generation (**FirstEnergy 2008a**, Page 7; **USDOE 2010**). The power produced by Davis-Besse, which represents a significant portion of the electricity FirstEnergy supplies to 2.1 million customers in its service territories located in Ohio (**FirstEnergy 2009a**, Page 81), would be unavailable in the event the Davis-Besse operating license is not renewed.

As provided in 10 CFR 51.53(c)(2), FENOC does not consider the need for power from Davis-Besse in this analysis, but does consider the potential impact of alternatives for replacing this power. Replacement options considered include building new base-load generating capacity, purchasing power, delaying retirement of non-nuclear assets, and reducing power requirements through demand reduction, as discussed in Section 7.2.

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7.2 ALTERNATIVES THAT MEET SYSTEM GENERATING NEEDS

If the Davis-Besse operating license is not renewed, then the State of Ohio, FirstEnergy Corp. and its subsidiary companies, and other participants in the wholesale power market would lose approximately 910 MWe* of base-load capacity. Renewal would preserve the option of relying on Davis-Besse to meet future electric power needs through the period of extended operation.

While many methods are available to generate electricity, the GEIS indicates that a "reasonable set of alternatives should be limited to analysis of single, discrete electric generation sources and only electric generation sources that are technically feasible and commercially viable" (**NRC 1996**, Section 8.1). Considering that Davis-Besse serves as a large base-load generator, FENOC considers reasonable alternatives to be those that would also be able to generate base-load power. FENOC believes that any alternative would be unreasonable if it did not consider replacement of the energy resource.

7.2.1 ALTERNATIVES CONSIDERED AS REASONABLE

Fossil-Fuel Alternatives Summary

FENOC believes that coal-fired and gas-fired generation capacity are feasible alternatives to nuclear power generating capacity, based on current (and expected) technological and cost factors, as compared to the other alternatives listed in the GEIS (**NRC 1996**, Section 8.1). FENOC considers the coal-fired and gas-fired technologies reasonable alternatives for purposes of this analysis to replace Davis-Besse generating capacity in the event its operating license is not renewed. The GEIS further notes that natural gas combined-cycle plants are particularly efficient and are used as base-load facilities (**NRC 1996**, Section 8.3.10). The specific coal-generating technologies that would represent viable alternatives are less certain, particularly in view of potentially higher air emissions compared to natural gas firing. For example, large-capacity integrated gasification combined-cycle (IGCC) and fluidized-bed-combustion (FBC) technologies (atmospheric and pressurized) are at or near commercial viability and could prove to be appropriate replacements. However, modern pulverized coal plants with advanced, clean-coal technology air emission controls represent currently proven technology and are economically competitive and commercially available in large-capacity unit sizes that could effectively replace Davis-Besse. Therefore, FENOC uses a representative plant of this type for purposes of impact evaluation, noting that air emission impacts of IGCC and FBC options may be lower than modern pulverized coal, but would be higher than the gas-fired combined-cycle alternative (**USDOE 1999**, Pages 5-7).

Deleted: FENOC considers the other technologies listed in the GEIS as not reasonable alternatives for the reasons discussed in Section 7.2.2.¶

*910 MWe is used for calculation convenience instead of 908 Mwe, as noted in Section 3.1.2.

Renewable Energy Alternatives Summary

On April 26, 2011, an NRC Atomic Safety and Licensing Board (Board) presiding over the license renewal proceeding for Davis-Besse issued a Memorandum and Order (LBP-11-13) admitting a contention alleging that the FENOC analysis of renewable energy alternatives in the Environmental Report was not adequate. As admitted by the Board, the contention states:

> [FENOC's ER] fails to adequately evaluate the full potential for renewable energy sources, specifically wind power in the form of interconnected wind farms and/or solar photovoltaic power, in combination with compressed air energy storage, to offset the loss of energy production from Davis-Besse, and to make the requested license renewal action unnecessary. The FENOC Environmental Report (Section 7.2) treats all of the alternatives to license renewal except for natural gas and coal plants as unreasonable and does not provide a substantial analysis of the potential for significant alternatives in the Region of Interest.

The Board's phrasing of the contention, as admitted, arguably includes the following renewable energy alternatives: 1) wind power in the form of interconnected wind farms; 2) wind power in the form of interconnected wind farms with compressed air energy storage (CAES); 3) solar (photovoltaic) power combined with CAES; or 4) a combination of interconnected wind farms and solar (photovoltaic) power with CAES.

FENOC does not believe that any of these are "reasonable" alternatives under NEPA. However, in order to resolve the issues raised in the admitted contention, FENOC has revised this ER to evaluate the renewable energy alternatives listed above as an alternative to replace the rated electrical output of Davis-Besse by 2017.

FENOC considers the other technologies listed in the GEIS as not reasonable alternatives for the reasons discussed in Section 7.2.2.

Disclaimer

Throughout Chapters 7 & 8, FENOC presents information about renewable energy resources compiled by others. FENOC has not independently confirmed the accuracy of these statements, nor does FENOC agree with them.

Additionally, FENOC does not agree that the renewable energy alternatives listed above can provide base-load generation or that the existing and any interstate transmission system available by 2017 could accommodate such renewable energy.

Finally, even if such a group of renewable resources were built, there is no way to assure that the power generated by those resources would be available to the CAES facility to create the alternative that Joint Petitioners envision. There are a number of considerations for the development of a solar or wind resource including the availability of sufficient sun or wind, the availability of land, grid access, cost of interconnection (which may be economically prohibitive in some cases), and sufficient transmission resources to assure the CAES's ability to interact with the resource.

The NRC has noted that, while there are many methods available for generating electricity and many combinations of alternative power generation sources that could provide base-load capacity, such an expansive consideration of alternatives would be too unwieldy (**NRC 1996**, Section 8.1).

7.2.1.1 Coal-Fired Generation

Deleted: Representative

For purposes of this analysis, FENOC assumed development of a modern pulverized coal-fired power plant with state-of-the-art emission controls similar to that described in its license renewal application, Appendix E (Environmental Report), for the Beaver Valley Power Station (**FENOC 2007**, Section 7.2.2.2). In defining the Davis-Besse coal-fired alternative, FENOC has used site-specific input as appropriate.

The representative plant would consist of commercially available standard-sized units, with a nominal net output of approximately 910 MWe, and would be designed to meet applicable standards with respect to control of air and wastewater emissions. As a minimum, FENOC assumed that the plant would feature low nitrogen oxide burners with overfire air to minimize formation of nitrogen oxides, and selective catalytic reduction for post-combustion nitrogen oxide control. Emissions of particulate matter and mercury would be limited by use of a fabric filter (baghouse), and sulfur oxide emissions would be controlled using a wet scrubber using limestone as the reagent.

Table 7.2-1 lists the basic specifications for the representative plant.

The Davis-Besse site would not be a viable location for the representative plant as a result of space limitations (see Section 7.3.1, Land Use). Land area requirements for a coal-fired plant of similar capacity to Davis-Besse would be approximately 1.7 acres per MWe (**NRC 1996**, Section 8.3.9), or 1,547 acres for a 910 MWe plant. The needed land area, therefore, far exceeds the 954-acre Davis-Besse site, most of which is occupied by marshland that is leased to the U.S. Government as a national wildlife refuge (Section 2.1).

Therefore, FENOC assumed for the analysis that the representative coal-fired plant would be located elsewhere at a greenfield or (preferably) brownfield site close to a commercially, navigable waterway or existing railway. A navigable waterway location would be highly desirable from a technical and economic perspective, considering the relative abundance of cooling water and low fuel cost afforded by barge transportation of coal and limestone. FENOC further assumed for the analysis that the representative coal-fired plant would use closed-cycle cooling with a natural draft cooling tower.

Lastly, FENOC assumed for the analysis that the environmental impacts associated with siting, design, and operation of the plant would be subject to comprehensive review under Ohio Power Siting Board (OPSB) rules or a comparable process.

7.2.1.2 Gas-Fired Generation

Deleted: Representative

For purposes of this analysis, FENOC assumed development of a modern natural gas-fired combined-cycle plant based on a commercially available design similar to that described in its license renewal application, Appendix E (Environmental Report), for the Beaver Valley Power Station (**FENOC 2007**, Section 7.2.2.1). In defining the Davis-Besse gas-fired alternative, FENOC has used site-specific input as appropriate.

The representative plant would consist of commercially available standard-sized units, with a nominal net output of approximately 910 MWe, and would be designed to meet applicable standards with respect to control of air and wastewater emissions. As a minimum, FENOC assumed that the plant would use natural gas as its only fuel and feature dry low-NO_X burners to minimize formation of nitrogen oxides during combustion and selective catalytic reduction for post-combustion nitrogen oxide control. Emissions of particulate matter and carbon monoxide would be limited through proper combustion controls.

Table 7.2-2 lists the basic specifications for the representative plant.

The Davis-Besse site is uncertain as a viable location for the representative plant due to space limitations. Land area requirements for a gas-fired plant of similar capacity to Davis-Besse, for example, would be approximately 0.11 acres per MWe (**NRC 1996**, Table 8.1), or 100 for a 910 MWe plant. Of the 954 acres of land occupied by the Davis-Besse site, 733 acres is occupied by marshland that is leased to the U.S. Government as a national wildlife refuge (Section 2.1). The remaining 221 acres is mostly occupied by Davis-Besse structures. Therefore, FENOC assumed for the analysis that the representative gas-fired plant would be located elsewhere at a greenfield or (preferably) brownfield site, but has not identified a specific site. However, primary considerations for a cost-competitive site include close proximity to adequate natural gas supply, transmission infrastructure, cooling water, and sufficient land suitable for development. For this analysis, FENOC assumed, based on FirstEnergy experience in gas-fired plant siting, that northwestern Ohio would be a realistic general area to locate the new plant (**FENOC 2007**, Section 7.2.2.1). FENOC further assumed for the analysis that the representative gas-fired plant would use closed-cycle cooling with mechanical draft cooling towers.

Lastly, FENOC assumed for the analysis that the environmental impacts associated with siting, design, and operation of the plant would be subject to comprehensive review under Ohio Power Siting Board (OPSB) rules or a comparable process.

7.2.1.3 Renewable Energy Generation

As explained above in Section 7.2.1, and subject to the disclaimers in that Section, FENOC is evaluating for the sole purpose of this NEPA analysis certain renewable energy alternatives. These alternatives are discussed in more detail below. Other renewable energy alternatives were rejected for the reasons explained below in Section 7.2.2.

Interconnected Wind Farms

Wind energy facilities use wind turbines to harness the kinetic energy of wind and transform it into electrical power. Output depends on a turbine's size and the wind's speed through the rotor as well as the availability of wind itself. Wind turbines manufactured today range from 250 watts (**AWEA 2002**) to 10 megawatts (MW) (**SWAY 2010**), and wind farms can range in capacity from a few megawatts to the 781+ megawatt Roscoe Wind Complex in Texas. (**CBS 2010**) Wind availability, speed and turbine height are critical factors for wind farm generating capacity. The stronger and more consistent the wind, and the taller the turbines, the higher potential capacity exists. Multiple land uses are often possible on wind farms. For example, a wind farm may generate electricity while cattle graze or corn grows on the land surrounding the turbines. (**AWEA 2002**)

Neither a single wind turbine nor interconnected wind farms currently provide baseload power anywhere in the United States. However, the theory that multiple wind farms located throughout a region and interconnected via the grid could provide for more consistent power generation due to the reduced likelihood that all sites would experience the same wind patterns at any given time, has been studied.

In one study, the benefits of interconnecting wind farms were evaluated for 19 sites located in the midwestern United States with annual average wind speeds greater than 6.9 meters per second (m/s) (class 3 or greater) at 80 m above ground, the hub height of modern wind turbines. The study reported that, on average, only 33% and a maximum of 47% of yearly-averaged wind power from interconnected wind farms could theoretically be relied upon to produce electricity. And there were days when no electricity was produced from these wind farms. (**JACM 2007**)

Additionally, delays in the implementation of interconnected wind technology can be due to transmission line construction difficulties, as the North American Electric Reliability Corporation (NERC) explains in its 2009 Long-Term Reliability Assessment. The NERC points out that siting of new bulk power transmission lines brings with it unique challenges due to the high visibility, their span through multiple states/provinces and, potentially, the amount of coordination/cooperation required among multiple regulating agencies and authorities. Lack of consistent and agreed-upon cost allocation approaches, coupled with public opposition due to land-use and property valuation concerns, have, at times, resulted in long delays in transmission line construction. New transmission, including transmission in the DOE's designated "National Interest Electric Transmission Corridors" can be delayed or halted by individual states, increasing the difficulty to site bulk transmission, including those projects focused on unlocking location-constrained renewable generation. These siting issues create a potential congestion issue and challenge the economic viability of new generation projects. **(NERC 2009)**

In the specific case of wind power, a wind project must be located where it would produce economical generation, and that location may be far removed from the nearest possible connection to the transmission system. A location far removed from the power transmission grid might not be economical, as new transmission lines would be required to connect the wind farm to the distribution system, and the question of who pays for the transmission upgrade would be at issue. 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 national authorities.

Jacobs and Archer completed a study of interconnected wind farms with consisting of up to 19 wind farm sites, and concluded that maximum capacity factors of approximately 45% could theoretically be obtained (**JACM 2007**). Davis-Besse's recent capacity factor has been in excess of 90%, which would generate approximately 7,158,672 MWh over a full year. To achieve a similar annual average at a 45% capacity factor, interconnected wind farms with a minimum of 1210 GE 1.5 MW turbines would be required, and would not be guaranteed due to the uncontrollability of the wind availability. It must be noted, however, that the studies by Jacobs and Archer were based on areas with higher annual average wind speeds (over 8 m/s). Thus, in Ohio, it would be expected that the GE 1.5-MW turbines might not operate as efficiently and thus the number of turbines required for replacement power generation would be higher. And there would still be times when reserve capacity from traditional generation or energy storage would be required. Using larger turbines could be used if wind speeds supported their economical use, especially in offshore locations (discussed below), which would reduce land use.

Since 1998-99, average turbine nameplate capacity has increased by 151%, but growth in this metric has slowed in recent years due to the dominance of GE's 1.5 MW turbine and as a result of the logistical challenges associated with transporting larger turbines to project sites. (**USDOE 2011**) There are several land based wind farms under construction or planned in Ohio. These wind farms will utilize wind turbines ranging from 1.8 MW (Timber Ridge Wind Farm) to 2.0 MW (Blue Creek Wind Farm). (**WAG 2011** and **TBM 2011**)

FENOC reviewed several recent documents describing studies conducted by the National Renewable Energy Laboratory (NREL) related to wind integration and transmission studies for both land-based and offshore wind generating facilities (**NREL 2011, NREL 2010, NREL 2010a**). Based on the findings in these documents, a land-based interconnected transmission system in the central and eastern United States is likely to be completed by 2024. For the sole purpose of this NEPA analysis, however, FENOC evaluates renewable energy alternatives as if an interconnected grid system would be available by 2017.

FENOC also evaluated the potential for offshore wind generation and integrating that power into the transmission system. Although both Lake Erie and Lake Michigan have significant wind resources, no offshore wind turbines have been sited in freshwater, particularly a potable water source such as the Great Lakes. (**USDOE 2011**)

Offshore wind power project and policy developments continued in 2010; however, to date no offshore projects have been installed in the United States and the emergence of an offshore wind power market still faces many challenges. Nonetheless, interest exists in developing offshore wind energy in several parts of the country, with nine projects totaling 2322 MW of unstated capacity factors primarily located in the Northeast and Mid-Atlantic, though proposed projects also exist in the Great Lakes and Gulf of Mexico. (**USDOE 2011**) Many of these projects have advanced significantly in the permitting and development process, including three that have signed power purchase agreements with terms and details that have been made public. Notably, the Cape Wind project was granted approval by the Department of Interior in 2010; several significant strides relating to offshore wind energy have been made recently in the federal arena; and a variety of other recent project and state policy announcements demonstrate continued activity in the offshore wind energy sector. (**USDOE 2011**)

In August 2009, Lake Erie Energy Development Corporation (LEEDCo) was created by the Great Lakes Energy Development Task Force (GLEDTF), then developed and launched by NorTech Energy Enterprise, the Cleveland Foundation, City of Cleveland, Cuyahoga and Lorain Counties (Ohio). It was founded as a private, non-profit regional corporation to initially build wind turbines in Lake Erie, and eventually help stimulate an entire offshore freshwater wind industry. Initially LEEDCo plans to build and install a 20-30 megawatt (MW) wind energy pilot project seven miles offshore of downtown Cleveland which would be the first offshore freshwater wind energy project in North America. LEEDco then plans to use the initial project as a road map to develop the permitting process and catalyze future offshore wind projects by commissioning the first 20-to-30 MW, five-to-seven turbines by 2013, with a long-term vision of generating 1000 MW of wind energy by 2020. (**LEEDCo 2011**)

Despite the unlikely development of sufficient offshore wind generation as outlined above, FENOC evaluates—for the sole purpose of this NEPA analysis—wind energy from interconnected wind farms as if such energy was available by 2017. Therefore, FENOC evaluated the potential environmental impacts for offshore wind generation and integrating that power into the transmission system as a replacement for Davis-Besse's rated electrical output.

Solar Farms

Electric power generation from photovoltaic (PV) cells has been commercially demonstrated. However, because the sun only shines during the day, solar PV arrays cannot by themselves consistently produce electricity. There is currently only one operational solar energy facility in Ohio greater than 10 MW—the 12-MWe Wyandot Solar Farm in Upper Sandusky, OH (**PSEG 2010**). The 49.9 MWe Turning Point Solar project near Cumberland, OH, is projected to be completed in 2015 (**AEP 2011**). FENOC is not aware of other planned solar energy facilities greater than 10 MW in Ohio that would be operational by 2017, and whose output is not already dedicated to an existing commercial or industrial facility.

A solar project would have to be located where the project would produce economical generation, and that location may be far removed from the nearest possible connection to the transmission system. A location far removed from the power transmission grid might require construction of new transmission lines to connect the solar farm to the distribution system, and the question of who pays for the transmission upgrade would be at issue. 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 solar farms. 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 national authorities.

Although solar resources are limited in Ohio, FENOC evaluates—for the sole purpose of this NEPA analysis—solar energy combined with CAES, and combined with interconnected wind farms and CAES, as alternatives to replace the rated electrical output of Davis-Besse by 2017.

Compressed Air Energy Storage

FENOC is presenting the following information about CAES technology as background for the discussion that follows about CAES combined with interconnected wind farms or solar energy facilities.

CAES can be linked with renewable energy by offering one way to supplement and back-up the electricity produced by intermittent resources such as wind and solar. This energy storage method enhances the ability of these resources to provide the electricity that customer's need, when they need it.

However, CAES facilities are generally operated as peaking plants with energy placed into storage during the less expensive, non-peak demand hours and generated from the storage units during the higher-priced, peak demand hours. CAES involves using compressors powered by the generation source to pump air into a storage facility, such as an underground cavern. During peak demand hours, the compressed air is used in combination with a heat source, such as natural gas, to drive turbines and generate electricity. To generate electricity from CAES, natural gas usage is between one-third and one-half that needed to generate the same amount of electricity at a natural gas generating plant (**USDOE 2009**). Due to the cost differential between peak and non-peak hours and the reduction in the volume of natural gas used to generate a specific amount of power, a CAES facility can be an economically and environmentally attractive method of producing peaking power (**RES 2005; PEI 2008**).

These economic benefits evaporate if the energy source used to pump air into the storage facility is solar power, or wind power available during the day. Since solar is a resource mostly available during the onpeak daytime hours, storage offers little economic benefit when evaluating solar (or daytime wind power) with CAES. FENOC is not aware of any existing CAES facilities that are combined solely with wind or solar power.

The Iowa Stored Energy Park (ISEP) was proposed to be a 270 MW CAES facility integrated with a wind farm in Iowa. However, testing and analysis of the site geology concluded that the ability to store the air underground at the ISEP site near Dallas Center, Iowa was unfeasible. (**ISEP 2011**)

Two CAES facilities combined with natural gas power plants, a 110-MW facility in Alabama and a 290-MW plant in Germany, have been built and are in operation (**PEI 2008**). A CAES facility powered with energy from generation facilities already on the power grid is proposed for Norton, Ohio. This facility, which is still in the project development stage, is planned to eventually—i.e., after 2017—provide 2700 MW of peaking power generation (**PEI 2008**). The Norton CAES project is somewhat different from the other CAES projects in that a pre-existing mine on a brownfield site would be utilized. The size and the mining engineered construction of the pre-existing mine allows a much greater planned capacity for the Norton facility as compared to other existing or proposed CAES projects.

Norton Energy Storage

In 2009, FirstEnergy Generation Corp., a subsidiary of FirstEnergy Corp., purchased the rights to develop the Norton Energy Storage (NES) facility. The facility is located on a 92-acre site in Norton, Ohio. The compressed air would be stored in a 600-acre underground cavern, formerly operated as a limestone mine, which is ideal for energy storage technology. The facility would generate electricity during on-peak and intermediate periods, which would enable the more efficient operation of large, base-load power plants. FirstEnergy is currently developing the NES facility and it would be constructed in phases. The initial phase is designed to produce 268 MW of generation, 220 MW of compression, and 373 hours of storage using two 134 MW generators. FirstEnergy estimates that up to four units or 536 MW of generation could be online by 2017. The existing air permit for the NES facility authorizes FirstEnergy Generation Corp to expand the facility to a capacity of 804 MW (see Table 7.2-3). (**NES 2010**) This project has two major components: the above-ground equipment and the subsurface abandoned limestone mine used to store compressed air. The size of the cavern could eventually allow the project to provide up to 2700 MW of generation if the current air permit could be modified.

The NES facility would include two power generation units designed specifically for the CAES application. Each unit would consist of an air compressor, a motor, an expander, an associated combustor and a generator. The facility would be designed to operate on natural gas only; no fuel oil would be combusted in the turbines or in-line burners. The major ancillary support equipment would consist of an emergency generator, a backup diesel fire pump, and wet cooling towers to cool compressor air to be injected into storage and provide other equipment cooling. Other support equipment would include cooling water treatment systems, acid/caustic or neutralization tanks, instrument air compressors, electric driven fuel compressors, sumps, and oil/water separators.

Available Alternatives for Renewable Energy Generation in Combination with Energy Storage

The potential for using renewable power sources as an alternative to license renewal can be enhanced if the generation source is combined with an energy storage technology, thus increasing the availability, reliability, and predictability of the delivery of power. The two renewable power generation sources evaluated in this ER are interconnected wind farms and photovoltaic solar facilities.

The theory behind the combination of renewable power generation with energy storage is that when the generation capacity is available, the amount of power produced could, at times, exceed the demand for power at that time. Excess energy could be stored and returned later to the electrical grid when the renewable power generation resource is either not available or is available at a diminished level that is insufficient to satisfy the demand for power.

Therefore, in order for this combination of technologies to function, the renewable energy source would have to be sized larger than the base-load power level in this case for Davis-Besse, 910 MW. The need to have generation capacity greater than base-load requirements in order to place energy into storage would cause greater environmental impacts than a generation source rated at the base-load value alone. For example, a solar or wind generation source assumed to be available for 12 hours every day, and a CAES facility assumed to be available to generate electricity the remaining 12 hours in the day, would require that generation source to be rated at, and consistently produce 1820 MW in order to provide 24-hours of continuous electricity (i.e., 12 hours to provide 910 MW of generation onto the grid, and the same 12 hours to provide 910 MW to recharge the CAES facility, so that the CAES facility could feed the grid the remainder of the day).

As explained in Section 7.2.1, FENOC evaluates—for the sole purpose of this NEPA analysis—renewable energy sources combined with energy storage as an alternative to replace the rated electrical output of Davis-Besse.

Wind Energy Generation Combined with CAES

As of 2011, there is currently 11 MWe of wind generation in Ohio with another 406 MWe under construction. **(AWEA 2011)** However, Ohio has a potential wind generation capacity of nearly 55,000 MW according to the NREL **(AWEA 2011 and NREL 2011a)**, which at a 30% capacity factor would be more than sufficient to provide power to operate a CAES facility. The 30% capacity factor is derived from PJM Interconnection (a regional transmission organization) and the U.S. Department of Energy (USDOE) (**PJM 2011** and **USDOE 2011**. The environmental impacts of developing this type of generation alternative are evaluated in Section 7.3.3.

For this combination, FENOC evaluated wind energy generating electricity for both 910 MW to replace Davis-Besse's rated output and 910 MW of storage capacity, for a total of 1820 MWe. Sufficient energy must be put into storage when the wind resources are available to account for the lack of power generation capabilities for the periods of time when adequate wind resources are unavailable. Under this alternative, natural gas would be needed to recover the energy captured in the CAES process, but would not be used as a source of supplemental power generation if wind generation or generation from the storage facility is not available for extended periods of time.

Photovoltaic Power Combined with CAES

As stated previously, there is currently only one operational solar energy facility in Ohio greater than 10 MW: the 12-MWe Wyandot Solar Farm in Upper Sandusky, OH. (**PSEG 2010**) The 49.9-MWe Turning Point Solar project near Cumberland, OH, is projected to be completed in 2015. (**AEP 2011**) FENOC is not aware of other planned solar energy facilities greater than 10 MW in Ohio that would be operational by 2017, and whose output is not already dedicated to an existing commercial or industrial facility. As with wind, FENOC evaluated solar farms as if they were interconnected with CAES to provide electricity to the grid.

Combinations of Wind and Solar with CAES

As referenced above, approximately 1820 MWe of base-load power would be required from renewable energy generation plus storage to account for the lack of power generation capabilities for the periods of time when adequate wind and solar resources are unavailable.

FENOC evaluates—for the sole purpose of this NEPA analysis—the following a combined alternative to replace the rated electrical output of Davis-Besse by 2017: sufficient interconnected wind farms and solar (PV) facilities available with high reliability, and connected to an operating CAES facility; an operating CAES facility expanded to a capacity similar to Davis-Besse; and an interconnected grid system. The potential environmental impacts related to this scenario are presented in Section 7.3.3.3.

7.2.2 ALTERNATIVES CONSIDERED AS NOT REASONABLE

The following alternatives were considered as not reasonable replacement base-load power generation for one or more reasons as listed in Section 7.2.2.1 and Section 7.2.2.2. Although several of the alternatives could be considered in combination for replacement power generation at multiple sites, they do not generally provide base-load generation, and would entail greater environmental impacts.

7.2.2.1 Alternatives Not Requiring New Generating Capacity

This section discusses the economic and technical feasibility of supplying replacement energy without constructing new base-load generating capacity. Specific alternatives include:

- Conservation measures (including implementing demand side management (DSM) actions);
- Delayed retirement of existing non-nuclear plants; and
- Purchased power from other utilities equivalent to the output of Davis-Besse (i.e., eliminating the need for license renewal).

Conservation Programs

There is a variety of conservation technologies (e.g., DSM) that could be considered as potential alternatives to generating electricity at Davis-Besse. Examples include:

- Conservation Programs—homeowner agreements to limit energy consumption; educational programs that encourage the wise use of electricity.

- Energy Efficiency Programs– discounted residential rates for homes that meet specific energy efficiency standards; programs providing residential energy audits and encouraging efficiency upgrades; incentive programs used to encourage customers to replace older inefficient appliances or equipment with newer versions that are more efficient.

- Load Management Programs – programs that encourage customers to switch load to customer-owned standby generators during periods of peak demand; programs that encourage customers to allow a portion of their load to be interrupted during periods of peak demand.

On a national basis, DSM has shown great potential in reducing peak demand (maximum power requirement of a system at a given time). In 2008, a peak load reduction of 32,741 MWe was achieved nationally, which is an increase of 8.2% from 2007; however, since these DSM costs increased by 47.4%. DSM costs can vary significantly from year to year because of business cycle fluctuations and regulatory changes. Since costs are reported as they occur, while program effects may appear in future years, DSM costs and effects may not always show a direct relationship. Since 2003, nominal DSM expenditures have increased at 22.9% average annual growth rate. During the same period, actual peak load reductions have grown at a 6.2% average annual rate from, 22,904 MW to 32,741 MW (**EIA 2010**, Page 9).

In Ohio, as part of Senate Bill 221, utilities must implement energy efficiency programs that, beginning in 2009, achieve energy savings of at least 0.3% of the utility's three-year average annual kilowatt-hour (kWh) sales, with energy savings increasing to 22.5% by the end of 2025. Peak demand reductions of 1% in 2009 and increasing to 7.75% by the end of 2018 are also required. (**FirstEnergy 2009a**, Page 100) However, since these DSM-induced load reductions typically are considered in load forecasts, the reductions do not offset the projected power demands that are expected to be supplied with the power generated by Davis-Besse.

Although FENOC believes that energy generation savings can increase from DSM practices, it would be unrealistic to increase those energy savings to completely and consistently replace the Davis-Besse generating capability. The variability in associated costs also makes DSM a less desirable option. Consequently, FENOC does not see DSM as a practicable offset for the base-load capacity of Davis-Besse.

Delayed Retirement

Extending the lives of existing non-nuclear generating plants beyond the time they were originally scheduled to be retired, as described in the GEIS (**NRC 1996**, Section 8.3.13), does not represent a realistic option with respect to FirstEnergy's generating assets.

Deleted: Also, FENOC is not knowledgeable of retirement plans of other regional electric power suppliers. Even without retiring any generating units, FirstEnergy expects to require additional capacity in the near future. Therefore, even if a substantial portion of its capacity were scheduled for retirement and could be delayed, some of the delayed retirement would be needed just to meet load growth.

Approximately 56% of FirstEnergy's generating capacity consists of coal-fired plants which, due to a lower cost of generation, are used at capacity factors higher than other fossil-fuel generating units (**FirstEnergy 2008b**). Virtually all of FirstEnergy's non-nuclear base-load generating capability is from coal firing. These coal-fired plants were developed in the 1980s or earlier and represent the only plants in FirstEnergy's portfolio that would have any potential for continued operation to replace the base-load generation represented by Davis-Besse. However, older plants that do become candidates for retirement generally represent less efficient generation and pollution control technologies than are available in more modern plants, and continued operation typically would require substantial upgrades to be economically competitive and meet applicable environmental standards. In many cases, it is unlikely that such upgrades would be economically viable. FENOC believes that the environmental impacts of implementing such upgrades and operating the upgraded plants are bounded by the assessments presented in Section 7.3 for the gas-fired and coal-fired alternatives.

For these reasons, the delayed retirement of non-nuclear generating units is not considered by FENOC as a reasonable alternative to the renewal of Davis-Besse's license.

<u>Purchased Power</u>

Each of the states (Ohio, Pennsylvania, and New Jersey) in which FirstEnergy serves load have undertaken electric industry restructuring initiatives that promote competition in retail energy markets by allowing participation of non-utility suppliers. Retail customers historically served by the regulated operating subsidiaries of FirstEnergy now have the option to choose between FirstEnergy-affiliated suppliers and other state-qualified energy suppliers. (**FENOC 2007**, Section 7.2.3.2)

In theory, purchased power is a feasible alternative to Davis-Besse license renewal. There is no assurance, however, that sufficient capacity or energy would be available during the entire license renewal time frame to replace the approximately 910 MWe of base-load generation. In addition, even if power to replace Davis-Besse capacity were to be purchased, FENOC assumes that the generating technology used to produce the purchased power would be one of those described in the GEIS. Thus, the environmental impacts of purchased power would still occur, but would be located elsewhere within the region.

As a result, FENOC has determined that purchased power would not be a reasonable alternative to replace power lost in the event the Davis-Besse operating license is not renewed.

7.2.2.2 Alternatives Requiring New Generating Capacity

The following conventional power plant types are evaluated in this section as potential alternatives to license renewal:

- New Nuclear Reactor
- Petroleum Liquids (Oil)

In addition, with the passage of Ohio's Senate Bill 221 in 2008, at least 25% of electricity supply for retail customers must come from renewable and advanced energy resources by 2025 **OHPUCO 2009**, Pages 3 and 4). Accordingly, the following alternative energy sources are evaluated.

- Hydropower
- Solar
- Geothermal
- Biomass (Wood Waste)
- Municipal Solid Waste
- Other Biomass-Derived Fuels (Energy Crops)
- Fuel Cells

Deleted: <#>Wind¶

Criteria used to determine if the potential energy alternatives represent a reasonable alternative include whether the alternative is developed and proven, can provide generation of approximately 910 MWe of electricity as a base-load supply, is economically feasible, and does not impact the environment more than Davis-Besse.

New Nuclear Reactor

Increased interest in the development of advanced reactor technology has been expressed by members of both industry and government. With energy demands forecasted to increase and public opposition to new carbon-fueled power plants, some companies are pursuing permits and licenses to build and operate new nuclear reactors to meet the country's future energy needs. As of June 2010, for example, 18 applications, for 28 units, for combined licenses have been submitted to the NRC for review (**NRC 2010**).

Nonetheless, there is ongoing uncertainty with respect to future electric demand due to the potential impacts of policy changes that could be enacted to limit or reduce greenhouse gas emissions. The downturn in the world economy also has had a significant impact on energy demand as well. The recovery of the world's financial markets is especially important for the energy supply outlook, because the capital-intensive nature of most large energy projects makes access to financing a critical necessity. (**EIA 2010**, Pages 5). Moreover, the economics of new nuclear plants remain uncertain with escalating fuel and construction costs emerging as forces which could affect this option.

In consideration of the extended schedule for construction of a new nuclear reactor, access to capital, and the schedule for the new reactor licensing process, construction of a new nuclear reactor at the Davis-Besse site or at an alternative site is not feasible prior to the period of extended operation for Davis-Besse, i.e., in this case, 2017. Therefore, a new nuclear reactor is not considered a reasonable alternative to renewal of Davis-Besse's operating license..

Petroleum Liquids (Oil)

Oil-fired generation has experienced a significant decline since the early 1970s. Increases in world oil prices have forced utilities to use less expensive fuels (**NRC 1996**, Section 8.3.11). From 2002 to 2008, for example, the average cost of petroleum for power generation increased by more than a factor of three (**EIA 2010**, Table 3.5).

This high cost of oil has prompted a steady decline in its use for electricity generation. Within Ohio, for example, oil-fired units produce only 0.2% of power generation (**NEI 2008**). Increasing domestic concerns over oil security also will intensify the move away from oil-fired electricity generation.

Therefore, FENOC does not consider oil-fired generation a viable alternative to renewal of Davis-Besse's operating license.

Hydropower

Considering the FirstEnergy transmission and distribution territory, Ohio and Pennsylvania have a combined potential for 1,758 MWe of additional undeveloped hydroelectric capacity, with Ohio contributing 57 MWe (**INEEL 1998**, Table 4). Thus, hydropower is a feasible alternative to Davis-Besse license renewal in theory.

However, as noted in the GEIS, hydropower's percentage of United States generating capacity is expected to decline because the facilities have become difficult to site as a result of public concern about flooding, destruction of natural habitat, and alteration of natural river courses (**NRC 1996**, Section 8.3.4). For example, the GEIS estimated that land requirements for hydroelectric power are approximately 1 million acres per 1,000 MWe. Replacement of the Davis-Besse generating capacity would therefore require flooding a substantial amount of land (910,000 acres). Consequently, even if the capacity for development were available in Ohio-Pennsylvania, there would be large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to replace Davis-Besse.

As a result, developing a hydropower base-load capacity of approximately 910 MWe is not considered by FENOC to be a reasonable alternative to renewal of Davis-Besse's operating license.

Solar Power

Solar power technologies, both thermal and photovoltaic (PV), have been commercially demonstrated. However, because the sun only shines during the day, solar arrays cannot, by themselves, provide consistent electrical output . Therefore, solar arrays alone are not considered in this ER as a reasonable alternative to the license renewal of Davis-Besse. Solar energy in combination with interconnected wind farms and CAES is discussed in Section 7.2.1.3.

Geothermal Energy

Geothermal energy has an average capacity factor of 90 percent and can be used for base-load power where available (**NRC 2009b** Section 8.2.5.5). However, geothermal electric generation is limited by the geographical availability of geothermal resources. As illustrated by Figure 8.4 in the GEIS, no feasible eastern location for geothermal capacity exists to serve as an alternative to Davis-Besse (**NRC 1996**, Section 8.3.5). As a result, FENOC does not consider geothermal energy to be a reasonable alternative to renewal of the Davis-Besse operating license.

Biomass Energy

Biomass is any organic material made from plants or animals. Agricultural and wood wastes such as forestry residues, particularly paper mill residues, are the most common biomass resources used for generating electricity. Regionally, eastern Ohio and most of Pennsylvania provide the largest biomass resources (**EERE 2009a, b**). The costs of these fuels, however, are highly variable and very site specific (**NRC 1996**, Section 8.3.6).

Most biomass plants use direct-fired systems by burning biomass feedstocks to produce steam directly for conventional steam turbine conversion technology. Although the technology is relatively simple to operate, it is expensive and inefficient. Conversion efficiencies of wood-fired power plants are typically 20-25%, with capacity factors of around 70-80%. As a result, biomass plants at modest scales (≤50 MWe) make economic sense if there is a readily available supply of low-cost wood wastes and residues nearby so that feedstock delivery costs are minimal. (**NRC 1996**, Section 8.3.6)

The construction impacts of a wood-fired plant would be similar to those for a coal-fired plant, although most facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, biomass and wood-waste plants require large areas for

Deleted: Wind Power¶
Areas suitable for wind energy applications must be wind-power Class 3 or higher (**NREL 1986**, Chapter 1). Coastal regions along Lake Erie in northwestern Ohio have an estimated wind power of Class 3, increasing to Class 5 over offshore areas (**NREL 1986**, Chapter 3) and some Class 6 areas mid-lake (**USDOE 2009a**). The rest of the state, however, is devoid of Class 3 or higher wind-power areas. Pennsylvania is mostly a wind power Class 1 region, although some areas, particularly along ridgelines, may provide wind classes ranging from 4 to 6. West Virginia is also mostly a wind power Class 1 region, with Class 2 and higher resources along highlands and ridges in the east-central part of the state. The total wind generation capacity for the three-state region in 2008 was 698 MWe. (**USDOE 2009a**) ¶
Thus, wind power in coastal Ohio along Lake Erie and along ridgelines in Pennsylvania and West Virginia is a feasible alternative to Davis-Besse license renewal in theory. However, wind power by itself is not suitable for large base-load capacity. As discussed in the GEIS, wind ha ... [1]

Deleted: Solar power technologies, bothphotovoltaic (PV) and thermal, depend on the availability and strength of sunlight. As such, it is an intermittent source of energy, requiring energy storage or a supplemental power source to provide electric power at night. Solar resource availability in Ohio, western Pennsylvania, and northern West Virginia is low compared to other parts of the United States. The three-state region, for example, has about 3.3 kWh per square meter per day of, solar radiation, which is less than half of that available in the southwestern United States (**NRC 1996**, Figure 8.2). ¶
The land requirement for solar technology is large. As noted in the GEIS, it requires 14 to 35 acres for every 1 MWe generated, depending on the solar technology (**NRC 1996**, Sections 8.3.2 and 8.3.3). At a minimum, it would require approximately 12,740 acres to replace the 910 MWe produced by Davis-Besse. In addition, although solar technologies produce no air pollution, little or no noise, and require no transportable fuels, ... [2]

fuel storage and processing. They also create impacts to land and water resources, primarily associated with soil disturbance and runoff, in addition to air emissions which must be managed. However, unlike coal-fired plants, biomass and wood-waste plants have very low levels of sulfur oxide emissions. (**NRC 1996**, Section 8.3.6)

Due to the relatively small scale of potential projects and uncertainties in securing long-term fuel supplies, biomass is not considered by FENOC to be a reasonable alternative to replace Davis-Besse's base-load power generation.

Deleted: FirstEnergy is retrofitting units 4 and 5 of the R.E. Burger plant in Shadyside, Ohio, for biomass capability. When completed, the units will be one of the largest biomass facilities in the United States capable of producing up to 312 MWe (**FirstEnergy 2009b**). Nevertheless, due to the relatively small scale of other

Municipal Solid Waste

Municipal solid waste (MSW) facilities that convert waste to energy use technology comparable to steam-turbine technology for wood waste plants, although the capital costs are greater due to the need for specialized separation and handling equipment (**NRC 1996**, Section 8.3.7). The decision to burn MSW for energy is typically made due to insufficient landfill space, rather than energy considerations.

There are 89 operational MSW energy conversion plants in the United States (**USEPA 2009a**), none of which were located in Ohio as of 2007 (**WTE 2007**). These plants generate approximately 2,500 MWe, or about 0.3% of total national power generation (**USEPA 2009a**). At an average capacity of about 28 MWe, numerous MSW-fired power plants would be needed to replace the base-load capacity of Davis-Besse.

Construction impacts for a waste-to-energy plant are estimated to be similar to those for a coal-fired plant. Air emissions are potentially harmful. Increased construction costs for new plants and economic factors (i.e., strict regulations and public opposition) may limit the growth of MSW energy generation (**NRC 1996**, Section 8.3.7; **USEPA 2009a**).

For reasons stated, MSW is not considered by FENOC to be a reasonable alternative to renewal of Davis-Besse's operating license.

Other Biomass-Derived Fuels

In addition to biomass energy such as wood and municipal solid-waste fuels, there are other concepts for biomass-fired electric generators, including direct burning of energy crops, conversion to liquid biofuels, and biomass gasification. The GEIS indicated that none of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a base-load plant (**NRC 1996**, Section 8.3.8). After recently re-evaluating current technologies, the NRC staff believes other biomass-fired alternatives are still unable to reliably replace base-load capacity (**NRC 2009b**, Section 8.2.5.8). For this reason, FENOC does not consider biomass-derived fuels to be a reasonable alternative to renewal of Davis-Besse's operating license.

Fuel Cells

Fuel cells are electrochemical devices that generate electricity without combustion and without water and air pollution. Fuel cells began supplying electric power for the space program in the 1960s. Today, they are being developed for more commercial applications. The U.S. Department of Energy (USDOE) is currently partnering with several fuel cell manufacturers to develop more practical and affordable designs for the stationary power generation sector. If successful, fuel cell power generation should prove to be efficient, reliable, and virtually pollution free. At present, progress has been slow and costs are high. The most widely marketed fuel cell is currently about $4,500 per kilowatt (kW) compared to $800 to $1,500 per kW for a diesel generator and about $400 per kW or less for a natural gas turbine. By the end of this decade, the USDOE goal is to reduce costs to as low as $400 per kW. (**USDOE 2009b**)

However, fuel cells presently are not economically or technologically competitive with other alternatives for base-load capacity. Therefore, FENOC does not consider fuel cells to be a reasonable alternative to renewal of Davis-Besse's operating license.

Deleted: Combination of Alternatives¶
Individual evaluation of renewable and advanced energy resources shows that, by themselves, these energy resources are not considered by FENOC to be reasonable alternatives to renewal of Davis-Besse's operating license. When considered in various combinations with generation equivalent to that of Davis-Besse, these same renewable and advanced energy resources still fail to be reasonable alternatives to renewal of Davis-Besse's operating license.¶
For example, consider a mix of 25 percent of renewable and advanced energy resources, such as wind, hydroelectric, geothermal, solar, and biomass, with 75 percent natural gas generation to replace the baseload 908 MWe of the Davis-Besse plant. This mix of energy resources would result in an increased uncertainty in energy output due to the fluctuation of wind and solar resources. The environmental impacts associated with the large amount of land required for siting the various resources would likely exceed those associated with continued operation of Davis-Besse. And, the air quality impacts of operation of the natural gas plant greatly exceed those associated with continued operation of Davis-Besse. Therefore, FENOC believes that various combinations of renewable and advanced energy resources with generation equivalent to that of Davis-Besse are not reasonable alternatives to renewal of Davis-Besse's operating license.¶

Table 7.2-1 Coal-Fired Alternative Emission Control Characteristics

Characteristic	Basis
Net capacity = 910 MW	Equivalent to Davis-Besse.
Capacity factor = 80%	From **FENOC 2007**, Table 7.2-2
Firing mode: subcritical, tangential, dry-bottom pulverized coal	Widely demonstrated, reliable, economical; tangential firing minimizes NO_X emissions (**FENOC 2007**, Table 7.2-2)
Fuel type = bituminous coal	Type used in FirstEnergy Ohio River plants (**FENOC 2007**, Table 7.2-2)
Fuel heating value = 12,285 Btu/lb	FirstEnergy Bruce Mansfield Plant average (**FENOC 2007**, Table 7.2-2)
Heat rate = 9,800 Btu/kWh at full load	FirstEnergy experience (**FENOC 2007**, Table 7.2-2)
Fuel sulfur content = 3.52 wt% ; 2.86 lb/MMBtu	FirstEnergy Bruce Mansfield Plant average (**FENOC 2007**, Table 7.2-2)
Fuel ash content = 11.88 wt%	FirstEnergy Bruce Mansfield Plant average (**FENOC 2007**, Table 7.2-2)
Uncontrolled SO_X emissions = 130 lb/ton coal	USEPA estimate calculated as 38 x wt% sulfur in coal (**FENOC 2007**, Table 7.2-2)
Uncontrolled NO_X emissions = 10 lb/ton coal	USEPA estimate (**FENOC 2007**, Table 7.2-2)
Uncontrolled CO emission = 0.5 lb/ton coal	USEPA estimate (**FENOC 2007**, Table 7.2-2)
Uncontrolled PM emission = 120 lb/ton coal	USEPA estimate calculated as 10 x wt% ash in coal (**FENOC 2007**, Table 7.2-2)
Uncontrolled PM_{10} emission = 27 lb/ton coal	USEPA estimate calculated as 2.3 x wt% of ash in coal (**FENOC 2007**, Table 7.2-2)
CO_2 emissions = 6,000 lb/ton	Approximate average for bituminous coal combustion (**FENOC 2007**, Table 7.2-2)
SO_X control = wet limestone flue gas desulphurization (95% removal)	Best available technology for minimizing SO_X emissions (**FENOC 2007**, Table 7.2-2)
NOX control = low NOX burners, overfire air, selective catalytic reduction (95% reduction)	Best available technology for minimizing NO_X emissions (**FENOC 2007**, Table 7.2-2)
Particulate control = fabric filters (99.9% removal)	Best available technology for minimizing particulate emissions (**FENOC 2007**, Table 7.2-2)

Btu = British thermal unit
CO = carbon monoxide
CO_2 = carbon dioxide
ft^3 = cubic feet
kWh = kilowatt-hour
lb = pound
MMBtu = million Btu
MW = megawatt
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = PM with diameter less than 10 microns
SO_X = sulfur oxides
USEPA = U.S. Environmental Protection Agency
wt% = percent by weight

Table 7.2-2: Gas-Fired Alternative Emission Control Characteristics

Characteristic	Basis
Net capacity = 910 MW	Equivalent to Davis-Besse.
Capacity factor = 80%	From **FENOC 2007**, Table 7.2-1
Fuel type = natural gas	Assumed
Heat rate = 6,500 Btu/kWh	FENOC Estimate (**FENOC 2007**, Table 7.2-1)
Fuel heating value = 1,025 Btu/ft^3	From **FENOC 2007**, Table 7.2-1
Fuel sulfur content = 0.2 grains/100 scf (0.00068 wt%)	From **FENOC 2007**, Table 7.2-1
SO_2 emissions = 0.00064 lb/MMBtu (0.94 x wt% sulfur in fuel)	USEPA estimate for natural gas-fired turbines (**FENOC 2007**, Table 7.2-1)
NO_X emissions (assuming dry low-NO_X combustors) = 0.099 lb/MMBtu	USEPA estimate for best available NO_X combustion control (**FENOC 2007**, Table 7.2-1)
NO_X post-combustion control: selective catalytic reduction (90% reduction)	USEPA estimate for best available NO_X post-combustion control (**FENOC 2007**, Table 7.2-1)
CO emissions (assuming dry low-NO_X combustors) = 0.015 lb/MMBtu	USEPA estimate (**FENOC 2007**, Table 7.2-1)
PM emissions (all PM_{10}) = 0.0019 lb/MMBtu	USEPA estimate (**FENOC 2007**, Table 7.2-1)
CO_2 emissions = 110 lb/MMBtu	USEPA estimate (**FENOC 2007**, Table 7.2-1)

Btu = British thermal unit
CO = carbon monoxide
CO_2 = carbon dioxide
ft^3 = cubic feet
kWh = kilowatt-hour
lb = pound
MMBtu = million Btu
MW = megawatt
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = PM with diameter less than 10 microns
scf = standard cubic feet
SO_X = sulfur oxides
USEPA = U.S. Environmental Protection Agency
wt% = percent by weight

Table 7.2-3: CAES Alternative Emission Control Characteristics

Characteristic	Basis
Net capacity = 804 MW	Six trains at 134 MW per train (maximum authorized under existing air permit, although only 536 MW could be online by 2017)
Capacity factor = 80%	Within typical range of base-load plant; results in approximate annual output near that of Davis-Besse.
Fuel type = natural gas	Assumed
Heat rate (HHV) = 4,395 Btu/kWh	From OEPA Air Permit P0106714; Norton CAES
Fuel heating value = 1,025 Btu/ft^3	From **FENOC 2007**, Table 7.2-1
Fuel sulfur content = 2 grains/100 scf (0.0066 wt%)	From OEPA Air Permit P0106714; Norton CAES
SO_2 emissions = 0.006 lb/MMBtu	From OEPA Air Permit P0106714; Norton CAES
NO_X emissions (assuming water injection & selective catalytic reduction) = 3.0 ppmvd @ 15% oxygen and 43.08 lbs/hr (6 units at 7.18 lbs/hr each)	From OEPA Air Permit P0106714; Norton CAES
CO emissions (assuming dry low-NO_X combustors & CO catalytic oxidation) = 5 ppmvd @ 15% oxygen and 43.68 lbs/hr (6 units at 7.28 lbs/hr each)	From OEPA Air Permit P0106714; Norton CAES
PM emissions (all PM_{10}) = 0.0066 lb/MMBtu and 23.34 lbs/hr (6 units at 3.89 lbs/hr each)	From OEPA Air Permit P0106714; Norton CAES
CO_2 emissions = 110 lb/MMBtu	USEPA estimate (**FENOC 2007**, Table 7.2-1)
VOC emissions = 13.2 lbs/hr (6 units at 2.2 lbs/hr each)	From OEPA Air Permit P0106714; Norton CAES

Btu = British thermal unit
CO = carbon monoxide
CO_2 = carbon dioxide
CAES = compressed air energy storage
ft^3 = cubic feet
HHV = higher heating value
kWh = kilowatt-hour
lb = pound
lbs/hr = pounds per hour
MMBtu = million Btu
MW = megawatt
NO_X = nitrogen oxides
OEPA = Ohio Environmental Protection Agency
PM = particulate matter
PM_{10} = PM with diameter less than 10 microns
ppmvd = parts per million volumetric dry
scf = standard cubic feet
SO_X = sulfur oxides
USEPA = U.S. Environmental Protection Agency
wt% = percent by weight
VOC = volatile organic compound

7.3 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

Environmental impacts are evaluated in this section for the coal- and gas-fired generation alternatives determined by FENOC to be reasonable in Section 7.2.1 compared to renewal of Davis-Besse's operating license.

The impacts are characterized as being SMALL, MODERATE, or LARGE. The definitions of these impact descriptions are the same as presented in the introduction to Chapter 4, which in turn are consistent with the criteria established in 10 CFR Part 51, Appendix B to Subpart A, Table B-1, Footnote 3. FENOC believes the environmental impacts associated with the construction and operation of new generating capacity at a greenfield site would exceed those for the same type plants located at Davis-Besse or at another existing disturbed site, i.e., brownfield site.

The new generating plants addressed in Section 7.2.1 would not be constructed only to operate for the period of extended operation of Davis-Besse. Therefore, FENOC assumes for this analysis a typical design life of 40 years for the coal-fired plant, 30 years for the combined-cycle natural gas-fired plant, and considers impacts associated with operation for the entire design life of the units in this analysis. The life span of a wind turbine is 20 years (**REN 2005**); however, turbines can be replaced and the tower would likely be in service for at least 40 years. The life span of a solar plant is estimated to be at least 30 years (**TEP 2005**).

Chapter 8 presents a summary comparison of the environmental impacts of license renewal and the alternatives discussed in this section.

7.3.1 COAL-FIRED GENERATION

This section presents the impact evaluation for the representative coal-fired generation alternative. As discussed in Section 7.2.1.1, FENOC assumed for purposes of this analysis that the representative plant would be located at a greenfield or (preferably) brownfield site along commercially navigable waterway or existing rail way. This assumption is a result of the space limitation at the Davis-Besse site.

Land Use

Land area requirements for a coal-fired plant of similar capacity to Davis-Besse, for example, would be approximately 1.7 acres per MWe (**NRC 1996**, Table 8.1), or 1,547 acres for a 910 MWe plant. This amount of land use will include plant structures and associated infrastructure. Additional acres would be needed offsite for transmission lines and possibly rail lines, depending on the location of the site relative to the nearest inter-tie connection or rail spur. This acreage could amount to a considerable loss of natural habitat or agricultural land for the plant site alone dependent upon whether a greenfield or brownfield site was used, excluding that required for mining and other fuel-cycle impacts. Some portion of the impacts could be mitigated by constructing new transmission line in existing rights-of-way (ROW) to as great an extent as possible.

Land-use changes also would occur offsite in an undetermined coal-mining area to supply coal for the plant. For example, the GEIS estimated that approximately 22 acres of land per MWe would be affected for mining the coal and disposing of the waste to support a coal-fired plant during its operational life (**NRC 1996**, Section 8.3.9). Therefore, for the 910 MWe plant used in this analysis, approximately 20,020 acres of land would be needed. Partially offsetting this offsite land use would be the elimination of the need for uranium mining and processing to supply fuel for Davis-Besse. The GEIS estimated that approximately one acre per MWe would be affected for mining and processing the uranium during the operating life of a nuclear power plant (**NRC 1996**, Section 8.3.12). Therefore, for Davis-Besse uranium mining and processing, approximately 910 acres of land would be required, resulting in offsite mining net land use of 19,110 acres for the representative coal-fired generation alternative.

In consideration of the above, FENOC considers that land use impacts associated with a coal-fired plant at an alternate site would depend on the location of the plant and be MODERATE to LARGE.

Water Use and Quality – Surface Water

Construction-phase impacts on water quality of greatest potential concern include erosion and sedimentation associated with land clearing and grading operations at the plant site and waste disposal site, and suspension of bottom sediments during construction of cooling water intake and discharge structures and facilities for barge delivery of coal and limestone. However, land clearing and grading activities would be subject to stormwater protections in accordance with the NPDES program, and work in waterways would be regulated by the USACE under the CWA Section 404 and Section 10 of the Rivers and Harbors Act. These activities would also be subject to corresponding state and local regulatory controls, as applicable. In addition, these adverse effects would be localized and temporary. As a result, FENOC considers that impacts on surface water quality associated with construction of the representative plant at an alternative site would be SMALL.

FENOC expects that potential impacts on water quality and use associated with operation of the representative plant would be similar to impacts associated with Davis-Besse operation. Cooling water and other wastewater discharges would be regulated by an NPDES permit, regardless of location. Cooling water intake, evaporative losses, and discharge flows for the representative coal-fired plant, assumed to use a closed-cycle cooling system, would be similar to or lower than those resulting from Davis-Besse operation (see Chapter 4). As a result, FENOC considers that impacts on surface water quality associated with operation of the representative plant at an alternative site would be SMALL.

In view of the environmental review afforded under OPSB rules or a similar program, FENOC considers the impacts of surface water use and quality from construction and operation of the representative plant at an alternative site would be SMALL.

Water Use and Quality – Ground Water

Impacts will depend on whether the plant will use ground water for any purposes, as well as the characteristics of local aquifers. Effects to ground water quality can also depend on waste-management and coal-storage practices, although proper disposal and material handling should reduce the likelihood of an effect, as would recycling a greater percentage of waste products. Regardless of location, FENOC believes it highly unlikely that a coal-fired power plant at an alternate site will rely on ground water for plant cooling, and that ground water and waste-management regulations will limit impacts to SMALL.

Air Quality

Air quality impacts of coal-fired generation differ considerably from those of nuclear generation. A coal-fired plant emits sulfur oxides (SO_x), nitrogen oxides (NO_x), particulate matter (PM), and carbon monoxide (CO), all of which are regulated pollutants. Additionally, there are substantial emissions of carbon dioxide (CO_2), a greenhouse gas, although future developments such as carbon capture and storage and co-firing with biomass have the potential to reduce the carbon footprint of coal-fired electricity generation (**POST 2006**). Coal also contains other constituents (e.g., mercury, beryllium) that are potentially emitted as hazardous air pollutants, which are also of concern from a human health standpoint. (**NRC 1996**, Section 8.3.9)

As noted in Section 7.2.1.1, FENOC has assumed a plant design that includes controls to minimize emissions of regulated air pollutants effectively. Based on emission factors, estimated efficiencies for emission controls, and assumed design parameters listed in Table 7.2-1, operation of the plant would result in the following annual air emissions for criteria pollutants:

- Sulfur dioxide = 8,267 tons
- Nitrogen oxides = 5,087 tons
- Carbon monoxide = 636 tons
- Total filterable particulates = 153 tons
- PM_{10} = 34.3 tons.

The annual emissions of carbon dioxide, which is currently unregulated, would be approximately 7.63 million tons. See Table 7.3-1 for details.

FENOC expects that these emissions would result in a decrease in local air quality compared to operation of a nuclear plant. However, FENOC anticipates that both sulfur dioxide and nitrogen oxide emissions will be subject to cap and trade programs (**FENOC 2007**, Section 7.2.1.3). As a result, the plant would not be expected to add to regional sulfur dioxide emissions and may not add to regional nitrogen oxide emissions, at least during the ozone season (**FENOC 2007**, Section 7.3.2, Air Quality). The representative plant would add to regional concentrations of other pollutants, including the criteria pollutants carbon monoxide and particulates; hazardous air pollutants; and carbon dioxide, which is a greenhouse gas.

Subject to regulatory controls, FENOC anticipates that the overall air quality would be noticeable, but not destabilizing. As a result, FENOC considers that the impacts to air quality from operation of the representative plant at an alternative site would be MODERATE.

Ecological Resources

Onsite and offsite land disturbances form the basis for impacts to terrestrial ecology. Constructing a coal-fired plant at an alternate site could alter onsite ecological resources because of the need to convert about 1,547 acres of land at the site to industrial use for the plant, coal storage, and ash and scrubber sludge disposal (see the Land Use subsection above). Coal-mining operations will also affect terrestrial ecology in offsite mining areas, although some of this land is likely already disturbed by mining operations.

Impacts could include wildlife habitat loss, reduced productivity, habitat fragmentation, and a local reduction in biological diversity. Impacts, however, will vary based on the degree to which the proposed plant site is already disturbed. On a previous industrial site, impacts to terrestrial ecology will be minor, unless substantial transmission line ROWs, a lengthy rail spur, or additional roads need to be constructed through undisturbed or less-disturbed areas. Any onsite or offsite waste disposal by landfilling will also affect terrestrial ecology at least through the time period when the disposal area is reclaimed.

During construction, impacts to aquatic ecology are likely. Regardless of where the plant is constructed, site disturbance will likely increase erosion and sedimentation runoff into nearby waterways, increasing turbidity. While site procedures and management practices may limit this effect, the impact will likely be noticeable. This is particularly true when intake and outfall structures are constructed alongside or in the body of water, as well as when any ROWs, roads, or rail lines require in-stream structures to support stream crossings. Noise and disturbance from construction, in addition to increased turbidity, may have a noticeable effect. Required regulatory permits, however, will help to mitigate these impacts.

During operations, the cooling water system would have a potential impact to aquatic communities. However, this system would be designed and operated in compliance with the CWA, including NPDES limitations to ensure appropriate protection of aquatic communities from thermal discharges and cooling water intakes. The cooling water intake and discharge flows would be comparable to or less than for Davis-Besse, the impact from which is considered to be SMALL (see Chapter 4). Therefore, associated impacts at a comparable site on commercially navigable waterway would also be expected to be SMALL.

Management of runoff from coal piles will also be necessary. However, subject to regulatory oversight, as afforded under OPSB rules or a similar program, FENOC considers the impacts to ecological resources from construction and operation of the representative plant at an alternative site may be noticeable, but not destabilizing.

On this basis, FENOC considers that the overall impact to ecological resources of constructing a coal-fired plant with a closed-cycle cooling system at an alternate site would be MODERATE.

Human Health

Coal-fired power generation introduces worker risk from coal and limestone mining, worker and public risk from coal and lime/limestone transportation, worker and public risk from disposal of coal combustion wastes, and public risk from inhalation of stack emissions. For example, the GEIS noted that there could be human health impacts (cancer and emphysema) from inhalation of toxins and particulates from a coal-fired plant, but the GEIS does not identify the significance of these impacts (**NRC 1996**, Section 8.3.9). In addition, the coal-fired alternative also introduces the risk of coal pile fires and attendant inhalation risks, though these types of events are relatively rare. (**NRC 2009b**, Section 8.2.1, Human Health)

Regulatory agencies, including the USEPA, USOSHA, and state agencies, set air emission standards requirements for workers and the public based on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health.

Given these extensive health-based regulatory controls, FENOC considers that operating the representative coal-fired plant at an alternate site would be SMALL.

Socioeconomics

The peak workforce during construction of the coal-fired plant alternative is estimated to range between 1.2 to 2.5 workers per MWe and the workforce required during operation is estimated to be 0.25 workers per MWe (**NRC 1996**, Section 8.3.9, Table 8.1 and

Table 8.2). For a plant with a capacity of 910 MWe, workforces of approximately 1,092 to 2,275 construction workers and 228 permanent employees would be required.

Potential impacts from construction of the coal-fired alternative would be highly location dependent. As noted in the GEIS, socioeconomic impacts are expected to be larger at a rural site than at an urban site, because more of the peak construction work force would need to move to the area to work (**NRC 1996**, Section 8.3.9). Not considering impacts of terminating Davis-Besse operations, socioeconomic impacts at a remote rural site could be LARGE, while impacts at a site in the vicinity of a more populated metropolitan area (e.g., Toledo) could be SMALL to MODERATE. FENOC assumed that the OPSB or comparable review process, including application of appropriate mitigation found to be needed as a result, would ensure that these construction impacts would not be destabilizing to local communities.

At most alternate sites, coal and lime would be delivered by barge, although delivery is feasible for a location near a railway. Transportation impacts would depend upon the site location. Socioeconomic impacts associated with rail transportation would be MODERATE to LARGE. Barge delivery of coal and lime/limestone would have SMALL socioeconomic impacts.

As noted in Section 4.17, communities in Ottawa County, particularly those within the tax jurisdiction of Carroll Township and the Carroll-Benton-Salem School District, would experience losses in both employment and tax revenues due to Davis-Besse closure, assuming the plant is constructed outside the area.

Based on the above, FENOC considers that the overall socioeconomic impacts of construction and operation of the representative coal-fired plant at an alternate site would be MODERATE.

<u>Waste Management</u>

The representative coal-fired plant would produce substantial solid waste, especially fly ash and scrubber sludge. Based on emission factors and controls scaled from Beaver Valley (**FENOC 2007**, Section 7.3.2 and Table 7.2-2)*, the plant annual waste generation amounts would be approximately 300,000 tons/year of ash and 470,100 tons of flue gas desulphurization waste (dry basis), consisting primarily of hydrated calcium sulfate (gypsum) and excess limestone reactant. Although these wastes represent potentially usable products, FENOC assumed the total waste generated would be disposed of at an offsite landfill. Based on a fill depth of 30 feet and scaling from Beaver Valley (**FENOC 2007**, Section 7.3.2), approximately 644 acres would be required for the landfill over an assumed plant operating life of 40 years.

* The scale factor for coal is the ratio of total electric capability, 910 MWe/1980 Mwe, or 0.460.

Disposal of the waste could noticeably affect land use and ground water quality. In addition, the December 2008 failure of the dike used to contain fly ash at the Tennessee Valley Authority Kingston Fossil Plant in Roane County, Tennessee, and subsequent cleanup, highlight other waste management issues (**USEPA 2009b**). However, environmental impacts related to the location, design, and operational aspects of waste disposal for the plant would be subject to regulatory review under OPSB rules or similar programs. As a result, FENOC believes that with proper disposal siting, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources.

On this basis, FENOC considers that waste management impacts from operation of the representative coal-fired plant at an alternate site would be MODERATE.

Aesthetics

Potential aesthetic impacts of construction and operation of the representative coal-fired plant include visual impairment resulting from the presence of a large industrial facility, including 500-foot-high stacks, and cooling towers up to approximately 500 feet high with associated condensate plumes. The stacks and condensate plumes from the cooling towers could be visible some distance from the plant. There would also be an aesthetic impact if construction of a new transmission line or rail spur were needed. Similarly, noise impacts associated with rail delivery of coal and lime/limestone if used would be most significant for residents living in the vicinity of the facility and along the rail route.

These impacts, however, are highly site-specific. Site locations could reduce the aesthetic impact of a coal-fired generation, for example, if siting were in an area that was already industrialized versus locating at largely undeveloped sites.

In view of the environmental review afforded under OPSB rules or a similar program, FENOC considers that the impacts to aesthetics from construction and operation of the representative plant at an alternative site would depend on location and be SMALL to MODERATE.

Cultural Resources

FENOC assumed that the representative coal-fired plant, associated infrastructure (e.g., roads, transmission corridors, rail lines, or other rights-of-way), and associated waste disposal site would be located with consideration of cultural resources afforded under OPSB or comparable rules. FENOC further assumed that appropriate measures would be taken to recover or provide other mitigation for loss of any resources discovered during onsite or offsite construction.

On this basis, FENOC considers that the potential impact on cultural resources from construction and operation of the representative plant at an alternative site would be SMALL.

7.3.2 GAS-FIRED GENERATION

This section presents the impact evaluation for the representative gas-fired generation alternative. As discussed in Section 7.2.1.2, FENOC assumed for purposes of this analysis that the representative plant would be located at a greenfield or (preferably) brownfield site in northwestern Ohio. This assumption is a result of the space limitation at the Davis-Besse site.

Land Use

Land-use requirements for gas-fired plants are relatively small, at about 100 acres for a 910 MWe plant (Section 7.2.1.2). An estimated 240 – 270 additional acres would be needed offsite at a greenfield location for new gas and electric transmission lines (**FENOC 2007**, Section 7.3.1, Land Use) and increased land-related impacts, which in turn would be location-specific.

Land use in northwestern Ohio is predominantly rural agricultural cropland with scattered rural residences and woodlots. Located in a rural area, the change in land use would be locally apparent and could include displacement of cropland, which is highly productive for corn, wheat, and soybeans relative to other areas of the state; however, substantial buffer with respect to highly incompatible land uses (e.g., residential use) could be provided and destabilization of overall land use would not be expected. If the plant were located in an area designated for industrial use, associated land-use impacts would not be significant. Agricultural practices could continue along most of the area occupied by offsite rights-of-way. (**FENOC 2007**, Section 7.3.1, Land Use)

Regardless of where the natural gas-fired plant is built, additional land would be required for natural gas wells and collection stations. Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for Davis-Besse. The GEIS estimated that approximately one acre per MWe would be affected for mining and processing the uranium during the operating life of a nuclear power plant (**NRC 1996**, Section 8.3.12). Therefore, for Davis-Besse uranium mining and processing, approximately 910 acres of land would be required, resulting in a net gain in reclaimed land for the representative natural gas-fired generation alternative.

In view of the environmental review afforded under OPSB rules or a similar program, FENOC considers that the overall impacts of land use from construction and operation of the representative plant at an alternative site would depend on plant location and be SMALL to MODERATE.

Water Use and Quality – Surface Water

Cooling water intake, evaporative losses, and discharge flows for the plant would be less than that of Davis-Besse, primarily because less power would be derived from a steam cycle (**FENOC 2007**, Section 7.2.2.1).

During operation, cooling water and wastewater discharges would be regulated under the federal CWA and corresponding state programs by an NPDES permit. Construction activities would be similarly regulated to ensure protection of water resources. In addition, impacts on water use and quality would be subject to scrutiny in the planning stage under OPSB or similar governing authority rules.

Overall, FENOC considers that the impacts from construction and operation of the representative plant at an alternative site on surface water use and quality would be SMALL.

Water Use and Quality – Ground Water

Impacts will depend on whether the plant will use ground water for any purposes, as well as the characteristics of local aquifers. Regardless of location, FENOC assumes that a gas-fired power plant at an alternate site will not rely on ground water for plant cooling, and that regulations for ground water use for potable water will limit impacts to SMALL.

Air Quality

Natural gas is a relatively clean-burning fuel with nitrogen oxides being the primary focus of combustion emission controls. As noted in the GEIS, air quality impacts for all natural gas technologies are generally less than for fossil technologies of equal capacity because fewer pollutants are emitted (**NRC 1996**, Section 8.3.10).

As noted in Section 7.2.1.2, FENOC has assumed a plant design that includes controls to minimize emissions of regulated air pollutants effectively. Based on emission factors, estimated efficiencies for emission controls, and assumed design parameters listed in Table 7.2-2, operation of the plant would result in the following annual air emissions for criteria pollutants:

- Sulfur dioxide = 13.3 tons
- Nitrogen oxides = 205 tons
- Carbon monoxide = 311 tons
- Total filterable particulates = 39.4 tons

The annual emissions of carbon dioxide, which is currently unregulated, would be approximately 2.28 million tons. See Table 7.3-2 for details.

FENOC expects that these emissions may result in a noticeable reduction in local air quality. However, FENOC anticipates that both sulfur dioxide and nitrogen oxide emissions will be subject to cap and trade programs (**FENOC 2007**, Section 7.2.1.3). As a result, the plant would not be expected to add to regional sulfur dioxide emissions and may not add to regional nitrogen oxide emissions, at least during the ozone season (**FENOC 2007**, Section 7.3.1, Air Quality). The representative plant would add to regional concentrations of other pollutants, including the criteria pollutants carbon monoxide and particulates; hazardous air pollutants such as mercury; and carbon dioxide, which is presently unregulated.

Subject to regulatory controls, FENOC anticipates that the overall air quality would be noticeable, but not destabilizing. As a result, FENOC considers that the impacts to air quality from operation of the representative plant at an alternative site would be MODERATE, but smaller than those of coal-fired generation.

Ecological Resources

As noted in the Land Use subsection above, development of the representative combined-cycle natural gas-fired plant may require approximately 100 acres for the plant site and approximately 240 – 270 additional acres for offsite infrastructure. Although the GEIS noted that land-dependent ecological impacts from construction from gas-fired plants would be smaller than for other fossil fuel technologies of equal capacity (**NRC 1996**, Section 8.3.10), the type and quality of terrestrial habitat that would be displaced is location-specific.

However, FENOC considers it likely that most of the area required for construction would consist of agricultural cropland with relatively low habitat value. Stream crossings and wetland disturbance, if any, would be subject to provisions of a USACE permit (CWA Section 404) and relevant state and local requirements. (**FENOC 2007**, Section 7.3.1, Ecology)

The most significant potential impacts to aquatic communities relate to operation of the cooling water system. However, the cooling system for the plant would be designed and operated in compliance with the CWA, including NPDES limitations for physical and chemical parameters of potential concern and provisions of CWA Sections 316(a) and 316(b), which are respectively established to ensure appropriate protection of aquatic communities from thermal discharges and cooling water intakes. Also, the siting, design, and operation of the plant would be subject to the environmental protections under OPSB rules.

Overall, FENOC expects that development of the representative natural gas-fired plant would likely have little noticeable impact on ecological resources of the area. As a result, FENOC considers that the overall impacts to ecology resources from construction and operation of the representative plant at an alternative site would depend on plant location and be SMALL to MODERATE.

Human Health

The GEIS cites risk of accidents to workers and public health risks (e.g., cancer, or emphysema) from the inhalation of toxics and particulates associated with air emissions as potential risks to human health associated with the gas-fired generation alternative (**NRC 1996**, Table 8.2). However, regulatory requirements imposed on facility design, construction, and operations under the authority of the Occupational Safety and Health Act, Clean Air Act, and related statutes are designed to provide an appropriate level of protection to workers and the public. Additionally, regulatory agencies, including the USEPA, USOSHA, and state agencies, set air emission standards requirements for workers and the public based on human health impacts.

Given the extensive health-based regulatory control, FENOC considers that operating the representative gas-fired plant at an alternate site, regardless of plant location, would be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from the representative gas-fired generation alternative include temporary increases in jobs, economic activity, and demand for housing and public services in communities surrounding the site during the construction period. Countering these increases are losses in permanent jobs, tax revenues, and economic activity attributable to gas-fired plant operation and termination of operations of Davis-Besse.

The estimated number of peak construction workers expected to build a gas-fired plant with a capacity of 910 MWe is 1,092 – 2,275 (**NRC 1996**, Tables 8.1). To operate the plant would require 137 workers (**NRC 1996**, Tables 8.2). Although northwestern Ohio is predominantly rural, most areas are within commuting distance of the metropolitan areas like Toledo and Cleveland, Ohio. Considering the proximity of these sources of labor and services, FENOC expects that most of the construction workforce would commute and relatively few would relocate into the area, and associated socioeconomic impacts during construction would be SMALL.

Communities in Ottawa County, however, particularly those within the taxing jurisdiction of Carroll Township and the Benton-Carroll-Salem School District, would experience losses in both employment and tax revenues due to Davis-Besse closure that could constitute MODERATE impact (see Section 4.17).

FENOC believes that these impacts, although noticeable, would not be destabilizing. As a result, FENOC considers that the overall socioeconomic impact of construction and operation of the representative gas-fired at an alternative site would be MODERATE.

Waste Management

Gas-fired generation would result in minimal waste generation, producing minor (if any) impacts (**NRC 1996**, Section 8.3.10). As a result, FENOC considers waste management impacts from the operation of the representative plant at an alternative site would be SMALL.

Aesthetics

Potential aesthetic impacts of construction and operation of a gas-fired plant include visual impairment resulting from the presence of a large industrial facility, including multiple exhaust stacks at least 150 feet high, and mechanical-draft cooling towers with associated condensate plumes. Considering the flat topography in northwestern Ohio, the stacks and condensate plumes would likely be visible for several miles from the site; new transmission lines constructed to connect the plant to the grid would also be relatively visible for the same reason, though would not be out of character for the rural northwestern Ohio landscape. (**FENOC 2007**, Section 7.3.1, Aesthetics) FENOC expects that the plant likely would be located in a rural area, and assumed that adequate buffer and vegetation screens would be provided at the plant site as needed to moderate visual and noise impacts.

In view of the environmental review afforded under OPSB rules, FENOC considers that the impacts to aesthetics from construction and operation of the representative plant at an alternative site would depend on location and be SMALL to MODERATE.

Cultural Resources

FENOC assumed that the representative gas-fired plant and associated gas-supply pipeline and transmission line would be located with consideration of cultural resources under OPSB or comparable program rules. FENOC further assumed that appropriate measures would be taken to avoid, recover, or provide other mitigation for loss of any resources discovered during onsite or offsite construction.

On this basis, FENOC concludes that the potential adverse impact on cultural resources of the representative plant at an alternative site, regardless of location, would be SMALL.

7.3.3 RENEWABLE ENERGY

This section presents the impact evaluation for wind power in the form of interconnected wind farms and/or solar photovoltaic power, in combination with CAES. To be specific, FENOC evaluated for purposes of this NEPA analysis electricity generation coming from: wind power in the form of interconnected wind farms; or wind power in the form of interconnected wind farms with CAES; or solar (photovoltaic) power with CAES; or a combination of interconnected wind farms and solar power with CAES, as described in Sections 7.2.1 and 7.2.1.3.

Wind and solar energy are renewable energy sources that produce electricity without releasing air or water pollutants; however, these advantages are offset by environmental impacts such as large land requirements (both wind and solar), potential harm to birds and bats (wind), aesthetic concerns (wind and solar), noise concerns (wind); radar interference (wind), and generation of hazardous waste streams (solar).

In addition, there would be environmental impacts associated with the construction and operation of new transmission lines associated with new renewable energy sources. These impacts are not evaluated as part of this analysis because the scope of new transmission would not be determined until the energy sources were sited.

The environmental impacts related to interconnected wind farms are discussed in Section 7.3.3.1. The environmental impacts of interconnected wind farms with CAES are discussed in Section 7.3.3.2. The environmental impacts of solar PV power with CAES are discussed in Section 7.3.3.3. Finally, a summary of the combined environmental impacts of wind farms, solar PV power, and CAES are provided in Section 7.3.3.4.

7.3.3.1 Interconnected Wind Energy

Using the assumptions and disclaimers in Section 7.2.1, development of a series of wind farms would be required to provide replacement power for Davis-Besse. Transmission impacts associated with an interconnected grid that would serve renewable energy sources would have to be evaluated once the renewable energy sources have been sited.

Development of large-scale, land-based wind power facilities could have MODERATE to LARGE impacts on aesthetics, land use, and terrestrial ecology. The environmental impacts of a large-scale wind farm are described in the GEIS (**NRC 1996**, Section 8.3.1). In summary, the construction of roads and turbine tower supports would result in short-term impacts, such as increases in noise, erosion, and sedimentation, and decreases in air quality from fugitive dust and equipment emissions. Construction in undeveloped areas would have the potential to disturb and impact cultural resources or habitat for sensitive species. During operation, some land near wind turbines could be available for compatible uses such as agriculture. There is some continuing noise from wind turbine operation, light flicker caused by reflection of the sun, and aesthetic impacts, although whether a wind farm improves the landscape is in the eye of the beholder. Wind farms generate very little waste and pose limited human health risk other than from occupational injuries. There is a potential for bird and bat collisions with turbine blades, which is discussed in this subsection.

Although most environmental impacts associated with a single wind farm are SMALL or can be mitigated, the cumulative impacts from the many wind farms that would be needed to support an interconnected grid system, such as impacts to sensitive habitats and endangered species, could be LARGE, depending on the locations.

The incorporation of offshore wind resources from Lake Erie could reduce the amount of land use impacts; however, a new set of impacts related to offshore wind would be created. Placing wind farms offshore eliminates some of the obstacles encountered when siting wind farms on shore and limits conflicts with other planning interests. However, other impacts are created, including influence on birds, marine life, hydrography, and marine traffic. (**IEAWIND 2002**)

A detailed discussion of impacts is presented below.

Land Use

The land use requirement for interconnected wind farms in open and flat terrain is about 50 acres per megawatt (MW) of installed capacity. Approximately 5% (2.5 acres) of this area is occupied by turbines, access roads, and other equipment. The remaining land area can be used for compatible activities such as farming or ranching (**AWEA 2002**), except if the wind farms are located offshore. The Roscoe Wind Farm near Roscoe, Texas has the capacity of 209 MW and is spread-out across 30,000 acres (**RWC 2010**), or 143 acres per MW. When complete, the entire Roscoe Wind Complex project is expect to have the capacity of 781 MW on approximately 100,000 acres (**CBS 2010**) or 128 acres per MW.

Assuming the use of interconnected wind as the only renewable source to generate the equivalent of Davis-Besse's net output of 910 MWe base-load power plus 910 MWe of energy storage to be used when wind power is not available, a series of wind farms with 2.0-MWe turbines with an average capacity factor of 30% as specified by PJM and USDOE (**PJM 2011** and **USDOE 2011**) would require approximately 3030 turbines to produce 1820 MWe. At 50 acres per MW, the land use potential would be as much as 91,000 acres (142 square miles), with about 4550 acres (7.1 square miles) occupied by turbines and support facilities.

Land use in Ohio, where additional wind generation would likely be developed, is predominantly rural agricultural cropland with scattered rural residences and woodlots.

In such a location, the change in land use would be locally apparent and could include some initial displacement of highly productive cropland for corn, wheat, and soybeans. However, a substantial buffer with respect to highly incompatible land uses (e.g., residential use) could be provided, and destabilization of overall land use would not be expected. Agricultural practices could continue along most of the area occupied by offsite rights-of-way. (**FENOC 2007**, Section 7.3.1, Land Use)

Offshore impacts have been extensively studied in Europe. An environmental impact report has been prepared by the Cape Wind Project (CWP) and a feasibility study was conducted by the Great Lakes Wind Energy Center (GLWEC) for an offshore area in Lake Erie near Cleveland, Ohio (**GLWEC 2009**). Based on the findings in the CWP Environmental Impact Report (EIR) (**CWP 2007**) and the study completed by GLWEC, land use impacts associated with offshore wind generation would be SMALL.

Regardless of where the wind generation facilities are built, additional land would be required for an interconnected grid system as described in Section 7.2.2.3. Partially offsetting these offsite land requirements would be the elimination of the need for uranium mining to supply fuel for Davis-Besse. The GEIS estimates that approximately one acre per MWe would be affected for mining and processing the uranium during the operating life of a nuclear power plant (**NRC 1996**, Section 8.3.12). Therefore, for the uranium mining and processing associated with fuel for Davis-Besse, approximately 910 acres of land would be required, resulting in a net avoidance of potentially disturbing 3640 (4550-910) acres of land when compared to wind generation land use.

Based on these data, FENOC considers that the overall impacts of land use from construction and operation of interconnected wind farms would depend on their locations, and be MODERATE to LARGE.

Water Use and Quality – Surface Water

Wind generation does not require cooling water or intake structures. Therefore, there would be no impact on water use and the only potential impact on local water quality would be erosion or sedimentation issues during construction. These impacts would be minimized by using best management practices during construction activities and are considered SMALL.

Water Use and Quality – Ground Water

A limited amount of ground water may be used during construction activities if other potable water supplies are limited. Minor amounts of water may be needed for operating wind generation facilities if surface water resources were not available. The potential impact to ground water is SMALL.

Air Quality

There are no air quality impacts associated with the operation of onshore or offshore interconnected wind farms. The construction of roads and turbine tower supports would result in short-term impacts in air quality from fugitive dust and equipment emissions and the overall impacts would be SMALL.

Ecological Resources

As noted in the Land Use subsection above, development of onshore interconnected wind farms would have a MODERATE to LARGE impact on land resources which could have a LARGE impact on the ecological resources, especially during construction.

Migratory bird, eagle and raptor, and bat mortality are potential impacts related to wind turbines. The deaths of birds and bats at wind farm sites have raised concerns by fish and wildlife agencies and conservation groups. United States Fish and Wildlife Service (USFWS) estimates indicate that wind turbine rotors kill 33,000 birds annually (**USFWS 2002**). Concerns of the potential impacts of wind power deployment have led the USFWS to release draft guidance that provides agency employees, developers, federal agencies, and state organizations information for reviewing and selecting sites for interconnected and community-scale wind energy facilities to avoid and minimize negative impacts to fish, wildlife, plants and their habitats (**USDOI 2011**). Direct effects include blade strikes, barotrauma, loss of habitat, and "displacement". Indirect effects occur later in time and include introduction of invasive vegetation that result in alteration of fire cycles; increase in predators or predation pressure; decreased survival or reproduction of the species; and decreased use of the habitat that may result from effects of the project or resulting "habitat fragmentation." (**USFWS 2011**)

Although wind turbine/bird collision studies seem to indicate that wind generating facilities in some locations of the United States have a minor impact on birds compared to other sources of collision mortality, one cannot assume that similar impacts would occur among birds using wind-generating sites built in Ohio or offshore in Lake Erie. Based on a feasibility study conducted by Great Lakes Wind Energy Center (GLWEC) the avian morality rate of this proposed offshore project is expected to be minimal. (**GLWEC 2009**) FENOC assumed that construction best management practices and awareness of critical habitat during operations would minimize impacts to ecological resources. Therefore, impacts to migrating species would depend on the location of the wind farms and could be SMALL to MODERATE.

Human Health

The only major health risk for the construction and operation of a series of wind farms (onshore or offshore) would be accidents. FENOC assumed that all Occupational

Safety and Health Act requirements would be complied with during construction and operation of these facilities and the impacts should be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from interconnected wind farms include temporary increases in jobs, economic activity, and demand for housing and public services in communities surrounding the sites during the construction period. These impacts would be spread throughout the region. Countering these increases are losses in permanent jobs, tax revenues, and economic activity attributable to the termination of operations of Davis-Besse. Typically, renewable energy sources are not subject to the tax rate of conventional energy-generating facilities, so the loss of permanent jobs and tax revenue could be significant to the communities near Davis-Besse and thus have a SMALL to MODERATE impact.

Communities in Ottawa County, however, particularly those within the taxing jurisdiction of Carroll Township and the Benton-Carroll-Salem School District, would experience losses in both employment and tax revenues due to Davis-Besse closure that could constitute MODERATE impacts.

The number of peak construction workers expected to build the wind farms is unknown at this time; however, it is likely similar to a gas-fired plant with a capacity of 910 MWe, which is 1200 (**NRC 1996**, Tables 8.1). To operate and maintain the wind farms would require approximately 150 to 200 workers. FENOC expects that most of the construction workforce would commute and relatively few would relocate into the area, and associated socioeconomic impacts during construction would be SMALL.

Waste Management

Construction of wind farms could result in generation of large amounts of vegetation from land clearing activities. If this material is managed correctly (e.g., recycled or composted) the impacts should be SMALL. Minor amounts of waste may be generated during the operations and maintenance of the wind turbines (onshore or offshore) which, if waste streams are managed correctly, the impacts would likely be SMALL.

Aesthetics

Most wind farms are located in remote areas and may generate large aesthetic concerns, particularly if sited on highlands or in recreational areas and could have some effect on the local aesthetic quality. The aesthetic impacts from wind farms located in flat-lying rural areas would likely be SMALL.

Offshore wind turbines would likely have a lesser aesthetic impact than onshore wind turbines and be limited to those individuals who reside close to the shoreline or participate in recreational activities close to the wind facilities. There have been concerns related to the related to aesthetic impacts. (**CA 2011**) The overall aesthetic impacts from wind turbines would be SMALL to MODERATE.

Cultural Resources

Due to the large amount of land needed to construct the necessary wind farms, the potential for impacting cultural resources could be LARGE. To minimize these impacts, FENOC assumed construction activities would consider cultural resources under OPSB or comparable program rules. FENOC further assumed that appropriate measures for both onshore and offshore construction activities would be taken to avoid, recover, or provide other mitigation for loss of any resources discovered during onsite or offsite construction.

On this basis, FENOC concludes that the potential adverse impact on cultural resources of the wind farms, regardless of location, would be SMALL.

7.3.3.2 Wind with Compressed Air Energy Storage

Environmental impacts associated with wind farms are discussed above in Section 7.3.3.1, and are not repeated here in detail. Impacts associated with the compressed air energy storage (CAES) facility are discussed below.

By combining CAES with interconnected wind farms, the anticipated environmental impacts would be greater than the impacts from interconnected wind farms alone. Therefore, wind farms with CAES generating 1820 MW* of power are expected to have greater environmental impacts than Davis-Besse during the proposed 20 year license extension.

Land Use

The overall land use impact for wind generation in this energy alternative, as discussed in Section 7.3.3.1, is MODERATE to LARGE.

Land use associated with the NES facility would be limited to the facility's 92 surface acres. There would be some land impacted during construction, but this site has been previously disturbed so the impact should be SMALL. However, if another site is

* Wind generation source is assumed to be available for 12 hours every day, and a CAES facility assumed to be 100% efficient (i.e., 910 MWe of energy input from wind and/or solar to the CAES facility results in 910 MWe of generation from the CAES facility), would require that generation source to be rated at 1820 MW in order to provide 24-hours of baseload electricity when integrated with a 910 MW CAES facility (i.e., 12 hours to provide 910 MW of base-load generation onto the grid, and the same 12 hours to provide 910 MW to recharge the CAES facility, so that the CAES facility could feed the grid the remainder of the day).

chosen for the CAES or an additional CAES facility is needed to meet base-load power requirements then there could be a MODERATE to LARGE land use impact.

Water Use and Quality – Surface Water

CAES facilities have cooling towers associated with the use of gas turbines to produce electricity and compressors to recharge the storage structure. These cooling towers are much smaller than those typically used for coal and gas generation plants. Cooling makeup water evaporative losses, and discharge flows for the plant would be considerably less than that of Davis-Besse, primarily because less power would be derived from a steam cycle. (**FENOC 2007**, Section 7.2.2.1)

During CAES operation, cooling water and wastewater discharges would be regulated under the federal CWA and corresponding state programs by an NPDES permit. Construction activities would be similarly regulated to ensure protection of water resources. In addition, impacts on water use and quality would be subject to scrutiny in the planning stage under OPSB or similar governing authority rules.

Overall, FENOC considers that the impacts from construction and operation of interconnected wind farms (onshore and offshore) combined with a CAES facility on surface water use and quality would be SMALL.

Water Use and Quality – Ground Water

Impacts would depend on whether the plant would use ground water for any purposes, as well as the characteristics of local aquifers. Regardless of location, FENOC assumed that the NES plant or a CAES plant at an alternate site would not rely on ground water for plant cooling, and that regulations for ground water use for potable water would limit impacts to SMALL.

Air Quality

CAES facilities use natural gas, which is a relatively clean-burning fuel with nitrogen oxides being the primary focus of combustion emission controls. As noted in the GEIS, air quality impacts for all natural gas technologies are generally less than for fossil technologies of equal capacity because fewer pollutants are emitted (**NRC 1996**, Section 8.3.10).

FirstEnergy Generation Corp. has applied for and received an Air Pollution Permit to Install and Operate (PTIO) proposed emission units for the Norton CAES facility (Facility ID 1677105001) (see Table 7.2-3). The permit (Number P0106714) was issued on September 7, 2010 by the Ohio EPA. The permit establishes emission limitations, air emission controls, monitoring, reporting, and recordkeeping requirements. The proposed emission units established in the PTIO are based on the original design of the facility and include six combustion trains and one cooling tower. Each combustion train includes a 589 mmBtu/hr (134 MWe) combustion turbine and a 1 mmBtu/hr in-line heater to remove moisture from the compressed air. (**NES 2010**) The combustion turbines and in-line heaters would fire only pipeline-quality natural gas. The only other sources associated with this facility are an emergency generator and a back-up firewater pump; both of these units would be diesel-fired.

The permitted annual air emission limits from this facility with six combustion trains (i.e., 804 Mwe) are as follows:

- Sulfur dioxide (SO_2) = 42.41 tons
- Nitrogen oxides (NO_x) = 93.67 tons
- Carbon monoxide = 90.36 tons
- PM_{10} = 46.65 tons
- Volatile Organic Compounds (VOCs) = 26.40 tons

The annual emissions of carbon dioxide from all sources would be approximately 681,100 tons. These emissions are based on the current air permit for NES and could change if different equipment is used during plants operations. A list of air emissions for the six combustion trains is presented in Table 7.3-4.

FENOC anticipates that both sulfur dioxide and nitrogen oxide emissions would be subject to cap and trade programs (**FENOC 2007**, Section 7.2.1.3). As a result, the plant would not be expected to add to regional sulfur dioxide emissions and may not add to regional nitrogen oxide emissions, at least during the ozone season (**FENOC 2007**, Section 7.3.1, Air Quality). The plant would add to regional concentrations of other pollutants, including the criteria pollutants carbon monoxide and particulates; hazardous air pollutants such as mercury; and carbon dioxide, which is presently unregulated.

Subject to regulatory controls, FENOC anticipates that the impacts to air quality from operation of the CAES plant at an alternative site would be MODERATE.

Ecological Resources

As noted in Section 7.3.3.1, development of the interconnected wind farms would have a MODERATE to LARGE impact on land resources which could have a LARGE impact on ecological resources, especially during construction.

Since the NES has an existing underground storage space and only has 92 acres of land use at the surface, the potential impact to ecological resources is SMALL. However, if another CAES site with compressed air storage on the land surface is chosen or needed to provide additional stored energy capacity the ecological impacts could be MODERATE to LARGE.

For an alternative CAES site, FENOC considers it likely that most of the area required for construction would consist of agricultural cropland with relatively low habitat value. Stream crossings and wetland disturbance, if any, would be subject to provisions of a USACE permit (CWA Section 404) and relevant state and local requirements. (**FENOC 2007**, Section 7.3.1, Ecology)

The most significant potential impacts to aquatic communities relate to operation of the cooling water system. However, the NES site (or alternative site) cooling system for the plant would be designed and operated in compliance with the CWA, including NPDES limitations for physical and chemical parameters of potential concern and provisions of CWA Sections 316(a) and 316(b), which are respectively established to ensure appropriate protection of aquatic communities from thermal discharges and cooling water intakes. Also, the siting, design, and operation of the plant would be subject to the environmental protections under OPSB or other state agency's rules.

Overall, FENOC expects that development of the CAES plant would likely have little noticeable impact on ecological resources of the area. As a result, FENOC considers that the overall impacts to ecology resources from construction and operation of the representative plant at an alternative site would depend on plant location and be SMALL to LARGE.

Human Health

The only major health risk for the construction and operation of a series of wind farms (onshore or offshore) would be accidents. FENOC assumed that all Occupational Safety and Health Act requirements would be complied with during construction and operation of these facilities and the impacts should be SMALL.

The NES or an alternative CAES facility would use natural gas in its power generation mode. The GEIS cites risk of accidents to workers and public health risks (e.g., cancer, or emphysema) from the inhalation of toxics and particulates associated with air emissions as potential risks to human health associated with the gas-fired generation alternative (**NRC 1996**, Table 8.2). However, regulatory requirements imposed on facility design, construction, and operations under the authority of the Occupational Safety and Health Act, Clean Air Act, and related statutes are designed to provide an appropriate level of protection to workers and the public. Additionally, regulatory agencies, including the USEPA, USOSHA, and state agencies, set air emission standards requirements for workers and the public based on human health impacts.

Given the extensive health-based regulatory control, FENOC considers that human health impacts from operating a CAES plant at NES or an alternate site, regardless of plant location, would be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from interconnected wind farms with CAES would be similar to those discussed in Section 7.3.3.1. The number of peak construction workers expected to build the NES facility is unknown at this time; however, it is likely not to exceed the number for a gas-fired plant with a capacity of 910 MWe, which is 1200 (**NRC 1996**, Table 8.1). FENOC expects that most of the construction workforce would commute and relatively few would relocate into the area, and associated socioeconomic impacts during construction would be SMALL. To operate and maintain the NES plant would require approximately 50 to 100 workers.

FENOC believes that the construction impacts, although noticeable, would be spread throughout the State and should not impact any one local community over another. The financial impacts from closing Davis-Besse, however, could be significant to the areas surrounding the station. The addition of an operational workforce for the CAES facility and new tax revenue for the local community near the CAES facility would be a beneficial impact in that local community. As a result, FENOC considers that the overall socioeconomic impact of construction and operation of the NES or an alternative CAES site would be SMALL to MODERATE.

Waste Management

Construction of interconnected wind farms could result in generation of large amounts of vegetation from land clearing activities. If this material is managed correctly (e.g. recycled or composted) then the impacts should be SMALL. Like gas-fired generation, NES or an alternative CAES site would result in minimal waste generation, producing minor (if any) impacts (**NRC 1996**, Section 8.3.10). As a result, FENOC considers waste management impacts from the operation of a CAES plant at an alternative site would be SMALL.

Aesthetics

Most wind farms are located in remote areas and may generate large aesthetic concerns, particularly if sited on highlands or in recreational areas and could have some effect on the aesthetic quality. In general, impact on aesthetic quality for wind farms located in flat-lying rural areas would be SMALL

Potential aesthetic impacts of construction and operation of NES or an alternative CAES plant may include visual impairment resulting from the presence of a large industrial facility, including multiple exhaust stacks and mechanical-draft cooling towers with associated condensate plumes. Considering the flat topography in northwestern Ohio and other areas where an alternative CAES may be placed, the stacks and condensate plumes would likely be visible for several miles from the site; new transmission lines constructed to connect the plant to the grid would also be relatively visible for the same reason, though would not be out of character for most rural areas including the northwestern Ohio landscape. (**FENOC 2007**, Section 7.3.1, Aesthetics)

The NES site is on a brownfield area located just south of Norton, Ohio. The construction of the facility would cause a minor change in the appearance of the area, but aesthetic impacts would be SMALL. FENOC expects that an alternative CAES plant likely would be located in a rural area, and assumed that adequate buffer and vegetation screens would be provided at the plant site as needed to moderate visual and noise impacts.

In view of the environmental review afforded under OPSB rules, FENOC considers that the impacts to aesthetics from construction and operation of interconnected wind farms and NES or an alternative CAES site would depend on location and be SMALL to MODERATE.

Cultural Resources

As discussed in Section 7.3.3.1, FENOC concludes that the potential adverse impact on cultural resources of the interconnected wind farms, regardless of location, would be SMALL.

FENOC assumed that the NES facility or alternative CAES plant and associated gas-supply pipeline and transmission lines would be located with consideration of cultural resources under OPSB or comparable program rules, and the impact would be SMALL.

7.3.3.3 Photovoltaic Power Combined with CAES

Environmental impacts of solar power systems can vary based on site-specific conditions. Land use and aesthetics are the primary environmental impacts of solar power. Land requirements for PV facilities are large, compared to the land currently used by Davis-Besse. During operation, however, PV technologies produce no air pollution, little or no noise, and require no transportable fuels.

Land Use

As stated in the GEIS, land requirements are high: 35,000 ac (14,000 ha) [i.e., 54.7 square miles] per 1,000 MWe for PV cells (**NRC, 1996**).

An NREL study (for the western United States) has indicated the amount of land required depends on the available solar insolation and ranges from about 3.8 to 7.6 acres per MW for photovoltaic systems with a capacity factor ranging from 20 to 25%. (**NREL 2002**) Assuming an average capacity factor of 24% from **NREL 2002**, and 5 acres per MW, plus an additional 910 MWe needed for energy storage, and the estimated required land would be approximately 37,900 acres (59.2 square miles).

Unlike wind power generation, all the land used to construct the solar generation facilities would be permanently disturbed and could not be used for other purposes.

To reduce the amount of land use, the solar facilities could be placed in the same locations as the wind generation facilities, or brownfield locations assuming these are flat areas with sufficient sunlight. PV arrays are placed on the rooftops of businesses and residential dwellings to generate electricity or to heat water. These units are usually small and are designed to provide energy directly to the facility or residence to which they are attached. Only in a few cases are these PV arrays large enough to provide excess energy to the grid.

Based on these data, FENOC considers that the overall impacts of land use from construction and operation of the representative solar power facilities alone would be LARGE.

Land use associated with the NES facility would be limited to the facilities' 92 surface acres. There would be some land impacted during construction but this site has been previously disturbed so the impact should be SMALL. However, if another site is chosen for the CAES or an additional CAES facility is needed to meet base-load power requirements then the potential impacts to land resources could be MODERATE to LARGE.

Water Use and Quality – Surface Water

Solar generation using PV technology does not require cooling water or intake structures. Therefore, there would be no impact on water use and the only potential impact on local water quality would be erosion or sedimentation issues during construction. These impacts would be minimized by using best management practices during construction activities. Significant amounts of water could be used to keep the solar panels clean so they remain effective in collecting the maximum amount of sunlight possible. Since the areas where these solar facilities would be located are not in a desert or semi-arid environment, the demands on water resources should be reduced. Overall, the impacts on water use and quality should be SMALL to MODERATE.

Surface water impacts associated with the CAES cooling systems are discussed in detail in Section 7.3.3.2, and are SMALL.

Overall, FENOC considers that the impacts from construction and operation of solar generation facilities and a CAES plant at alternative sites on surface water use and quality would be SMALL to MODERATE.

Water Use and Quality – Ground Water

Impacts would depend on whether the plant would use ground water for any purposes, as well as the characteristics of local aquifers. Regardless of location, FENOC assumed that the NES plant or a CAES plant at an alternate site would not rely on ground water for plant cooling, and that regulations for ground water use for potable water would limit impacts to SMALL.

Air Quality

There are no air quality impacts associated with the operation of solar generation facilities.

Potential emissions from NES are discussed in Section 7.3.3.2 and Table 7.3-3. FENOC considers that the impacts to air quality from operation of a CAES facility at an alternative site would be MODERATE.

Ecological Resources

As noted in the Land Use subsection above, development of solar generation facilities would have a major impact on land resources, which could have a significant impact on the ecological resources during construction and operation of these facilities. As stated in the Land Use subsection, approximately 37,900 acres would be permanently disturbed, and with the possible loss of important habitat. Although FENOC assumed that construction best management practices and awareness to critical habitat during operations would minimize effects to ecological resources, the potential for significant impacts would be MODERATE to LARGE.

As discussed in Section 7.3.3.2, since the NES is a former underground limestone mine and only has 92 acres of land use at the surface, the potential impact to ecological resources is SMALL. However, if another CAES site with compressed air storage on the land surface is chosen or needed to provide additional stored energy capacity, then the ecological impacts could be MODERATE to LARGE.

Human Health

The health risks for the construction and operation of a series of solar generation facilities would be accidents and potential exposure to hazardous materials. FENOC assumed that all Occupational Safety and Health Act requirements would be complied with during construction and operation of these facilities and the impacts should be SMALL.

As discussed in Section 7.3.3.2, given the extensive health-based regulatory control, FENOC considers that operating the CAES plant at NES or an alternate site, regardless of plant location, would be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from the solar power with associated NES or CAES facility alternative include temporary increases in jobs, economic activity, and demand for housing and public services in communities surrounding the sites during the construction period. These impacts would be spread throughout the state and should not impact any one local community over another. Countering these increases are losses in permanent jobs, tax revenues, and economic activity attributable to operation of the alternative generation facilities and termination of operations of Davis-Besse. Typically, renewable energy sources are not subject to the tax rate of conventional energy generating facilities, so the loss of permanent jobs and tax revenue could be significant to the communities near Davis-Besse and thus the impacts could be SMALL to MODERATE.

Communities in Ottawa County, however, particularly those within the taxing jurisdiction of Carroll Township and the Benton-Carroll-Salem School District, would experience losses in both employment and tax revenues due to Davis-Besse's closure that could constitute MODERATE impacts.

The number of peak construction workers expected to build the solar power facilities and the NES facility is unknown at this time. However, it is likely not to exceed that of a gas-fired plant with a capacity of 910 MWe, which is 1200 (**NRC 1996**, Table 8.1). To operate and maintain the solar facilities and NES plant would require approximately 150 to 200 workers. FENOC expects that most of the construction workforce would commute and relatively few would relocate into the area, and associated socioeconomic impacts during construction would be SMALL.

In summary, FENOC considers that the overall socioeconomic impact of construction and operation of the representative solar generation combined with CAES generation facility would be SMALL to MODERATE.

Waste Management

PV technology creates environmental impacts related to manufacture and disposal. 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. The cumulative and long-range impacts from transporting and disposing of hazardous waste could be SMALL to MODERATE.

Aesthetics

Most solar facilities are located in remote areas and would likely not generate large aesthetic concerns and would likely meet minor public resistance. Overall, the impacts from the construction and operation of solar power facilities would be SMALL.

Cultural Resources

Due to the large land use to construct the necessary solar generation facilities and for the CAES facility, the potential for impacting cultural resources could be LARGE. To minimize these impacts, FENOC assumed construction activities would consider cultural resources under OPSB or comparable program rules. FENOC further assumed that appropriate measures would be taken to avoid, recover, or provide other mitigation for loss of any resources discovered during onsite or offsite construction.

On this basis, FENOC concludes that the potential adverse impact on cultural resources of the solar generating facilities, regardless of location, would be SMALL.

FENOC assumed that the NES facility or alternative CAES plant and associated gas-supply pipeline and transmission line would be located considering cultural resources under OPSB or comparable program rules and, therefore, any impacts would be SMALL.

7.3.3.4 Combinations of Wind and Solar with CAES

As discussed in Sections 7.2.1 and 7.2.1.3, FENOC evaluated a combination of wind and solar generation along with CAES as an alternative to replace the rated electrical output of Davis-Besse.

The environmental impact results for interconnected wind farms and PV solar and CAES facilities are discussed in detail in Sections 7.3.3.1 through 7.3.3.3. A summary of these results is described below and listed in Table 8.0-1.

Land Use

The amount of territory required for the construction and operation of a series of wind farms and solar PV facilities would result in LARGE land use impacts. Most of this land would be in greenfield or agricultural areas. Although some land used to develop wind farms could be used to generate solar power, there could be several issues including agriculture needs, transmission capacity and sunlight duration that may limit the multiuse of this land.

Land use associated with the NES facility would be limited to the facility's 92 surface acres. There would be some land impacted during construction, but this site has been previously disturbed so the impact should be SMALL. However, if another site is chosen for the CAES or an additional CAES facility is needed to meet base-load power requirements, then the land use impact could be MODERATE to LARGE.

Water Use and Quality – Surface Water

Wind farms and solar generation using PV technology do not require cooling water or intake structures. Therefore, there would be no impact on water use and the only potential impact on local water quality would be erosion or sedimentation issues during construction. These impacts would be minimized by using best management practices during construction activities.

Significant amounts of water could be used to keep the solar panels clean so they remain effective in collecting the maximum amount of sunlight as possible. Since the areas where these solar facilities would be located are not in a desert or semi-arid environment, the demands on water resources should be reduced. Overall, the impacts on water use and quality should be SMALL to MODERATE.

CAES have cooling towers associated with the use of gas turbines to produce electricity and compressors to recharge the storage structure. These cooling towers are much smaller than those typically used for coal and gas generation plants. Cooling makeup water evaporative losses and discharge flows for the plant would be considerably less than that of Davis-Besse, primarily because less power would be derived from a steam cycle. (**FENOC 2007**, Section 7.2.2.1)

During CAES operation, cooling water and wastewater discharges would be regulated under the federal CWA and corresponding state programs by an NPDES permit. Construction activities would be similarly regulated to ensure protection of water resources. In addition, impacts on water use and quality would be subject to scrutiny in the planning stage under OPSB or similar governing authority rules.

Overall, FENOC considers that the impacts from construction and operation of this combined energy alternative on surface water use and quality to be SMALL to MODERATE.

Water Use and Quality – Ground Water

Impacts would depend on whether the combined energy alternative facilities would use ground water for any purposes, as well as the characteristics of local aquifers. Regardless of location, FENOC assumed that the NES plant or a CAES plant at an alternate site would not rely on ground water for plant cooling, and that regulations for ground water use for potable water would limit impacts to SMALL. FENOC also assumed that construction of the facilities would employ best management practices to keep the impact to groundwater quality SMALL.

Air Quality

The construction of roads and turbine tower supports would result in short-term impacts in air quality from fugitive dust and equipment emissions. There are no air quality impacts associated with the operation of wind farms and solar PV facilities, therefore the overall impacts would be SMALL.

CAES facilities use natural gas, which is a relatively clean-burning fuel with nitrogen oxides being the primary focus of combustion emission controls. The NES facility has been issued an air permit by the Ohio EPA, and emission details are discussed in Section 7.3.3.2 and Table 7.3-3. FENOC assumed that best management practices would be utilized during construction activities to minimize impacts to air quality. In addition, FENOC assumed that the NES or alternate CAES facility would comply with its air permit, thus impacts to air quality should be MODERATE.

Ecological Resources

As noted in the Land Use subsection above, development of wind farms and solar PV facilities and CAES would have a MODERATE to LARGE impact on land resources which could have a MODERATE to LARGE impact on the ecological resources during construction and operation of these facilities. FENOC assumed that construction best management practices and awareness to critical habitat during operations would minimize impacts to ecological resources.

Human Health

The only major health risk for the construction and operation of a series of wind farms and solar PV facilities, and a CAES plant would be accidents. There may be minor health impacts from reduced air quality during construction and the operation of the CAES facility and from handling potential hazardous substances or waste materials. FENOC assumed that all air permits and Occupational Health and Safety Act requirements would be complied with during construction and operation of these facilities, and the impacts should be SMALL.

Socioeconomics

Major sources of potential socioeconomic impacts from wind farms and solar PV systems with an associated NES or CAES facility include temporary increases in jobs, economic activity, and demand for housing and public services in communities surrounding the sites during the construction period. Socioeconomic impacts are similar to those discussed in Sections 7.3.3.1 to 7.3.3.3 and would be SMALL to MODERATE.

Waste Management

PV technology creates environmental impacts related to manufacture and disposal. 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. The cumulative and long range impacts from transporting and disposing of hazardous waste could be a MODERATE to LARGE impact. Minimal waste streams should be generated from the construction and operations of the wind power and CAES facilities. Therefore, the impacts should be SMALL.

Aesthetics

Most wind farms are located in remote areas and may generate large aesthetic concerns, particularly if sited on highlands or in recreational areas. Solar PV generation requires relatively flat land, which limits the view to the public. However, presence of overhead transmission lines may cause some moderate public resistance. To minimize these impacts, the renewable generation facilities would likely be located in rural areas as much as possible. The proposed NES facility is located in a brownfield area and should not change the aesthetic view of the area. Overall, the aesthetic impacts from these facilities should be SMALL.

Cultural Resources

Due to the large amount of land needed to construct the necessary wind farms and solar PV facilities, and for the CAES facility, the potential for impacting cultural resources could be LARGE. To minimize these impacts, FENOC assumed construction activities would consider cultural resources under OPSB or comparable program rules. FENOC further assumed that appropriate measures would be taken to avoid, recover, or provide other mitigation for loss of any resources discovered during onsite or offsite construction. On this basis, FENOC concludes that the potential adverse impact on cultural resources of this combined energy alternative regardless of location would be SMALL.

7.3.3.5 Conclusions of Combining New Generation Power Sources with Storage

The use of wind power in the form of interconnected wind farms and/or solar photovoltaic power, in combination with CAES to provide power to replace Davis-Besse's output by 2017 has been evaluated and discussed in the subsections above. The environmental impacts associated with renewable sources and CAES were evaluated in Subsections 7.3.3.1, 7.3.3.2, 7.3.3.3 and 7.3.3.4. The overall conclusion from this impact analysis is that the combination of these energy source alternatives has SMALL to LARGE impacts. These impacts are compared in Section 8.0 to the impacts from renewal of the Davis-Besse license for another 20 years as well as those for the alternative coal and natural gas fired plants.

Table 7.3-1: Air Emissions from Coal-Fired Alternative

Parameter[1]	Calculation	Result
Annual Coal Consumption	Total Gross Capability $\times \frac{\text{Heat Rate}}{\text{Heat Value}} \times$ Conversion Factors $\times$ Capacity Factor	tons/year
	$\frac{910\text{ MW} \times 9{,}800\text{ Btu}}{\text{kW x hr } 12{,}285\text{ Btu}} \times \frac{\text{lb}}{\text{MW}} \times \frac{1{,}000\text{ kW}}{\text{year}} \times \frac{8{,}760\text{ hr}}{\text{year}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times 0.80$	2,543,644
Emissions	Coal Consumption x Uncontrolled Emissions x Conversion Factors x [100 – removal efficiency (%)][2]	tons/year
SO_x	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{130\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-95}{100}$	8,267
NO_X	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{10\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-60}{100}$	5,087
CO	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{0.5\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}}$	636
PM	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{120\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-99.9}{100}$	152.6
PM_{10}	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{27\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-99.9}{100}$	34.34
CO_2	$\frac{2{,}543{,}644\text{ tons}}{\text{year}} \times \frac{6{,}000\text{ lb}}{\text{ton}} \times \frac{\text{ton}}{2{,}000\text{ lb}}$	7,630,933

Btu = British thermal units
CO = carbon monoxide
CO_2 = carbon dioxide
hr = hour
kW = kilowatt
lb = pound
MW = megawatt
NO_X = nitrogen oxides
PM = total filterable particulate matter
PM_{10} = PM having a diameter less than 10 microns
SO_X = sulfur oxides

Notes:
(1) Source: Table 7.2-1
(2) There are no emission controls for CO and CO_2.

Table 7.3-2: Air Emissions from Gas-Fired Alternative

Parameter[1]	Calculation	Result
Annual Gas Heat Input	Gross Capability x Heat Rate x Conversion Factors x Capacity Factor	MMBtu/year
	$910\text{ MW} \times \frac{6{,}500\text{ Btu}}{\text{kW}-\text{hr}} \times \frac{1{,}000\text{ kW}}{\text{MW}} \times \frac{8{,}760\text{ hr}}{\text{year}} \times 0.80$	41,452,320
Emissions	Annual Gas Heat Input x Uncontrolled Emissions x Conversion Factors x [100 – removal efficiency (%)] [2]	tons/year
SO_2	$\frac{41{,}452{,}320}{\text{year}} \times \frac{0.00064\text{ lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\text{ lb}}$	13.3
NO_X	$\frac{41{,}452{,}320}{\text{year}} \times \frac{0.099\text{ lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\text{ lb}} \times \frac{100-90}{100}$	205
CO	$\frac{41{,}452{,}320}{\text{year}} \times \frac{0.015\text{ lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\text{ lb}}$	311
PM (all PM_{10})	$\frac{41{,}452{,}320}{\text{year}} \times \frac{0.019\text{ lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\text{ lb}}$	39.4
CO_2	$\frac{41{,}452{,}320}{\text{year}} \times \frac{110\text{ lb}}{\text{MMBtu}} \times \frac{\text{ton}}{2{,}000\text{ lb}}$	2,279,878

Btu = British thermal units
CO = carbon monoxide
CO_2 = carbon dioxide
hr = hour
kW = kilowatt
lb/MMBtu = pounds per million British thermal units
MW = megawatt
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = PM having a diameter less than 10 microns
SO_X = sulfur oxides (mainly SO_2)

Notes:

(1) Source: Table 7.2-2
(2) There are no emission controls for SO_2, CO, PM, and CO_2.

Table 7.3-3 Permitted Air Emissions from the Proposed Norton Energy Storage Project

Parameter	Quantity	Volume
SO_2	42.41	tons/year*
NO_X	93.67	tons/year*
CO	90.36	tons/year*
PM (all PM_{10})	46.65	tons/year*
Volatile Organic Compounds	26.40	tons/year*
CO_2	681,100	tons/year*

CO = carbon monoxide
CO_2 = carbon dioxide
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = PM having a diameter less than 10 microns
SO_2 = sulfur dioxide

* Based on rolling, 12-month permits
Emissions are listed based on Permit information, and are from units P001 – P006, combined (including startups/shutdowns), which equates to 804 MW (134 MW x 6 units).
Equipment Description: Each Combustion Train - 589MMBtu/hr Dresser Rand natural gas fired combustion turbine (134 MW) operating in simple cycle mode with recuperator controlled by catalytic oxidation, water injection, and selective catalytic reduction.
As explained in Section 7.2.1.3, FirstEnergy estimates that only up to four units (i.e., 536 MW) could be online by 2017.

Source: **NES 2010**

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7.4 REFERENCES

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8.0 COMPARISON OF ENVIRONMENTAL IMPACT OF LICENSE RENEWAL WITH THE ALTERNATIVES

Regulatory Requirement: 10 CFR 51.45(b)(3)
"To the extent practicable, the environmental impacts of the proposal and the alternatives should be presented in comparative form." as adopted by 10 CFR 51.53(c)(2)."

FENOC presents its evaluations of the environmental impacts of Davis-Besse license renewal in Chapter 4 and reasonable alternatives in Chapter 7. In this chapter, FENOC provides a comparative summary of these impacts.

Table 8.0-1 summarizes environmental impacts of the proposed action (license renewal) and the alternatives, for comparison purposes. The environmental impacts compared in Table 8.0-2 are those that are either Category 2 issues for the proposed action or are issues that the GEIS (**NRC 1996**) identified as major considerations in an alternatives analysis. For example, although the NRC concluded that air quality impacts from the proposed action would be small (Category 1), the GEIS identified major human health concerns associated with air emissions from alternatives (Section 7.2.2). Therefore, Table 8.0-1 compares air quality impacts from the proposed action to the alternatives. Table 8.0-2 is a more detailed comparison of the alternatives.

As shown in Table 8.0-1 and Table 8.0-2, environmental impacts of the proposed action (Davis-Besse license renewal) are expected to be SMALL for all impact categories evaluated. In contrast, FENOC expects that environmental impacts in some impact categories would be MODERATE or MODERATE to LARGE for the no-action alternative (NRC decision not to renew Davis-Besse operating license), considered with or without development of replacement generation facilities.

As codified in the NRC regulations at 10 C.F.R. § 51.95(c)(4), "the NRC staff, adjudicatory officers, and Commission shall determine whether or not the adverse environmental impacts of license renewal are so great that preserving the option of license renewal for energy planning decision makers would be unreasonable."

Deleted: As a result,

The Commission explained this standard as follows:

> *Given the uncertainties involved and the lack of control that the NRC has in the choice of energy alternatives in the future, the Commission believes that it is reasonable to exercise its NEPA authority to reject license renewal applications only when it has determined that the impacts of*

license renewal sufficiently exceed the impacts of all or almost all of the alternatives that preserving the option of license renewal for future decision makers would be unreasonable.

Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed. Reg. 28,467, 28,473 (June 5, 1996).

FENOC concludes that the environmental impacts of the continued operation of Davis-Besse, providing approximately 910 MWe of base-load power generation through 2037, when compared to alternatives discussed in Section 7.0 of this Environmental Report, demonstrate that preserving license renewal as an option is not unreasonable.

Deleted: are superior to impacts associated with the best case among reasonable alternatives. Davis-Besse continued operation would create significantly less environmental impact than the construction and operation of new base-load generation capacity. Additionally, Davis-Besse continued operation will have a significant positive economic impact on the communities surrounding the station

Table 8.0-1: Impacts Comparison Summary

Impact[2]	Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1]			
			With Coal-Fired Generation	With Gas-Fired Generation	With Interconnected Wind	With Renewable & CAES Generation
Land Use	SMALL	SMALL	MODERATE to LARGE	SMALL to MODERATE	MODERATE to LARGE	LARGE
Water Quality	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE
Air Quality	SMALL	SMALL	MODERATE	MODERATE[3]	SMALL	MODERATE
Ecological Resources	SMALL	SMALL	MODERATE	SMALL to MODERATE	SMALL to LARGE	MODERATE to LARGE
Human Health	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	SMALL	MODERATE	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Waste Management	SMALL	SMALL	MODERATE	SMALL	SMALL	SMALL
Aesthetics	SMALL	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL
Cultural Resources	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL

Notes:

(1) Environmental impacts associated with the construction and operation of new coal-fired or gas-fired generating capacity at a greenfield site would exceed those for a coal-fired or gas-fired plant located at a brownfield, i.e., existing disturbed site.

(2) From 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3:
- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE - Environmental effects are sufficient to alter noticeably, but not destabilize, any important attribute of the resource.
- LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

(3) Moderate, but less than with coal-fired generation.

Table 8.0-2: Impacts Comparison Detail

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[(1), (2)] With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Alternative Descriptions					
Davis-Besse license renewal for 20 years, followed by decommissioning	Decommissioning following expiration of current Davis-Besse license. Adopting by reference, as bounding Davis-Besse decommissioning, GEIS description (**NRC 1996**, Section 7.1).	New construction at greenfield (but preferably brownfield) site.	New construction at greenfield (but preferably brownfield) site.	New construction at greenfield locations.	New construction at greenfield (wind, and solar) CAES at brownfield site.
		Pulverized coal units, 910-MW (equivalent to Davis-Besse); capacity factor 0.80.	Combined-cycle units, 910-MW (equivalent to Davis-Besse); capacity factor 0.80.	Wind generation units, 910-MW (equivalent to Davis-Besse); capacity factor 0.80.	Assume CAES with natural gas units at electrical output of 804 MW (6 trains).
		Closed-cycle cooling with 500-foot-tall natural-draft cooling towers.	Closed-cycle cooling with mechanical-draft cooling towers.	No cooling required.	Closed-cycle cooling with mechanical-draft cooling towers for CAES.
		Coal and limestone delivery via waterway or rail.	Delivery of natural gas via a new 10-mile-long pipeline.	No fuel delivery system required.	Delivery of natural gas via a new 10-mile-long pipeline for CAES.

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
		Air emission controls: Particulates: fabric filter (99.9% removal) Sulfur oxide: wet limestone scrubber (95% removal) Nitrogen oxide: low-NO_X burners, overfire air, selective catalytic reduction (95% removal).	Air emission controls: Nitrogen oxides: dry low-NO_X burners; selective catalytic reduction (90% removal). Particulate matter and carbon monoxide emissions limited through proper combustion controls.	No air emission controls required.	Air emission controls: Nitrogen oxides: dry low-NO_X burners; selective catalytic reduction (90% removal). Particulate matter and carbon monoxide emissions limited through proper combustion controls for CAES.
		Emissions dispersed via 500-foot-tall stacks.	Exhaust dispersed via 150-foot-tall stacks.	No emissions or heat plume exhaust.	Exhaust dispersed via 150-foot-tall (or less) stacks.
825 permanent and 60 contract workers (Section 3.4)		Estimated workforce: Construction: 1,092 – 2,275; Operation: 228	Estimated workforce: Construction: 1,092 – 2,275; Operation: 137	Estimated workforce: Construction: 1,200 – 1,500; Operation: 150.	Estimated workforce: Construction: 1,200 – 1,500; Operation: 150.

Table 8.0-2: Impacts Comparison Detail (continued)					
Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Land Use Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 52, 53).	SMALL – Adopting by reference applicable NRC impact conclusions in the GEIS Section 8.4 and Supplement 1 to NUREG-0586.	MODERATE to LARGE – 1,547 acres required for the powerblock and associated facilities; assumed 10 miles of 345-kV transmission line on a 150-foot right-of-way; 22 acres/MW for mining and disposal (Section 7.3.1).	SMALL to MODERATE – 100 acres for facility and 240 to 270 additional acres for gas pipeline and electric transmission lines (Section 7.3.2).	MODERATE to LARGE – Would be dependent on how many wind farms onshore verses offshore (Section 7.3.3).	LARGE – up to 91,000 acres required for wind and 37,900 acres for solar generation and associated facilities; (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)					
Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives(1), (2)			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Water Quality Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 1-3, 6-11, and 31). Five Category 2 water quality issues do not apply: Section 4.1, Issue 13; Section 4.6, Issue 34, Section 4.5, Issue 33; Section 4.7, Issue 35; and Section 4.8 Issue 39.	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 89) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	SMALL – Construction impacts minimized by regulatory controls; operation-phase impacts similar to those of Davis-Besse; cooling water and wastewater discharges subject to regulatory controls (Section 7.3.1).	SMALL – Construction impacts minimized by regulatory controls; cooling water and wastewater discharges subject to regulatory controls (Section 7.3.2).	SMALL – Construction impacts minimized by regulatory controls (Section 7.3.3).	SMALL to MODERATE - Construction impacts minimized by regulatory controls; cooling water and wastewater discharges subject to regulatory controls (Section7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Air Quality Impacts					
SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 51). One Category 2 issue does not apply: Section 4.11, Issue 50.	SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issue 88) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	MODERATE – 8,267 tons SO_X/year 5,087 tons NO_X/year 636 tons CO/year 153 tons PM/year 34.3 tons PM_{10}/year 7.63×10^6 tons CO_2/year (Section 7.3.1).	MODERATE – 13.3 tons SO_2/year 205 tons NO_X/year 311 tons CO/year 39.4 tons PM/year 2.28×10^6 tons CO_2/year (Section 7.3.2).	SMALL - Construction impacts minimized by regulatory controls (Section 7.3.3).	MODERATE – 42.41 tons SO_2/year 93.67 tons NO_X/year 90.36 tons CO/year 46.65 tons PE/year 26.40 tons VOCs/year 681.1×10^3 tons of CO_2/year (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Ecological Resource Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 14-24, 28-30, 41-43, and 45-48). Three Category 2 issues do not apply: Section 4.2, Issue 25; Section 4.3, Issue 26; and Section 4.4, Issue 27.	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 90) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	MODERATE – Potential loss or alteration of more than 1,500 acres of habitat (e.g., transmission, waste disposal landfill); facilities siting would be subject to regulatory controls limiting impacts to ecological resources, including wetlands and threatened or endangered species. Impact on aquatic habitats and biota from dredging (e.g., for intake and discharge structures and, if applicable, barge terminal), cooling water withdrawal, and discharge would be	SMALL to MODERATE – Approximately 100 acres onsite and 240 to 270 acres offsite of largely agricultural land would be converted to industrial use for plant site and offsite infrastructure, respectively; facilities siting would be subject to regulatory controls limiting impacts to ecological resources, including wetlands and threatened or endangered species. Potential for impacts to aquatic resources from construction and operation (e.g., cooling water withdrawal and	SMALL to MODERATE – Habitat and migratory impacts would be greater for land based wind farms then offshore wind farms (e.g., wind facilities, transmission); facilities siting would be subject to regulatory controls limiting impacts to ecological resources, including wetlands and threatened or endangered species (Section 7.3.3).	MODERATE to LARGE– Potential loss or alteration of more than 90,000 acres of habitat (e.g., wind and solar facilities, transmission); facilities siting would be subject to regulatory controls limiting impacts to ecological resources, including wetlands and threatened or endangered species (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2] With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
		subject to regulatory controls (Section 7.3.1).	discharge) reduced by best management practices and regulatory controls (Section 7.3.2).		
Threatened or Endangered Species Impacts					
SMALL – Federally and state threatened or endangered species are protected through company and plant procedures. (Section 4.10, Issue 49)	SMALL – Not an impact evaluated by the GEIS.	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats.	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats.	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats.	SMALL – Federal and state laws prohibit destroying or adversely affecting protected species and their habitats.

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Human Health Impacts					
SMALL – Adopting by reference Category 1 issues (Table A-1, Issues 54-56, 58, 61, 62). One Category 2 issue does not apply: Section 4.12, Issue 57. Risk due to transmission-line induced currents minimal due to conformance with consensus code (Section 4.13, Issue 59).	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 86) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	SMALL – Some risk of cancer and emphysema from air emissions and risk of accidents to workers, as the NRC notes in the GEIS. Assumed that regulatory controls would reduce risks to acceptable levels (Section 7.3.1).	SMALL – Similar to the coal-fired alternative (Section 7.3.2).	SMALL (Section 7.3.3).	SMALL – Similar to the gas-fired alternative (CAES plant) (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2]			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Socioeconomic Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 64, 67). Two Category 2 issues do not apply: Section 4.16, Issue 66 and Section 4.17.1, Issue 68. Location in high population area with no growth controls minimizes potential for housing impacts (Section 4.14, Issue 63). Capacity of public water supply as well as education and transportation infrastructures minimizes potential for related impacts (Section 4.15, Issue 65; Section 4.16, Issue 66; and Section	SMALL – Adopting by reference Category 1 issue finding (Table A-1, Issue 91) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	MODERATE to Reduction in permanent work force and tax base at Davis-Besse would adversely affect surrounding communities. Construction and operational impacts would depend upon the site location. Regulatory controls and appropriate mitigation would ensure that impacts are not destabilizing (Section 7.3.1).	MODERATE – Reduction in permanent work force and tax base at Davis-Besse would adversely affect surrounding communities. Impacts from construction would be mitigated by siting plant within commuting distance of large metropolitan areas (Section 7.3.2).	MODERATE – Reduction in permanent work force and tax base at Davis-Besse would adversely affect surrounding communities. Impacts from construction would be mitigated by siting renewable facilities within commuting distance of metropolitan areas when possible (Section 7.3.3).	MODERATE – Reduction in permanent work force and tax base at Davis-Besse would adversely affect surrounding communities. Impacts from construction would be mitigated by siting renewable facilities within commuting distance of metropolitan areas when possible (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives[1], [2] With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
4.18, Issue 70). Plant tax payments range from <10% to nearly 20% of local jurisdictions tax revenues (Section 4.17.2, Issue 69).					
Waste Management Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 77-85).	SMALL – Adopting by reference Category 1 issue finding Table A-1, Issue 87) in the GEIS Chapter 7 and Section 8.4, and in Supplement 1 to NUREG-0586.	MODERATE – Annual waste of approximately 300,000 tons ash and 470,000 tons flue gas desulphurization waste, requiring disposal offsite in a 644-acre landfill over an assumed 40-year plant life (Section 7.3.1).	SMALL – Solid waste is minimal (Section 7.3.2).	SMALL – Solid waste is minimal (Section 7.3.3).	SMALL – Solid waste is minimal (Section 7.3.3).

Table 8.0-2: Impacts Comparison Detail (continued)

Proposed Action (License Renewal)	Base (Decommissioning)	No-Action Alternatives(1), (2)			
		With Coal-Fired Generation	With Gas-Fired Generation	Interconnected Wind Generation	With Renewable & CAES Generation
Aesthetic Impacts					
SMALL – Adopting by reference Category 1 issue findings (Table A-1, Issues 73, 74).	SMALL – Adopting by reference conclusions in the GEIS Section 8.4 and Supplement 1 to NUREG-0586.	SMALL to MODERATE – Highly dependent on location. Stacks, cooling tower plumes likely would be visible for several miles. Operation of waste disposal site would have adverse impact potential (Section 7.3.1).	SMALL to MODERATE – Highly dependent on location. Stacks, cooling tower plumes would be visible offsite (Section 7.3.2).	SMALL to MODERATE – Highly dependent on location of wind farms (Section 7.3.3).	SMALL – Aesthetic impacts are minimal (Section 7.3.3).
Cultural Resource Impacts					
SMALL –License renewal does not require additional land disturbance (Section 4.19, Issue 71).	SMALL – Adopting by reference conclusions in the GEIS Section 8.4 and Supplement 1 to NUREG-0586.	SMALL – Siting of plant and offsite infrastructure (e.g., transmission line, natural gas pipeline) would be subject to regulatory review, and mitigation measures would be implemented (Section 7.3.1).	SMALL – Same as the coal-fired alternative (Section 7.3.2).	SMALL – Cultural resource impacts are minimal (Section 7.3.2).	SMALL – Cultural resource impacts are minimal (Section 7.3.2).

Btu = British thermal unit
CO = carbon monoxide
CO_2 = carbon dioxide
ft^3 = cubic foot
GEIS = Generic Environmental Impact Statement (NRC 1996)
kWh = kilowatt hour
lb = pound
MM = million
MW = megawatt
NO_X = nitrogen oxides
PM = particulate matter
PM_{10} = particulates having diameter less than 10 microns

Notes:

(1) Environmental impacts associated with the construction and operation of new coal-fired or gas-fired generating capacity at a greenfield site would exceed those described in the table for a coal-fired or gas-fired plant located at a brownfield, i.e., existing disturbed site.

(2) From 10 CFR Part 51, Subpart A, Appendix B, Table B-1, Footnote 3:

- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- 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 important attributes of the resource.

8.1 REFERENCES

NES 2010. Norton Energy Storage, LLC, Final Air Permit-To-Install and Operate, Ohio EPA, September 2010.

NRC 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants (GEIS), NUREG-1437, Volumes 1 and 2, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, May 1996.

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